UNIVERSITY OF LOUISIANA AT LAFAYETTE

STEP Committee

Technology Fee Application

Digital Cadaver Lab

Title

Greggory R. Davis

Name of Submitter

(Faculty or Staff Only)

UL Lafayette School of Kinesiology

Organization

Title: Digital Cadaver Lab Date: 1/15/2021

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Department/College/Org: Kinesiology/Education/10

ABSTRACT (250 words or less):

The addition of a digital cadaver lab (Anatomage table) will directly affect all Kinesiology, Nursing, and Biology students (close to 3,000 students in total). This equipment will also enhance the likelihood of approval of new proposed allied health programs and degrees, such as a physician assistant program, since cadaver labs (or an Anatomage table) are almost always required to be housed within the university. If these programs are approved, this equipment could also be utilized by that student population, increasing student impact. The Anatomage table would also serve as a highly effective recruitment tool because it is an aesthetically impressive and engaging learning tool that has been shown to improve test scores, student interest, thereby increasing student retention and success. The cadaver lab experience is one of, if not the most useful courses students in health and allied health professions will take during their academic careers. Thus, as the university continues to advance, this investment will become essential. It would also provide significant savings in terms of cost, time, and space compared to a traditional cadaver lab, but it would provide the same benefits to the students and faculty. There is no cost associated with equipment setup, training, or maintenance, all costs are directly associated with purchasing the actual equipment. Software updates, maintenance, and repairs are included with the cost of the equipment. Approximately once every ten years, we will have to update the graphics card on the equipment, and this would be paid from another account.

a. **Purpose of grant and impact to student body as a whole**

The purpose of this grant is to provide a digital human cadaver lab experience primarily to Kinesiology, Nursing, and Biology students. Any other student interested in human anatomy with appropriate prerequisite courses would also benefit from this equipment. While textbooks and online software programs help students gain a basic understanding of anatomy and physiology, the Anatomage Table (https://www.anatomage.com/table/) emulates a three-dimensional life-size cadaver dissection lab used by Medical Schools and universities around the world. This interactive hardware and software has been shown to increase student interest as well as improve test scores and educational outcomes. This has the potential to improve student retention, enhance career opportunities or prospects for entrance into professional programs for students, and enhance the reputation of the university for effective and engaging learning. Based upon current enrollment numbers, this will affect 725 Kinesiology students, 1,458 Nursing students, and 771 Biology students, for a total of 2,954 students.

b. **Projected lifetime of enhancement:**

Anatomage Table is under warranty for as long as we own the equipment. We will receive technical support as long as we own the equipment and there are no maintenance costs. Graphics cards (range from $500 - $1,000) must be replaced approximately every ten years. The equipment itself should last for, at minimum, 25 years.

c. **Person(s) responsible for**

i. **Implementation**

Gregg Davis, Director of the School of Kinesiology and Aimee Gros, the program coordinator for the Athletic Training program, will be responsible for implementation.

ii. **Installation**

Support and technical staff from the Anatomage company will be responsible for the installation of the equipment. The equipment will initially be housed in Bourgeois Hall. When and if the new Nursing building is completed, the Anatomage Table can be moved to that building. The table can be plugged into any standard electrical outlet and runs in the same manner as a computer.

iii. **Maintenance**

Gregg Davis, Director of the School of Kinesiology and Aimee Gros, the program coordinator for the Athletic Training program, will work with support and technical staff to maintain the equipment. Support and technical staff from the Anatomage company will be responsible for the initial maintenance of the equipment.

iv. **Operation**

Professors and instructors will be responsible for learning the primary operating functions of the equipment. Under the supervision of a professor or instructor, students will have an opportunity to interact with the equipment in a virtual/digital cadaver lab setting.

v. Training (with qualifications)

Gregg Davis, Director of the School of Kinesiology and Aimee Gros, the program coordinator for the Athletic Training program, will receive initial remote training on maintenance, troubleshooting, standard, and advanced operation of the equipment from the Anatomage company at no cost. These faculty members will then train individual faculty members responsible for teaching courses involving a cadaver lab component.

