Using live tissue laboratories to promote clinical reasoning in doctor of physical therapy students

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Moore WA, Noonan AC. Using live tissue laboratories to promote clinical reasoning in doctor of physical therapy students. Adv Physiol Educ 34: 54–58, 2010; doi:10.1152/advan.00059.2009.—Recently, the use of animal laboratories has decreased in medical and basic science programs due to lack of trained faculty members, student concerns about animal welfare, and the increased availability of inexpensive alternatives such as computer simulations and videos. Animal laboratories, however, have several advantages over alternative forms of instruction, including an increased sense of learner responsibility, long-term psychomotor competency, and improved ability to examine functional relationships. While the use of animal laboratories has been studied in medical programs, it has not been examined in physical therapy or other allied health programs. The purposes of this study were to examine the attitudes of student physical therapists toward clinically relevant animal laboratories and to determine if student physical therapists felt that the laboratory modules prepared them for future course work and clinical internships. Written surveys completed by the study participants indicated that most students enjoyed the labs and believed that they helped prepare them for course examinations. Additionally, the majority of students believed that the laboratory modules helped them prepare for future course work and clinical internships.

physical therapy; live tissue laboratory; physiology laboratory; active learning

LIVE TISSUE ANIMAL LABORATORIES are implemented in basic science, allied health, and medical programs to reinforce and expand on content taught in the classroom. Live tissue animal laboratories use freshly euthanized or anesthetized animals to allow students to practice procedures and experience physiological or anatomic phenomenon not easily observed in preserved tissue or specimens (such as the effects of exogenous drugs on heart rate). The use of animal laboratory modules, in combination with classroom lecture, has been reported to have several advantages over lecture alone or lecture in combination with computer simulations or multimedia. These reported advantages include students feeling a sense of responsibility, immediate feedback from actions (9), increased student confidence (4), the ability to explore functional relationships, an appreciation for observation gained through the uncertainty of not being able to predict what may happen next, an appreciation for the process of scientific inquiry (14), and the chance to observe physiological concepts that can’t be simulated by other means (13).

Despite these advantages, the use of animal laboratories is on the decline in medical schools, basic science programs, and veterinary programs (13). In 1985, a study conducted by the Association of Chairmen of Physiology Departments found that 84% of all physiology departments used animals in educational laboratories for students in a broad array of undergraduate and graduate health science programs (5). A 1992 survey by the Association of American Medical Colleges, however, found that only 73% of responding medical schools reported using animal laboratories as part of their curriculums (8). A followup study conducted by Hanson and Boss (6) reported that by 2001 only 32% of medical schools reported using animal laboratories and that when animal laboratories were conducted, attendance was optimal. The most common reasons cited for the decrease in using animal laboratories are the high cost of live animals and laboratory space, curricular changes, the availability of computer programs and multimedia as alternatives to animal laboratories, lack of appropriately trained faculty members, time compression (2), and student concerns about the use of live animals in education (2, 14).

As the use of educational animal laboratories has been declining, research on active learning has become an area of intense interest in science and medical education (10). Active learning seeks to increase the students’ understanding of content by charging the student to take a more dynamic role in the educational process and to rely less on the teacher (12). Active learning has several advantages over traditional lecture, including increased student engagement in class activities, peer learning (10), the development of critical thinking skills (15), and the enhancement of student interest, motivation, responsiveness, and enjoyment (12). Animal laboratories promote active learning by encouraging students to design and/or carry out experiments where they are asked to observe physiological phenomenon and make decisions about how to progress through the laboratory based on their observations. Additionally, students may be asked to generalize their experimental findings to some aspect of their discipline of study. For example, a pharmacology student may observe the effects of a particular chemical on an animal’s blood pressure and then, based on their observations, be asked to determine the appropriate medication dosage to maintain normal blood pressure.

This study examined the attitudes of student physical therapists toward the use of live tissue animal laboratory modules in the human physiology course taught in the physical therapy curriculum at the University of North Florida. In our review of the literature, we were unable to locate any reports that cited the use of live tissue laboratories in physical therapy or other allied health curriculums. In an e-mail survey conducted in the spring of 2009, we asked the program directors of 202 United States-based graduate physical therapy programs the following question: “Do you include the use of live tissue modules in physiology courses within your curriculum?” Of the 107 respondents, 1 program director refused to answer, whereas 5 program directors reported using live tissue modules in physi-
iology, wound management, and/or neuroscience courses. The remaining program directors reported that they do not use live tissue laboratories within their curriculum. The majority of program directors indicated that students were required to participate in live tissue laboratory modules during their undergraduate education and therefore did not need further instruction in this area. However, we believe that including these experiences in graduate education can assist students in synthesizing concepts and better understanding how basic sciences relate to patient care activities in a clinical setting.

