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Usefulness of a Cadaver-Based Dissection Course as Perceived by Matriculants in a Professional School

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Abstract

We examined the perceived adequacy and effectiveness of BIO 0475, Advanced Human Dissection, in preparing undergraduate students for the transition into gross anatomy (or equivalent) during their first year of professional school. A 16-item, electronic survey was distributed to course graduates (n=18) that evaluated 1) the importance of BIO 0475 as it related to gross anatomy, 2) student preparedness as provided by their undergraduate training, and 3) perceived level of comfort with adapting to the increased demands of professional school. Students reported the course as beneficial to their professional studies and improving their perceived preparedness for the demands of gross anatomy at the professional level. The development of the Advanced Human Dissection course is reported as a benefit to the students as they matriculate into their professional studies.
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Key words: Cadaver, undergraduate, anatomy, dissection, professional school

Introduction

Anatomy is recognized as a central core of medical and dental education (ADEA 2018; Louw et al. 2009). Although admissions requirements vary, there is currently no global requirement for anatomy as a prerequisite for medical or dental schools in the United States (AACOM 2022; AAMC 2021; ADEA 2018). For undergraduate students, human anatomy and combined human anatomy and physiology courses are historically difficult, as these courses require a significant time investment on the part of the student and extensive mastery of anatomical language in order to be successful (Daempfle 2003; Hopper 2016). Despite this, many undergraduate students interested in professional schools elect to complete these courses as prerequisites, primarily based on advisement of school faculty and medical educators (Finnerty et al. 2010).

Interestingly, completion of anatomy prerequisites does not always translate immediately to success in gross anatomy at the professional level (Robertson et al. 2020). Multiple reports have indicated varying outcomes for students possessing premedical coursework in anatomy (Binstock and Junsanto-Bahri 2014; Forester et al. 2002; Kondrashov et al. 2017; Peterson and Tucker 2005; Robertson et al. 2020). Comparisons of students with prior anatomy exposure noted no statistical difference in cumulative grade-point averages for the first year in medical school or in the students' scores in the medical courses examined. This was also consistent when analyzing performance among students in the upper and the lower quartiles (Canaday 1985). In contrast, Forester and colleagues (2002) found that students with premedical gross anatomy and/or histology coursework show improved academic performance in corresponding medical school courses, with premedical exposure to prosected anatomical specimens significantly improving academic performance in medical gross anatomy.

More recent reports have outlined the number of anatomy prerequisites as having an impact on performance in gross anatomy in medical school. Kondrashov and colleagues (2017) reported that having three premedical anatomy prerequisites, including one with dissection experience, resulted in significantly higher performance in anatomy. Various reports have highlighted the importance of anatomy content knowledge as reported by students and residents, residency directors, and dental professionals (Bakr et al. 2017; Binstock and Junsanto-Bahri 2014; Farey et al. 2014; 2018). Supporting the increased exposure of prior anatomical coursework as a key factor for success in professional school, a study surveying medical students in Australia denoted six factors positively associated with increased confidence as medical students: vertical anatomy integration, frequency of anatomy assessment, integration of anatomy with basic sciences, male gender, anatomy instruction prior to medical school, and exposure to dissection (Farey et al. 2018). Indeed, there have been previous calls to develop recommendations that explicitly outline the core anatomy knowledge needed for medical students at various professional stages of development (Farey et al. 2014).

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Missouri Southern State University is a small liberal arts university with an enrollment of approximately 5,500 students. A range of anatomy courses are offered to students, including Human Anatomy, Anatomy and Physiology I/II, and Comparative Vertebrate Anatomy. These courses served as electives for pre-professional (pre-medical, dental, pharmacy, physician associate, veterinary) and health science (pre-nursing, dental hygiene, radiologic technology) students before matriculating into their respective programs. These courses utilized models, anatomical software, cat dissections, and bovine and sheep specimens to progress through the required anatomical structures. In light of the demands of gross anatomy curricula in professional schools, the university installed a cadaver dissection suite on campus in 2011 and incorporated prosected human specimens into the undergraduate anatomy courses.