d. Narrative

i. Equipment

1. Anatomage Table

a. Purpose

The Anatomage Table is the most technologically advanced anatomy visualization system for anatomy education available on the market today. It provides an interactive digital cadaver lab experience which enhances student interest, learning outcomes, and test scores beyond that which is achievable through textbooks or online software.

b. Justification

The usefulness of a cadaver lab is evident given its presence in many allied health and medical schools around the world. In the absence of a cadaver lab, the Anatomage table provides a highly desirable alternative. While textbooks provide a foundation of knowledge, they are not interactive, and it is often difficult for students to visualize how the physiology and anatomy work together. Online software can provide a more interactive experience for the students, but it is often not possible to provide actual size images on a screen (i.e. rectus femoris) and the types of interactions that are possible are limited by the software creators. For example, if a student wants to view joint and muscle interactions, he/she can likely do that, but if the student also wants to view the blood supply and nerves for those muscles, he/she may or may not be able to do that all on the same screen overlayed, the same can be said to view connective tissue or view superficial to deep. The students may be able to do view some, but not everything he/she needs. The effectiveness of the software is also highly dependent upon the student being able to use it correctly. The most intricate anatomy software program in the world isn't useful if students don't know how to navigate it effectively. Most importantly, online software programs come as a cost to the individual students. They use the software for one semester or one year, then lose access unless they continue to pay. This is highly inefficient considering when students typically take anatomy (sophomore year) compared to when they take licensure or medical school entrance exams (senior year).

The Anatomage table provides four actual size (1:1 ratio) three-dimensional cadavers that can be dissected and studied in real-time at no cost to the students. The Anatomage Table mimics the experiences provided in an actual cadaver lab used in medical schools. Many medical schools have recently transitioned to the use of the Anatomage table in place of a traditional cadaver lab due to costs. While the initial price is relatively high, long term savings compared to a cadaver lab make it well worth the cost [see reference 1].

It is important to note that reference 1 was published in 2014 and costs have likely increased since then. Clearly, even under a one-cadaver program, the costs to run a cadaver lab are at minimum **$8,385 per year.** Over the course of ten years, that cost jumps $83,850. Thus, this equipment will pay for itself within ten years, but it should last, at minimum, 25 years, which would be a cost savings of $125,775 over that time-span.

ii. Software

There is no software cost, it is included with the equipment. Software updates are included for as long as we own the equipment (see quote for details [2]). The equipment is connected to the internet and runs as a Windows program and can receive updates in the same manner as a PC.

iii. Supplies

No supplies are required for the operation of this equipment.

iv. Maintenance

Remote technical support and maintenance is provided by the company at no cost as long as we own the product. Graphics cards must be replaced approximately every ten years.

a. Purpose

The hardware of a graphics card must be able to handle the software in order to run properly.

b. Justification

Much like a computer, software technology advances rapidly and eventually the hardware becomes outdated. The cost of a graphics card runs between $500 - $1,000 depending on need and must be purchased approximately every ten years.

v. Personnel

There are no personnel costs associated with the operation of this equipment.

vi. Other

There are no other costs associated with this equipment.

2. **Budget proposal:**

Budget Proposal

1.	**Equipment**	**$ 81,225**
2.	**Software**	**$ 0**
3.	**Supplies**	**$ 0**
4.	**Maintenance**	**$500 -1,000 for graphics card every 10 years (no initial cost)**
5.	**Personnel**	**$ 0**
6.	**Other**	**$ 0**
TOTAL:		**$81,225**

3. **Additional information:**

   References

1. Simpson, J.S. (2014). An Economical Approach to Teaching Cadaver Anatomy: A 10-Year Retrospective. *The American Biology Teacher 76* (1), 42-26. DOI: 10.1525/abt.2014.76.1.9
2. Quote provided by the Anatomage company outlining costs.