A review of the literature showed that most students have a preferred way of learning and processing information. Frequently, students are classified as “visual learners” (prefer to read textbooks and articles), “auditory learners” (prefer to listen to a lecture), or “psychomotor” or “kinesthetic learners” (prefer to complete hands-on projects and put information to practical use). In a 2004 study by Hauer and colleagues (7), student physical therapists were found to enjoy learning primarily, but not exclusively, through active experimentation (kinesthetic). Further studies, however, have shown that student physical therapists, like most students entering the medical professions, prefer multimodal learning styles, using a combination of the methods described above (3, 7, 11).

The American Physical Therapy Association (APTA) is a professional association for physical therapists. According to the APTA’s Vision Statement, by the year 2020, physical therapists will have doctoral degrees, be autonomous practitioners, provide direct access for patient care, and be consumers’ practitioners of choice for interventions and the prevention of impairments, functional limitations, and disabilities related to movement, function, and health (1). For students to gain the knowledge needed to assume these additional responsibilities, the entry-level degree for practice is moving from a Masters Degree to a Doctorate of Physical Therapy (DPT).

The physical therapy program at the University of North Florida graduated its first DPT class in 2009. The 3-yr post-baccalaureate curriculum includes a combination of didactic classroom and laboratory education as well as field training in which students complete 34 wk of full-time clinical internships away from the university and under the supervision of clinical faculty members. The students move through the curriculum as a cohort, and each student is required to successfully complete all courses before advancing with their classmates. Active learning is encouraged. In addition to lectures, faculty members use paper-based case studies, role playing, small-group discussions, and laboratory activities to enhance learning. To assist students in understanding the relationship between classroom learning and real life in the clinic, students receive early exposure to the clinical setting by participating in a part-time internship during their second semester on campus.

In 2007, we implemented the use of live tissue laboratories in the Human Physiology for Physical Therapists course for several reasons. First, we wanted to enhance lectures by including activities that required active student participation. Second, we wanted to take advantage of the multimodal learning preferences that student physical therapists were found to possess (3, 7, 11). Finally, and most importantly, we wanted to demonstrate to students that a basic science course, such as physiology, has direct implications in clinical practice for physical therapists. We felt that relating patient case studies to live animal experimentation would help us accomplish our goals. While students in our graduating class of 2009 did not have the opportunity to participate in live tissue laboratories, two cohorts of students have since participated in such experiences.

The purposes of this study were as follows: 1) to examine the attitudes of DPT students toward live animal laboratories; 2) to determine if DPT students felt that live animal laboratory modules were beneficial to learning physiological concepts relevant to the practice of physical therapy; and 3) to determine if DPT students felt that the laboratory modules prepared them for future course work and clinical internships.

METHODS

This study was approved by the Institutional Review Board and Institutional Animal Care and Use Committee of the University of North Florida. A total of three cohorts of DPT students participated in the study. The first cohort consisted of 23 students, the second cohort consisted of 29 students, and the third cohort consisted of 25 students. While the first cohort did not participate in laboratory modules, the proposed modules were described, and students were surveyed regarding whether they thought the use of live tissue modules would improve learning in the course. The second and third cohorts participated in two live tissue laboratory modules while enrolled in the Human Physiology for Physical Therapists course. During the last week of the semester, both groups were surveyed about their experiences with the laboratory modules (Table 1). After two additional semesters of course work and a 6-wk clinical internship, students in the second cohort completed an additional survey that contained questions regarding whether the laboratory modules helped prepare them for additional classroom and clinical experiences (Table 2).

Laboratory modules. The second and third cohorts completed two live tissue laboratory modules as part of the human physiology course taken during the spring semester of their first year. Both laboratory modules used freshly euthanized frogs (Rana sphenoecephala, supplied by Carolina Biological Supply) with students grouped so that no more than six or seven students worked with one frog. Electrophysiological data was collected using iWorx software and hardware (HK/256NI Human Physiology Teaching Kit) on Windows-based desktop computers that met or exceeded the minimum specifications required to run the iWorx system.