To take full advantage of this new cadaveric facility, a novel dissection-based course, BIO 0475 – Advanced Human Dissection, was created for highly-motivated pre-professional students to complete as part of their undergraduate degree. The course was conceived as an advanced exploration of human anatomy designed to prepare students for professional school or specialized graduate study. The course format involves both lectures and laboratory sessions each week, with the lectures providing the conceptual and organizational framework for laboratory experiences that emphasize cadaveric dissection supplemented with anatomical software. Requiring pre-requisite coursework in Human Anatomy, Human Anatomy & Physiology II (the second course of a Human Anatomy & Physiology course sequence), or Comparative Vertebrate Anatomy ensured that students had adequate exposure to critical terminology and fundamental principles. Students qualified for enrollment through a selection process based on academic coursework and performance, professional goals, and a written statement; these were evaluated by the course director with input from faculty involved in related courses.

After some introductory content relating to organization of organ systems, systems versus regional approaches, and laboratory procedures plus basic dissection skills, the course proceeded as a region-based survey of the human body. Lectures comprehensively described the organization of structures in a region that would provide a functional context for student comprehension as well as a spatial framework for the exploration of these same structures in the lab. The cadaveric lab component was student-led and instructor-assisted, with students having the opportunity to apply landmarks and relationships from lecture as they learned through discovery. The small enrollment in the course ensured all students had time to dissect, and multiple anatomical donors provided important variations on normal anatomy. An exam composed of a written portion as well as a practical exam using the structures students had spent time uncovering and exploring closed each regional unit. It is worth noting that the course was designed to replicate many of the aspects of the gross anatomy curriculum students would encounter at a professional school: a regional approach providing landmarks and relationships complemented by cadaveric dissection to provide a 3D framework and an appreciation of anatomy in the real human body.

The course provided a unique opportunity to examine the perceived adequacy and effectiveness of BIO 0475 in preparing students as they transition into gross anatomy (or equivalent) during their first year of professional school. To address this, an electronic survey was distributed to students who had completed BIO 0475, the majority of whom were currently enrolled in a professional or graduate program. The survey requested information about the importance of BIO 0475 as it related to gross anatomy (or its equivalent), their preparedness as provided by their undergraduate training, and the perceived level of comfort with adapting to the increased demands of a professional school. Here, we report a multiple cohort study of student outcomes from an undergraduate, advanced dissection course, and how completion of the course resulted in increased student preparedness and improved adjustment to the demands of professional school.

Methods

Course Logistics

BIO 0475, Advanced Human Dissection, is a four-credit course with two, one-hour lectures and two, two-hour laboratories per week. It runs for 16 weeks with a total of 32 lecture and 64 lab contact hours. Enrollment into the course was selective and limited to no more than 8 students per semester. Requirements for entry included completing an anatomy prerequisite course in Human Anatomy, Human Anatomy & Physiology II, or Comparative Vertebrate Anatomy with a minimum grade of C or better, as well as presenting their reasoning and motivation for participating in BIO 0475. The course was advertised to all Biology majors, as well as Biochemistry and Nursing majors. Applications were reviewed and selected by the anatomy faculty at Missouri Southern and successful applicants were enrolled in the course by the department chair.

Cadaveric donors (n=2) were obtained each semester from the Gift Body Program at Kansas City University, Kansas City, MO. Four students were assigned to each donor for the semester. The course utilized a regional approach divided into the following five units: Unit One - posterior torso, neck, gluteal region, Unit Two – extremities, Unit Three – thorax, Unit Four - abdominopelvic cavity, and Unit Five - head and anterior neck. The same instructor led the lecture and laboratory sessions. The donors were treated as the student's first patients.

IRB Approval and Data Collection

IRB approval was obtained through the MSSU IRB committee (#985985-1). Students who completed BIO 0475 from Spring 2013 through Fall 2014 (n=36) were requested to complete an

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electronic Likert scale questionnaire with items addressing the perceived benefit, recommendations for, and expected grade outcomes from their professional coursework. A single open-ended item was included to provide an opportunity for qualitative feedback. All submissions (including comments) were anonymous. The survey was distributed in 2016 via SurveyMonkey (Momentive, San Mateo, CA), with participants initially consenting to the survey prior to reviewing and answering any survey items. Responses were received by 18 of the 36 students (50%) who had completed BIO 0475.