4. **I have no previously funded STEP projects.**

RESEARCH ON LEARNING

An Economical Approach to Teaching Cadaver Anatomy: A 10-Year Retrospective

JEFF S. SIMPSON

Abstract

Because of shrinking budgets and computerized virtual dissection programs, many large and small institutions are closing the door on traditional and expensive cadaver dissection classes. However, many health-care educators would argue there is still a place for cadaver dissection in higher education, so the continuing challenge is to provide the undergraduate, pre-allied health-care student with dissection experience as budgetary constraints lead institutions away from this valuable and time-honored teaching tool. I present a teaching model that looks to address those concerns and is taught in a unique way, with minimal overhead and with the potential to provide an effective and rewarding experience for students entering the medical, nursing, and physical rehabilitation fields.

Key Words: *Cadaver anatomy; dissection; station approach; undergraduate.*

Many academic institutions have adopted an all-or-nothing philosophy with regard to cadaver-based anatomy courses, feeling the need to either teach the full traditional program, which can be very expensive, or eliminate the course altogether. It is evident that the use of cadaver dissection is on the decline (Older, 2004; Hanna & Tang, 2005; Turney, 2007). A 10- to 20-year trend reveals that a large number of undergraduate students are taught by studying prosected specimens, or more recently through the use of computer simulations and virtual dissection. While these ancillaries serve as valuable teaching tools, they simply cannot replace the hands-on experience that dissection affords (Kerby et al., 2011). Currently, most undergraduate students are not offered the dissection opportunity (Lempp, 2005). Students continue to learn anatomical structures (Perry & Kuehn, 2006), but they develop little dissection technique.

Many academic institutions have adopted an all-or-nothing philosophy with regard to cadaver-based anatomy courses.

Here, I assess whether a more cost-effective alternative to the traditional teaching model that still affords each student the opportunity for cadaver dissection might be a viable option for teaching human anatomy. While many educators may not see the benefits of all aspects of this model, it does illustrate the potential to present a different approach to the traditional cadaver program.

○ Materials & Methods

A new course in cadaver anatomy dissection was designed and first implemented in the spring of 2001 to address the need for hands-on dissection experience for students who were predominantly applying to physician assistant, physical therapy, and medical schools. The course focus was fourfold: (1) to foster the development of critical-thinking skills through problem-based learning (PBL) for the upper-division, pre-allied health-care students enrolled in the course (Albanese & Mitchell, 1993; Chang et al., 1995); (2) to cultivate and enhance dissection skills prior to admission to graduate-level coursework; (3) to format the course in such a way that ensured its long-term success with relatively low overhead; and (4) to evaluate the effectiveness of this model for teaching cadaver anatomy, based on student ratings over a 10-year period.

There are few statistics on the average cost of human cadavers in the United States. However, the State of Virginia Anatomical Board put their cost per cadaver at $1500 in 2011–2012 (Virginia Department of Health, 2012). The national average is most likely closer to $2000 per cadaver. Stainless steel humidors for cadaver storage range in price nationally from $4000 to $8000. Six to eight cadavers per class in the traditional setting equates to $12,000–$16,000 in cadaver costs alone, and humidor startup costs could reach $50,000 or more (Table 1). So, a traditionally outfitted cadaver anatomy program can become very costly (Turney et al., 2001). The original questions posed were (1) all other costs being equal, could one cadaver be used instead of the typical six to eight cadavers per semester, and (2) how could 20 to 30 students keep busy with only one cadaver? The original course format was structured in such a way to potentially address those significant concerns.

○ Course Format

This single-cadaver teaching model included a beginning lecture period followed by time spent at laboratory stations that reinforced

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Table 1. General cost comparisons between a one-cadaver program and an eight-cadaver program, including initial outlay costs.

	One-Cadaver Program (1 Cadaver)	Traditional Program (8 Cadavers)
Cadaver cost	$2000	$16,000
Snorkel ventilation – equipment only	$964	$7712
Dissection table	$5421	$43,368
Initial cost – excluding construction	$8385	$67,080

Table 2. One-week sample time-block division for lecture and laboratory.