The first laboratory module was a skeletal muscle physiology module. For this module, frogs were euthanized, and the gastroce-

Table 1. Questions from the first survey, which was asked of students enrolled in the Human Physiology for Physical Therapists course near the end of the semester in which they took that course

| Question 1 | The physiology modules were fun. |
| Question 2 | The physiology laboratory modules helped me to understand physiological concepts introduced during the lecture. |
| Question 3 | The laboratory modules helped me to prepare for the written course examinations. |
| Question 4 | I enjoyed using live animal tissue in the physiology course. |

Students were asked to rate their responses to each of the questions using a 1- to 5-point Likert scale, where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree.
understand the physiological concepts introduced during lectures; strongly agreed that the laboratory modules helped them to better agree. Ninety-four percent of survey participants either agreed or disagreed. Of the 51 students from both cohorts that completed the survey, 88.2% either agreed or strongly agreed that the laboratory modules were enjoyable experiences, whereas 1 student disagreed. The remaining students disagreed. Sixty-nine percent of respondents agreed or strongly agreed that they enjoyed using live animal tissue in the physiology course, whereas 13.7% disagreed or strongly disagreed (see Figs. 2 and 3).

After completion of two additional semesters of classroom work and one full-time clinical internship, students in the second cohort completed an additional survey. This survey contained questions to determine whether students thought that the laboratory modules helped to better prepare them for the classroom and clinical experiences (Table 2). Of the 27 students who completed the survey, 67% either agreed or strongly agreed that participation in the laboratory modules enhanced their understanding of concepts encountered during their first 6-wk clinical internship; 1 student disagreed. Fifty-two percent of students reported that the laboratory modules enhanced their learning in courses taken during the following two semesters of classroom work, whereas two students disagreed (Fig. 4). Courses taken during the following two semesters included Therapeutic Modalities, Pharmacology, Clinical Education Preparation, Orthopedics I (Extremities), Applied Pathophysiology, Neurology I (Examination and Intervention), Neuroscience II (Motor Control and Learning), and Management of the Integument.

### RESULTS

Students were asked to anonymously complete surveys using a five-point Likert scale. During the presurvey instructions, students were instructed not to respond to questions that they did not feel comfortable answering. The first cohort did not participate in the laboratory modules, but after a detailed explanation of the proposed laboratory modules and a description of the objectives of the modules, students were asked to answer the following question: “Participating in laboratory experiences may have enhanced my understanding of physiological concepts.” Sixty-eight percent of the 19 students that responded either agreed or strongly agreed with the statement, whereas only 1 student disagreed. The remaining students indicated a neutral attitude toward live tissue laboratory modules (see Fig. 1).

During the last week of the human physiology course, students in the second and third cohorts completed anonymous surveys pertaining to their experiences with the laboratory modules. Twenty-eight students in the second cohort and 23 students in the third cohort were present and agreed to participate in the survey. Students in both cohorts were asked the same questions (see Table 1). Of the 51 students from both cohorts that completed the survey, 88.2% either agreed or strongly agreed that the laboratory modules were enjoyable experiences, whereas 1 student disagreed. Ninety-four percent of survey participants either agreed or strongly agreed that the laboratory modules helped them to better understand the physiological concepts introduced during lectures; no student disagreed or strongly disagreed with this statement. Students were also asked if the laboratory modules helped them prepare for course exams; 65% agreed or strongly agreed that the modules helped them prepare for course exams, whereas 3 students disagreed. Sixty-nine percent of respondents agreed or strongly agreed that they enjoyed using live animal tissue in the physiology course, whereas 13.7% disagreed or strongly disagreed (see Figs. 2 and 3).

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### DISCUSSION

Results from this study indicate that students found the laboratory modules enjoyable and beneficial in preparing for exams and understanding materials presented in class. In addition, the majority of students thought that the laboratory

![Fig. 1. Responses of the first cohort to the following question: “Participating in laboratory experiences may have enhanced my understanding of physiological concepts.”](http://advan.physiology.org/)
modules enhanced future learning in the clinical and classroom settings that followed.

With the recent transition to the DPT degree and the push toward autonomous practice (practice without a referral from a physician), there is an increased emphasis on physical therapists being able to quickly evaluate patients and accurately decide whether to treat a patient or refer him/her to a physician or other healthcare provider. This requires practitioners to synthesize and interpret data from a variety of sources. Therefore, when we designed these laboratory modules, we felt it was important to frame our prelaboratory discussions and our postlaboratory questions in a manner that challenged students to organize their responses to the observed physiological phenomenon in a clinical context. In the postlaboratory writeup for the heart laboratory, for instance, we asked students to design and modify aerobic exercise programs based on observations of the effects of the different drugs used in the laboratory. Most students correctly decided to limit rigorous activity for subjects taking β-blockers because β-blockers suppress heart rate during exercise. In addition, many students decided to monitor blood pressure and ratings of perceived exertion rather than heart rate to determine exercise tolerance and intensity in patients taking β-blockers.