Data Analyses

Quantitative data were collected and analyzed using Microsoft Excel (Microsoft Inc., Seattle, WA). Likert data were not normally distributed, therefore, medians and standard deviations for each group were calculated. Qualitative comments were analyzed for relative usefulness and preparing the alumni for professional school. Open-ended responses describing the usefulness of the course were coded by the authors. A code is a word or short phrase generated by the researcher to summarize the essence of a qualitative datum; descriptive codes were applied to the data to summarize responses provided by participants (Saldaña 2016). Percent frequencies and Chi-square analysis of the frequencies were calculated. Four categories of codes were applied to the responses: (1) positive accolades; (2) perceived advantage in the future; (3) recommendation to future students; and (4) clinical relevance. Direct quotes included as examples are verbatim from survey responses.

Results

The Advanced Human Dissection course was reported as a benefit to students as they matriculated into their professional studies. Quantitative analysis of student responses to Likert scale questions specific to the perceived benefits of BIO 0475, including improved ability to adjust to the demands of professional studies and feeling more prepared in comparison to their peers, are presented in Table 1. The majority of respondents strongly agreed (n=16) that BIO 0475 had a perceived benefit to their professional studies. Those strongly agreeing with the perceived impact on their subsequent grade in gross anatomy (or equivalent) specific to their professional program dropped slightly (n=14). BIO 0475 course grades and the expected grades for respondents for their gross anatomy course in a professional school are reported in Table 2. Interestingly, a majority of students (n=13) also indicated that their peers expressed a desire to complete a dissection-based course prior to entering a professional school. The clinical component of the course was reported as helpful to future professional studies (n=12), but almost one-third of respondents (n=5) were neutral on the level of significance (Table 1). Respondents did not report any preference for the prerequisite needed to be successful in BIO 0475 (data not shown).

Survey Item	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Median (±SD)
I found the advanced human dissection course to be beneficial to my professional studies	16	0	2	0	0	4.77 (± 0.01)
I felt more adequately prepared than my peers because I had completed a cadaver-based dissection course	16	2	0	0	0	4.77 (± 0.12)
I was better able to adjust to the demands of professional school due to BIO 0475	15	1	2	0	0	4.77 (± 0.05)
My peers expressed a desire to have also completed a dissection course before entrance to professional school.	13	4	1	0	0	4.77 (± 0.10)
I believe BIO 0475 positively impacted my grade performance in gross anatomy (or its equivalent).	14	1	3	0	0	4.77 (± 0.16)
The clinical component of BIO 0475 was extremely helpful in my professional studies.	12	1	5	0	0	4.77 (± 0.38)

Table 1. *Survey addressing perceived benefit and impact of BIO 0475, Advanced Human Dissection (n = 18 respondents).*

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Student responses to Likert scale questions specific to recommendations of BIO 0475, including the usefulness to future students and increasing the structure list and/or number of donors, are reported in Table 3. All respondents (n=18) indicated that they strongly agreed with recommending BIO 0475 to all pre-professional students. The distribution of responses specific to the number of donors and the breadth of the structure list was varied. The majority of students either strongly agreed (n=7) or agreed (n=7) with increasing the number of donors. Fifty percent of the respondents (n=9) were neutral regarding the breadth of the structure list and about one-third (n=5) recommended an increase in length.

Qualitative feedback

Responses (n=13) from the open-ended survey item were coded qualitatively following Saldaña (2016) and reported in Table 4. The two highest categories were those that included positive accolades (53.8%) and those that perceived a future advantage (53.8%) from the course. The first category included responses from students who gave accolades specific to their level of enjoyment for the course:

"I absolutely loved this class! I was so fortunate to have had the opportunity to learn so much, from such a great instructor. I would highly recommend this course to any student pursuing higher medical education."