		Lecture	Lab Stations			
	Time		1	2	3	4
Day 1	10:00–11:15	ABCD	–	–	–	–
	11:15–12:30	–	A	B	C	D
	12:30–1:45	–	B	A	D	C
Day 2	10:00–11:15	ABCD	–	–	–	–
	11:15–12:30	–	C	D	A	B
	12:30–1:45	–	D	C	B	A

comprehension of lecture material. According to Biasutto et al. (2006), a combination of various teaching instruments in conjunction with dissection yielded better results in comprehending anatomy than dissection or use of computer resources alone.

Students met 8 hours a week, which were divided into approximately two 4-hour time blocks. Lecture comprised the first hour and 15 minutes of class. Students downloaded lecture notes covering anatomy from a regional perspective, emphasizing clinical aspects of each region, including orthopedics, neurology, developmental biology, and basic pathology. Hanna and Tang (2005) underscored the importance of including a clinical component to anatomical study. Netter's, Clemente's, and Grant's atlases all provide excellent visual representation of anatomical structures to supplement the lecture, as well as x-rays, magnetic resonance imaging, computerized tomography scans, and angiography.

To overcome the challenge of utilizing one cadaver for the entire course, the 2.5-hour lab period is divided into two separate 1.25-hour time blocks. At the beginning of the semester, students divide into four groups of six to eight for the lab portion of the class and are assigned a letter designation of A, B, C, or D. Student groups rotate through all four separate lab stations (with numerical designations) in one week's time. For example, groups A and B start out on Stations 1 and 2, respectively, for the first half of the lab period, while groups C and D begin at Stations 3 and 4. At the half-way point in lab, groups A and B switch stations, and groups C and D switch stations. On day two, groups A and B begin at Stations 3 and 4 while groups C and D begin at Stations 1 and 2 and switch accordingly (Table 2). This format guarantees an even number of rotations, ensuring that every group rotates through all four stations and covers all lab objectives prior to examinations. Lab objectives are handed out at the beginning of each week, and each group works as a team to achieve the goals set forth in the objectives. This format appears to promote thoughtful discussion and interaction among group members.

Cadaver dissection is performed at Station 1. Winkelmann (2007) found that cadaver dissection presented better outcomes in student learning than human prosected specimens and certainly better than learning anatomy without the cadaver experience (Anyanwu & Ugochukwu, 2010). As the foundation for the course, it is imperative that all students within the group have the opportunity to dissect every week. Initially at this station, a disproportionate amount of time was spent assisting the students. This technique did not work well, primarily because the instructor was unable to devote enough time to the students at the other stations. To address this concern, two students from the previous cadaver class were recruited to serve as teaching assistants for the course. The sole function of the assistants is to aid the students at Station 1 during dissection. The four groups rotate through the cadaver station once per week and the teaching assistants bring the next group up to speed on where and how they should continue to proceed and review previously dissected material as the next group rotates in. For testing purposes, the students at this station learn the structures dissected for that portion of regional anatomy. Test 1 material covers the anterior chest wall and the upper extremity. Test 2 material covers the back and lower extremity. Test 3 material covers the head and neck. Test 4 material covers thorax and abdominal anatomy. Before each test, the teaching assistants review the cadaver structures that students must know for that region.

At Station 2, the students review a radiological film library in combination with the disarticulated bones of the skeleton. Here, students visualize the human skeleton from three-dimensional and two-dimensional planes to promote the development of spatial-relationship skills. Recognizing and comparing structures on the film adds a different visual perspective to the learning process, and students frequently comment that this is one of their favorite stations. An x-ray view box was mounted on the wall for observing the films. The film library started out in 1999 as a small collection of plain films (x-rays) and eventually grew to more than a thousand plain films, computerized tomograms (CTs), magnetic resonance images (MRIs), and angiograms. The x-rays allow visualization of boney structure, whereas the CTs and MRIs allow observation of soft tissue and angiograms allow visualization of the vessels. Hospitals are good sources of x-rays, as are well-established, older clinics. Most health-care facilities maintain records for seven or more years and dispose of them after that time. If facilities agree to release the films, HIPAA regulations require all personal identification to be removed. However, gender and age on the film can most likely be left on the films as a teaching tool. Check with local government agencies to verify. Many students enrolled in the course already work in a hospital or clinical setting and were excellent sources for obtaining films ready for discard or recycle. The objectives each week for this station cover topographic landmarks of the specific bones, as well as approximately one hundred plain films of normal regional anatomy. CTs and MRIs are also supplemented, especially in the head, neck, and torso regions, to illustrate soft-tissue anatomy. Angiograms were also relatively easy to procure, showing normal and anomalous vascular structure. Note that as we move toward digital storage of patient information in health care, film obsolescence may quickly become a reality. So, traditional radiographs may not be available much longer, instead being replaced by compact discs and digital video discs for viewing structures on computer.