During the postlaboratory writeup for the skeletal muscle laboratory, we asked students to suggest modifications to functional activities (e.g., removing heavy items from a high shelf) based on observations of decreasing maximal muscle force at muscle lengths beyond the optimal length. Once again, students correctly decided to provide a ladder or step stool so that subjects were not forced to manage items with arms outstretched high overhead. Instead, subjects had their arms positioned within the middle of the range of motion, where muscle strength is optimal. The important concept here is that students rationalized these clinical solutions based on observations of physiological phenomenon in an animal laboratory. This type of situation and the students’ ability to find appropriate solutions appears to support the earlier findings of Hauer et al. (7) that student physical therapists prefer to learn through experimentation.

A majority of the courses offered in our physical therapy program have an active learning component. Clinical courses are taught using a combination of lecture and laboratory, where students are given clinical scenarios to discuss and techniques to practice on each other or simulated patients. In addition, a large portion of curricular time is spent in hospitals, outpatient centers, and rehabilitation facilities, where students practice under the supervision and direction of licensed clinical faculty members. The addition of live tissue modules added an active learning component to the human physiology course that was previously lacking. Since students in physical therapy programs tend to have multimodal learning styles (3, 7, 11), the incorporation of live tissue laboratory modules may benefit a wide range of students within the physical therapy program. It is likely that the positive student reviews of the live tissue laboratory modules were the result of at least two factors: 1) students are familiar with a laboratory setting in their clinical courses where they have the opportunity to observe, measure, and manipulate objects and 2) the addition of the live tissue laboratory modules provided an additional way for students to learn the material, which may be appreciated by students with a variety of learning styles.

Since physiology is a required course, we were sensitive to the possibility that some students might object to the use of live animals. Therefore, in the days leading up to the laboratory modules, the use of animals was discussed in a forum that encouraged students to ask questions and have their concerns
answer. While the students were not formally asked whether they objected to the use of live animals, seven students from the two cohorts either disagreed or strongly disagreed with question 4 of the initial survey, which stated, “I enjoyed using live animal tissue in the physiology course.” Despite these responses, and even though students were given the option to opt out of the laboratory, all students were present on the days that the laboratories were conducted. We believe this openness may have played a role in shaping student impressions on the use of animals in educational laboratories. Furthermore, we are hopeful that through participation in the laboratory modules, students recognize that the clinical practice of physical therapy has roots based in basic bench sciences.

Limitations of the study. Demographic data were collected, but we did not attempt to match the data to the individual surveys because the sample size was small and matching the data to the survey would have jeopardized subject anonymity. We would like to administer the second survey to the third cohort, but due to minor changes to the student population of that cohort, we did not present those data. Subjects were limited to student physical therapists attending a state university within the northeast section of Florida. Also, since all responses were self-reported, students may have been biased and provided the answers that they thought the faculty members were hoping to find. Finally, since all of the students participated in the surveys, we did not have a control group for comparison.

Future directions. The survey results indicated that students found the experiences gained through the laboratory modules to be relevant to future course work and clinical internships. We would like to thoroughly examine any correlations that may exist between the laboratory modules and the settings in which the students complete their clinical internships and their areas of practice after graduation (acute care hospital, subacute rehabilitation center, outpatient clinic, pediatrics, and geriatrics). We also found that students reported that the laboratory modules were beneficial in preparing them for written examinations; we are interested in quantifying the impact laboratory modules have on written examination scores.

Conclusions. The use of animals in educational laboratories has been declining for the past few decades due to high costs, inexperienced faculty members, and student concerns about the welfare of animals. Despite research pointing to the benefits of using animals in health and medical education, animal laboratories are being replaced with computer simulations, multimedia, and lectures. In our curriculum, we focused on designing laboratory modules that students would find relevant to their future practice as physical therapists. In doing so, we found that students enjoyed the laboratories and found that principles learned in the laboratory setting helped them assimilate information that they could later apply in both classroom and clinical settings.

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DISCLOSURES
No conflicts of interest are declared by the author(s).

REFERENCES