	BIO 0475 Grade	Final/Expected Gross Anatomy Grade
A	15	14
B	2	2
C	0	0
D or below	0	0
Did not answer	1	2

Table 2. *Grade outcomes in BIO 0475 and final or expected course grades upon completion of a gross anatomy course in a professional school.*

Survey Item	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Median (± SD)
I would recommend the Advanced Human Dissection course to all pre-professional students.	18	0	0	0	0	5.00 (± 0.00)
I would recommend an increase in the number of cadavers for dissection in the course.	7	7	4	0	0	4.00 (± 0.17)
I would recommend an increase in the breadth of structure lists in the BIO 0475 course.	2	5	9	2	0	2.61 (± 0.78)

Table 3. *Survey regarding recommendations specific to BIO 0475, Advanced Human Dissection (n = 18 respondents).*

Category	Percent Response	P-value
Positive accolades	53.8% (7)	0.001
Perceived future advantage	53.8% (7)	
Recommendation to future students	38.5% (5)	
Clinical relevance	23.1% (3)	

Table 4. *Qualitative Categories applied to Responses from the Open-Ended Survey regarding BIO 0475 (n = 13 responses).*

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The second category of responses were specific to the perceived future advantage students felt the course contributed to their professional studies. A specific example highlights the perceived benefit:

"The course was more than helpful. It was an EXCELLENT experience. I cannot imagine entering medical school without this exposure. Many of my peers in medical school were jealous of my experience and I was often able to take the lead on team dissections. I would definitely recommend or even require this course for students wishing to enter medical school."

The third category of responses (38.5%) were specific to students recommending the cadaver dissection course to all pre-professional students. These responses were made independent of Likert question(s) already included in the survey.

"I think it's a great undergraduate course to prepare for a graduate anatomy class. I felt very prepared for lab in my graduate course thanks to this class."

The final category emphasized feedback specific to the clinical component to the course (23.1%). Many noted the application of pathologies found in the donor as it corresponded to course content:

"I greatly appreciate the clinical relevance and applications incorporated into the course. Overall, I couldn't be more thankful for the opportunity to take this course."

Specific suggestions for improvement related to the inclusion of: 1) more clinical content, 2) structures of the hand, and 3) osteology surface features and attachments.

"We needed to learn the various surface names, and what purposes they served (insertions). Having had advanced human dissection, grad school Anatomy was more like a review, and I was able to focus more on the advanced topics, like nerve pathways, origins and insertions, and worried less about gross structures."

Discussion

Results of the current study indicate that completion of a cadaveric dissection course was perceived as beneficial by students who subsequently enrolled in professional programs. Students indicated they could focus on other study habits instead of having to devote time to becoming comfortable with working with cadavers and dissection.

Nwachukwu and colleagues (2015) reported that the quality of dissection completed by students is associated with higher scores on practice as well as final practical examinations, supporting the role of working though the layering of organs in promoting a better understanding of structural relationships and spatial organization. Considering the role that a complete, dedicated dissection has for the performance of the dissector, a similar principal can be applied to the undergraduate student who completes a team-based dissection course.

Thompson and Griffin (2021) reported differences in assessment outcomes among undergraduate and medical students in a gross anatomy course, suggesting that dissection can provide a cognitive load similar to medical school for matriculating students. Collectively, the medical students performed better on higher- and lower-order written assessments, despite similar time spent per question. A larger difference in scores was identified on practical questions, and this was accounted for by the heavy laboratory load in the gross anatomy training of medical students. Students in BIO 0475 get an early preview of this cognitive load, and, while we cannot follow their specific performance in professional school, the general improvement in self-confidence based on the dissection experience provided by BIO 0475 suggests that a positive correlation is likely.

Further, we have begun documenting and emphasizing the clinical anatomy and pathology of the cadavers as part of the BIO 0475 course curriculum. It is imperative that we recognize the value of a human dissection course at the undergraduate level in adequately preparing students for the transition into professional school. As such, we have begun advising all pre-professional students to complete the Advanced Human Dissection course. This has created small, but welcome challenges due to the positive course feedback, as well as the popularity of the experience as shared among students. To accommodate the increased demand, the cadaver laboratory was physically expanded to house eight whole-body donors. This has allowed us to offer the course twice per academic year and, with the added donors, the course enrollment was simultaneously increased to 16 students. Future studies will be able to be implemented due to a higher number of students and increased frequency of the courses

Does the Dissection Experience Increase Self-Efficacy?