The Visible Human Project is the focus of Station 3. As a National Library of Medicine funded project, the original Visible Human highlights the male human body from several different planes and perspectives and reinforces material learned at both the cadaver and Station 2. Here, students observe cross sections of the human body, allowing them to compare soft-tissue structures to MRIs and CT scans of the same area. Initially, we projected the images on a 27-inch standard-definition television, but they were relatively small and hard to see. Images for Station 3 are now projected on a 42-inch high-definition television, mounted to a rolling cart and placed back in the cadaver storage closet when not in use. To protect the high-definition TV from rough handling, a piece of plexiglass covers the screen. Several lab groups use dry erase markers to label structures on the plexiglass and erase the marks when moving to the next station. The lab objective at this station each week consists of approximately 30–40 regional anatomical structures the students must identify for the upcoming examination.

Station 4 allows students the opportunity to foster critical-thinking skills and improve their anatomical knowledge (Staśkiewicz et al., 2007), in a group setting through problem-based learning (PBL) modules that focus on clinical anatomy case studies, specific to human anatomy and pathology. For instance, after discussing rotator cuff anatomy in lecture, students are asked in the laboratory to formulate and defend their answer as to why, based on anatomy, rotator cuff injuries are commonplace. During this station, it is emphasized that there may not be only one correct answer. Instead, the important feature here is the process by which the groups come up with their answers. Are their answers logical, and can they be substantiated? Students at this station discuss and debate information while working toward their conclusions. Interestingly, with the advent of smart phones, iPads, and laptops, students have access to a wealth of online information and frequently utilize this technology, along with ancillary physical-examination textbooks provided in class, to support their conclusions. Problem-based learning in several meta-analyses by Vernon and Blake (1993), Colliver (2000), and Newman (2005) was shown to increase students' positive attitudes and opinions of a course but did not necessarily increase students' factual knowledge.

Ultimately, this overall format affords all 30 or so students the ability to dissect once each week and reinforces their understanding of human anatomy from a varied and contextual perspective while utilizing only one cadaver.

○ Room Logistics

Cadaver dissection provides the foundation for the course. However, other modifications were added over the years to potentially improve the quality of the learning experience. In the beginning, the class was held in a plant physiology laboratory to keep costs down. Of course, a major consideration for cadaver anatomy is proper ventilation to mitigate off-gassing of formaldehyde from the cadaver. Because of the significant amount of organic solvents used to prepare botanical specimens, the room was built with a powerful HVAC system and easily met the health requirements for ventilation. The Colorado State Anatomical Board requires that all cadavers be stored behind two locked doors. A small closet was built in 2001 to specifically house the cadaver in its humidor for less than $5000.

A new laboratory was built in 2009 in the new wing of our science building, allowing for several upgrades over the previous facility. The new laboratory room was built for multiple sections of the lower-division combined anatomy and physiology laboratories, as well as for cadaver anatomy, so it was designed as a multipurpose room from its inception. The upgrades, specific to the needs of a cadaver course, were added in such a way to be unobtrusive during the time that lower-division students occupied the room. They included a ventilated and locked cadaver storage closet, which was added to store more than one cadaver and all of the equipment used during the course. Tabletop ventilation for small-animal dissection was installed for the combined anatomy and physiology labs, and a ceiling-mounted, telescoping snorkel was added to connect to the new humidor for ventilation during cadaver dissection. A ceiling-mounted document camera, placed directly above the dissection area, projects images to a large screen at the front of the class. The cost for the AV/Doc camera was $4790, including labor. This provides all students an unobstructed view of small structures found on the cadaver during dissection from almost any location within the room.

