Introduction

Planning the dissection of a cadaver requires an understanding of anatomy above and beyond simple structural identification. To achieve this level of understanding, one must be able to construct a three-dimensional “mental model” of the body. A mental model is a verbal or diagrammatic representation of a complex problem or system.\(^1,2\) It serves as a structure onto which new information can be assimilated and can be used to solve problems and predict outcomes.

The undergraduate students enrolled in our human cadaver dissection course usually demonstrate proficiency at visually identifying anatomical structures displayed in a pre-dissected cadaver, prosections, or illustrated in a book. However, when presented with written questions that involve an application of that knowledge, students generally perform poorly. The problem may be a difficulty in assimilating identification knowledge into knowledge where the relationship among structures is understood and can be applied to practical situations.

To identify our students’ depth of understanding, we designed a module that employs a three-step approach to studying anatomy: 1) identification of structures, 2) description of relative structural location, and 3) case study analysis. We hypothesized that students would be able to identify structures accurately, but would encounter difficulty when asked to identify the relative locations of structures or to use this knowledge to solve case studies. We also hypothesized that students who performed better on the modules would perform better on examinations.

Methods

Nineteen students enrolled in a one-semester human cadaver dissection course were recruited to participate in this study. Students entering the course had at least one pre-requisite course in human anatomy/physiology or biology. The experimental methods were reviewed and approved by the Institutional Review Board. All participants provided written informed consent prior to participation.

The class was divided into eight dissection groups; each group was assigned to one cadaver. Dissection assignments were divided into nine different learning units (e.g., superficial muscles of the back, brachial, and lumbosacral plexuses, etc.). Each cadaver dissection group was assigned to present the dissection procedure of one of the nine units prior to dissection of that unit by the class as a whole. (The first unit was presented by the instructors at the beginning of the semester.) The group presentation included preparation of the prosection, oral presentation of the dissection procedure, and preparation of a written handout which was distributed to the remaining students in the class.

For each unit, a learning module was developed. Each student (including those responsible for the presentation of that unit) was asked to complete and hand in these modules prior to the oral presentation and dissection of the corresponding unit. Modules were graded and returned at the next class session. Verbal and written feedback were provided. Completion of the modules was included as part of class participation; however scores on the modules were not included as part of the overall course grade. Three unit examinations were administered during the semester, each encompassing three sequential learning units. Questions on the examination were divided into simple structural recall, relative relationships of structures, and clinical case questions.

The modules consisted of three components outlined below. Students completed all three components of each module before returning them to the instructor.

**Step 1. Diagram Labeling**

Students were given diagrams from anatomical atlases. The diagrams were selected by the instructors. A list of structures was provided for students to label on each of the diagrams.

**Step 2. Relationships**

Students were presented with a series of questions that prompted them to look at the physical location of structures in relation to...
one another. Students were encouraged to use the labeled diagrams to answer the questions. An example is as follows:

The trapezius lies ____________ to the supraspinatus and infraspinatus. (superficial)

The supraspinatus lies in the ______________ of the scapula and is separated from the infraspinatus by the ____________. (supraspinous fossa, scapular spine)

Step 3. Case study questions

Students were given a case study. These were identical in format, but not in content, to the case study questions in the examinations. The case study consisted of questions that required students to apply information drawn from the corresponding diagrams and relationship questions. An example is as follows:

You are working in the emergency room at the local county hospital on a Saturday night. A stab wound victim arrives with a large butcher knife lodged perpendicularly in his left posterior thorax. An x-ray confirms that the butcher knife is lodged in the center of the supraspinous fossa of the left scapula. Given this information answer the following questions:

a. From superficial to deep, through which muscle(s) would that knife be passing? (trapezius and supraspinatus)

b. What bony process prevents the knife from sliding inferiorly? (scapular spine)

c. What muscle lies inferior to this bony process? (infraspinatus)

Results

As shown in Figure 1, the percentage of incorrect responses was greatest for the case study questions and least for the diagram labeling.

The mean (±s.d.) number of questions missed per student for diagram labeling was 5.2 (±3.6) %, for relationship questions was 22.5 (±9.8) %, and for case study questions was 26.6 (±12.4) %. Paired samples t-test demonstrated that performance on each of these modular components was significantly different (p ≤ .0001 diagram vs. relationship and diagram vs. case; p ≤ .003 relationship vs. case). As shown in Table 1, significant correlations were demonstrated between the number of incorrect responses in each component of the module. In addition, a significant correlation was demonstrated between performance on the relationship questions and mean exam performance, but not between diagram questions or case study questions and exam performance.

Discussion

The purpose of this study was to identify weaknesses in the level of students’ understanding of human anatomy beyond simple identification. Students correctly responded to structural identification questions more frequently than either relationship or case study questions. Performance within each component of the module correlated with other modular components. In other words, students who performed well on the diagram labeling, also tended to perform well on other areas of the module.

The unit exams administered for grades were weighted more heavily in relationship questions than other types of questions. Therefore, it is not surprising that exam scores correlated with performance on the relationship portion of the module and not with diagram labeling or case study questions. During completion of the modules, students were allowed and, in fact, encouraged to look at their diagrams. However, students were denied access to diagrams during written exams. Therefore, the use of the diagram during the module assignment may have served as a “crutch.” Students may not have formed a mental model sufficient to independently answer an exam question. In fact, several students commented on their inability to formulate such mental pictures during their unit examinations.

The correlation between performance on diagram, relationship, and case study questions could be interpreted that student performance tends to be consistent at all levels. However, it could also be that the diagrams themselves mislead some of the students to answer the relationship and/or case study questions incorrectly. Reviewing the modules post hoc, we identified patterns in student responses indicating that two-dimensional diagrams may in fact have led to incorrect interpretations of structural relationships. This raises the concern that students who spend more time studying from textbooks than from three-dimensional anatomical structures and actual cadaver dissections may perform poorly on a laboratory practical examination.

Conclusion

The use of this three-step modular approach to anatomy can help identify deficiencies in levels of student understanding of anatomy. It can also be used as a teaching tool to assist students and instructors in focusing their studying toward increasing the conceptual understanding of human anatomy. Details and specific questions could also be modified to address the learning objectives of instructors’ specific courses.

References