The theory of self-efficacy defines perceived self-efficacy as "people's judgments of their capabilities to organize and execute a course of action required to attain designed types of performance." (Bandura 1986). An individual with high self-efficacy perceives themselves to have the skills to be able to succeed at the task at hand; it is self-perception of capability (Morris 2004) and impacts student motivation and a number of academic behaviors (Cavallo 2004). Perceived anatomical self-efficacy includes an individual's judgment of his or her ability to complete tasks such as dissecting, learning anatomical knowledge, and applying anatomical knowledge to clinical situations, and has been shown to be highly predictive of student performance on practical exams (Burgoon et al. 2012).

Interestingly, McNulty and colleagues (2016) reported the benefit of pre-matriculation course work in evaluating success in a veterinary program. Students participating in a week-long pre-course in canine thoracic extremity anatomy resulted in significant improvement on examinations throughout the academic year, with a distinct improvement in scores on the exam that corresponded to the pre-course material.

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Additionally, analysis of qualitative comments from a similar study examining the role of a pre-course experience on veterinary anatomy examinations revealed middle (60-79%) and lower (≤ 59%) tiers of students identified specific benefits related to self-efficacy including, skill acquisition (study and dissection skills), impact of course environment (hands-on experience, familiarity of learning environment, course structure), and exposure to anatomic knowledge (improved anatomy learning, exposure to anatomic language) (McNulty and Lazarus 2018). Collectively, these data provide evidence that recommendation or requirement for anatomy-related coursework before matriculating into professional programs is beneficial to the students' experience due to positive reinforcement of their self-efficacy (McNulty and Lazarus 2018; McNulty et al. 2016).

Similarly, students in the present study who completed the Advanced Human Dissection course would likely score higher on self-efficacy assessments as suggested by their willingness to apply for, enroll in, and complete the dissection course with the purpose of having a perceived better chance of admission into a professional program. Indeed, the dissection capabilities learned in the course reduced the slopes of learning curves once these students were enrolled in professional schools and increased their self-efficacy for future tasks.

Student engagement has been suggested as one of the most important predictors of student success (Reinke 2019). Pizzimenti and Axelson (2015) also characterized the correlation of academic performance with the Motivated Strategies for Learning Questionnaire (MSLQ) and demonstrated that greater use of learning strategies by a given student were associated with a higher level of performance in a gross anatomy course. Indeed, significant differences were identified in self-perceived preparedness by students who had participated in problem-based-learning activities coupled with cadaveric dissection, as compared to individualized learning activities (Thompson et al. 2019).

Although we did not measure the students' learning strategies with the MSLQ, the application barrier to course enrollment served somewhat as an indicator of the level of interest and engagement on behalf of the student. As such, the active learning and engagement involved in completing the course dissections potentially translate to improved anatomical self-efficacy. It would be of special interest to evaluate the self-efficacy of students before and after completion of BIO 0475 to determine the course's impact on students' own feelings of success.

A more recent report evaluating previous exposure to anatomical knowledge compared to academic performance in occupational therapy did not find a correlation (Giles 2021). However, statistically significant correlations were reported, including perceived preparedness and the perceived benefit of an anatomy review course. Indeed, an overwhelming majority of students (92%) indicated they would have benefited from and participated in an anatomy review, suggesting that pre-course experience and/or an anatomy review course may or may not directly impact student outcomes, but can positively impact students' self-efficacy.

The development of the Advanced Human Dissection course is reported as a benefit to students after their matriculation into professional programs. Furthermore, we have begun documenting and emphasizing the clinical anatomy and pathology of the cadavers as part of the BIO 0475 course curriculum. It is imperative that we recognize the value of a human dissection course at the undergraduate level in adequately preparing students for transition into professional schools. At our institution, we currently advise all pre-professional students to complete the Advanced Human Dissection course and will continue to analyze the perceived usefulness of this course in the future.

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About the Authors

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