○ Results

Student comments since 2001, before and after addressing the various logistical concerns, are favorable. Student Ratings of Instruction collected at the end of each semester provide insight into students' perception of class effectiveness and help us determine the level of student satisfaction. Statistical data of course evaluations since 2001 ask the students to rate the course in a number of different categories, comparing this course to other courses students have taken at the university (Figure 1). Drop rates for this course are comparable to those of other upper-division college courses at Metropolitan State University of Denver and hover in the 5–10% range. All numerical data are based on a 1.0–6.0 rating scale, with 6.0 being rated the highest.

Figure 2 compares the cadaver course's ratings against means for other courses within the department and the university during the same period, once again rated on a 1–6 scale, with 6 being rated highest. Rows 1 and 2 show average student ratings for the cadaver course. Row 3 and 4 include average faculty ratings within the department, and rows 5 and 6 include average faculty ratings for all courses throughout the university. Figure 3 includes class averages measured in percentage points since 2005. Although this course was not compared with other courses within the department or across the college, this table may provide some insight as to how students perform in the course and whether the majority of students learned the material and met the minimum expectations. Documentation collected prior to 2005 was measured in a different format and was not included in this graph.

○ Discussion

The course model proposed here uses a combination of lecture, PowerPoint presentations, and hands-on demonstrations (i.e.,

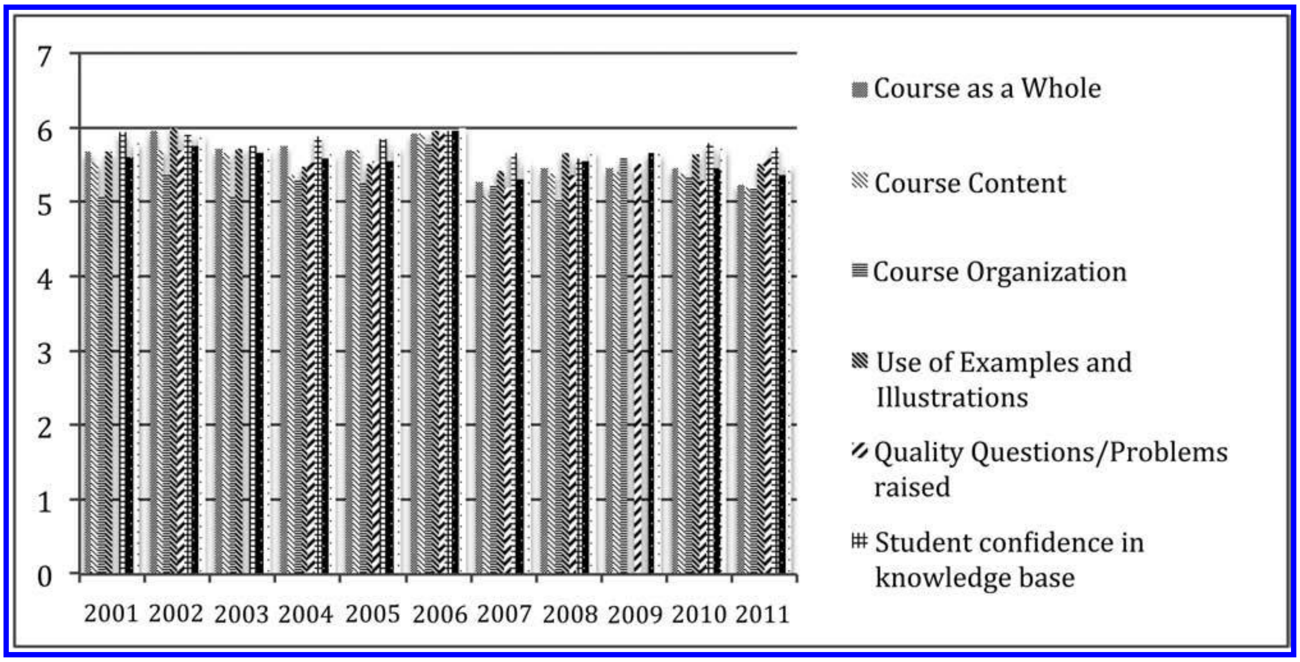

Figure 1. Student ratings of the cadaver course (general student perception, of course). Blank spaces indicate that no data were acquired for the field.

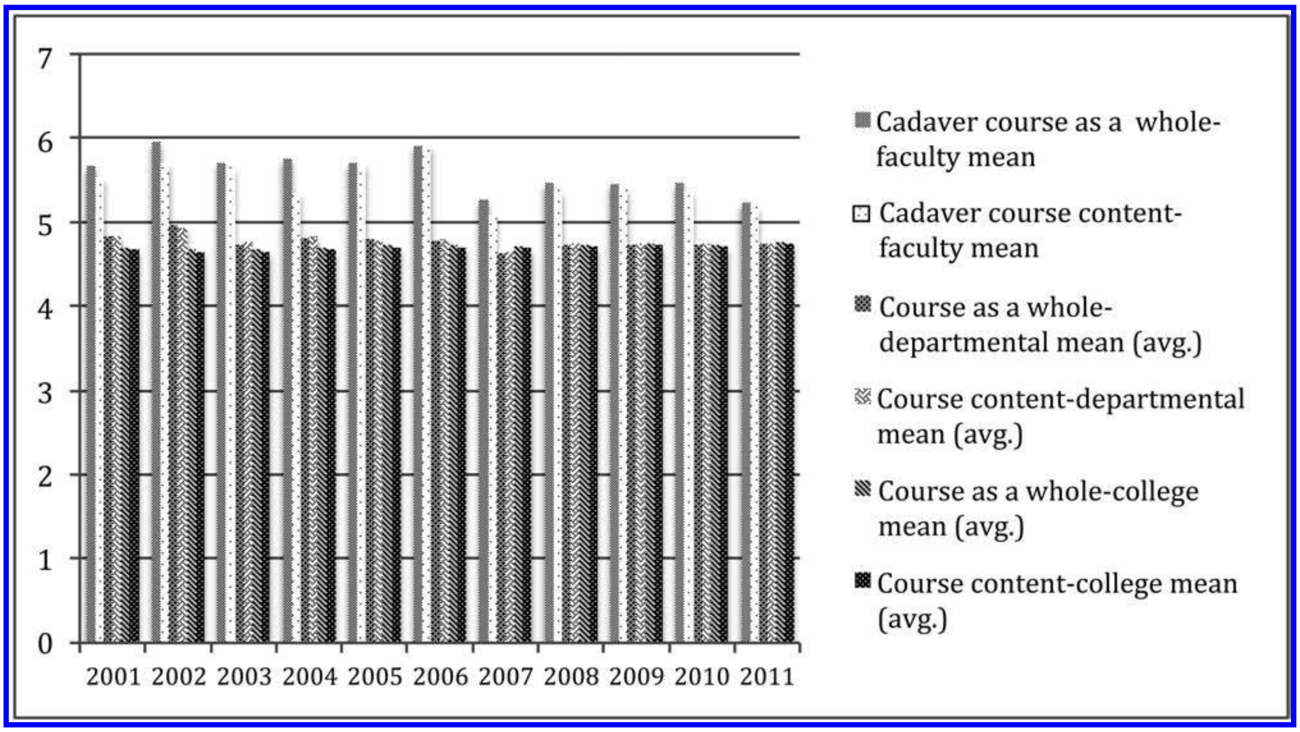

Figure 2. Departmental and university course comparisons against the cadaver course during the same year in two major categories.

demonstrating orthopedic and neurologic testing to illustrate applied anatomy and posing critical-thinking questions), all of which serve to engage the student, and present the material in a more holistic manner and from different perspectives. The four lab stations also reinforce this goal. Through this applied model, both in lab and in lecture, students can gain a better understanding of anatomy and its importance as one of the cornerstones of health-care science.

A principal consideration in any course is the ability to meet specific student learning objectives set forth in the course syllabus. Objectives listed from the beginning for this course included helping the student acquire a broad understanding of applied human anatomy, applying principles of critical thinking to the material, and preparing them for success in graduate anatomy coursework. Medical-school admissions committees look for applicants that possess the ability to logically formulate accurate conclusions from the various facts learned in class. This ability to “transfer” learned information to solve a more complex problem, discussed by Bergman et al. (2011), is often lacking in the undergraduate student skill set. That skill, maybe more than any other,

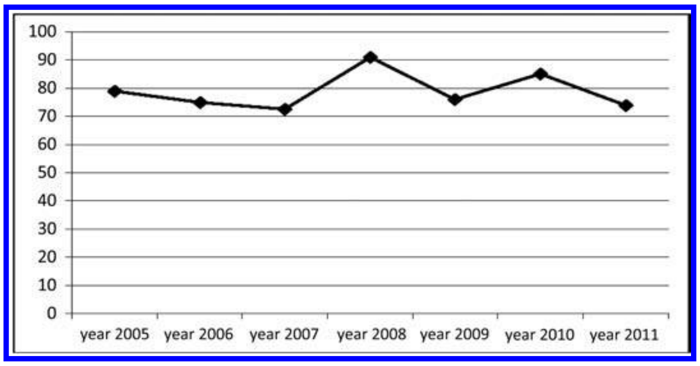

Figure 3. Class averages rated in percentage points since 2005.

helps determine success in graduate health-care programs. Teaching cadaver anatomy in this contextual format applies these pedagogical principles through PBL modules in the case-study section and applies this knowledge from many different angles and applications. As previously stated, the majority of the students who take this course plan on attending physical therapy, physician assistant, medical, and nursing graduate programs. During the more than 10 years that this model has been utilized to teach cadaver anatomy, the course has developed a reputation within the state as one that effectively prepares students for graduate-school success in anatomical studies.

○ Conclusion

The initial question when first developing the course was, logistically, could it work? Was it possible to develop a cadaver course that utilized only one cadaver yet, through the implementation of various teaching modalities, kept all students engaged and interested for the entire semester? Would the laboratory approach reinforce the applied anatomical concepts learned in lecture? The assessment over a 10-year period reveals that this model may serve as a viable alternative to the more expensive, traditional program. Fitzpatrick et al. (2001) found higher positive student attitudes and perception when teaching anatomy in a more contextual format over the traditional dissection format. The course frequently has wait lists of more than 40 students and fills within minutes after opening for registration. Students often comment that this course was the highlight of their undergraduate education. Because of overwhelming demand, class size has been increased from 24 in the beginning to 32 students as of 2012, and the department began offering the course during both spring and fall semesters in 2012. The utilization of virtual simulation programs in medical and graduate health-care education, allowing future physicians to perform virtual surgery, is still in developmental stages (Cahill & Leonard, 1997). This may eventually become commonplace, but many would argue that cadaver dissection must continue to be an essential part of the health-care student's coursework (Azer & Eizenberg, 2007; Sugand et al., 2010). As educational costs rise, institutions and students continue to look for ways to extract the best value for the dollar invested. This proposal meets that need by allowing students the opportunity to dissect the human cadaver through a less expensive, yet effective, alternative teaching model.

○ Acknowledgment

I thank Mark Mazurek for his contribution to this article.

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Anatomage

Price Quotation

Anatomage Inc.
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Prepared By	Jonathan Perry	Created Date	12/29/2020
Email	jperry@anatomage.com	Expiration Date	3/29/2021
		Quote Number	2020-5974

Contact Name: Gregg Davis
Email: gregg.davis@louisiana.edu

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