

Assessing veterinarians' perspectives of anatomy education and the effect of supplemental resources on student learning

by

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B.S., Kansas State University, 2019

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Abstract

Gross anatomy is usually one of the first courses encountered by veterinary students in professional school as it lays a foundation of knowledge that is to be built upon. Veterinarians use anatomy in diagnoses, surgery, physical exams, treatment planning, communication, and more. Undergraduate students must complete various prerequisite courses as minimum preparation for a professional program and curriculum; however, anatomy is typically not a required prerequisite. Consequently, anatomy poses academic challenges due to the prevalence of Latin or Greek anatomical terms, alongside the extensive and detailed course content that covers multiple species and their anatomical variations. Additionally, anatomy education is increasingly focusing on competency-based learning and transitioning to more technologically focused teaching methods. For these reasons, this dissertation seeks to address the question, “How can veterinary anatomy instruction be improved to enhance student retention, reduce cognitive load, and improve clinical relevance?”

To address these challenges, this dissertation explores the development of two supplemental resources and an alumni perception survey to improve veterinary anatomy education. First, pre-laboratory videos were created to provide students a synopsis of lab assignments, allowing deeper engagement and reducing cognitive overload. By using visual and auditory elements, these videos facilitate better understanding of complex anatomical concepts. Second, a novel winter-break pre-course was designed to aid the transition from canine to ungulate anatomy. This resource builds upon prior knowledge, offering preparatory material to ease cognitive strain during the transition between canine and ungulate anatomy. Lastly, in response to the shift towards competency-based curricula in many veterinary schools, the third project gathered alumni perceptions of their veterinary anatomy education. These findings help

ensure that present curricula adequately prepare graduates for real-world veterinary practice. Alumni perceptions may be used to adjust teaching methods or assist with the creation of additional innovative resources to further prepare graduates for clinical application.

In conclusion, this dissertation proposes novel, online resources to improve veterinary anatomy education, including pre-laboratory videos and a winter-break pre-course designed to better equip students for classroom learning. Additionally, by incorporating alumni feedback, this work ensures ongoing enhancement of teaching methods to better prepare veterinary graduates for real-world practice.

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Abstract

Gross anatomy is usually one of the first courses encountered by veterinary students in professional school as it lays a foundation of knowledge that is to be built upon. Veterinarians use anatomy in diagnoses, surgery, physical exams, treatment planning, communication, and more. Undergraduate students must complete various prerequisite courses as minimum preparation for a professional program and curriculum; however, anatomy is typically not a required prerequisite. Consequently, anatomy poses academic challenges due to the prevalence of Latin or Greek anatomical terms, alongside the extensive and detailed course content that covers multiple species and their anatomical variations. Additionally, anatomy education is increasingly focusing on competency-based learning and transitioning to more technologically focused teaching methods. For these reasons, this dissertation seeks to address the question, “How can veterinary anatomy instruction be improved to enhance student retention, reduce cognitive load, and improve clinical relevance?”

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Table of Contents

| | |
|---|------|
| List of Figures | ix |
| List of Tables | xii |
| Acknowledgements | xiii |
| Dedication | xiv |
| Chapter 1 - Introduction and Literature Review | 1 |
| Chapter 2 - Pre-Lab Videos as a Supplemental Teaching Tool in First-Year Veterinary Gross Anatomy | 19 |
| Chapter 3 - The Use of a Novel Winter Break Pre-Course for Transitioning from Canine to Ungulate Anatomy | 56 |
| Chapter 4 - Assessing Veterinarians' Perspectives on the Applicability of Anatomy Education to Clinical Practice | 99 |
| Chapter 5 - Enhancing Educational Practices Across Disciplines | 144 |
| Chapter 6 - Conclusion | 165 |
| Appendix A - Anatomy Education Adequacy and Clinical Practice Readiness Questionnaire . | 169 |

List of Figures

| | |
|--|----|
| Figure 2-1: Screenshot of pre-lab video exhibiting the use of a brief caption to describe the structure of a canine left lung..... | 27 |
| Figure 2-2: Screenshot of pre-lab video demonstrating the use of a short annotation to help students visualize how a specific word or structure may be spelled..... | 27 |
| Figure 2-3: An example of a typical quiz question asked in relation to the information discussed in the pre-lab video. | 28 |
| Figure 2-4: Pre-lab video duration and pre-lab video number depicting the length of the 34 pre-lab videos created during the Fall 2022 semester. Gaps in the graph show radiology or review labs in which videos were not created. Video 17 was split into 17A and 17B. | 31 |
| Figure 2-5: Total pre-lab video view time for each practical exam compared to average pre-lab video view time for all 120 students in the Class of 2026. | 31 |
| Figure 2-6: Class of 2026 gender differences in total pre-lab video view time during the Fall 2022 semester, which are not statistically significant. | 34 |
| Figure 2-7: Class of 2026 gender differences in average practical exam scores during the Fall 2022 semester, which are not statistically significant. | 34 |
| Figure 2-8: Correlations between number of pre-lab videos viewed per each practical exam and practical exam grade. Positive correlations were found for all exams, however, exam 4 had the highest correlation between videos viewed and exam 4 grade. | 37 |
| Figure 2-9: Correlations between number of pre-lab videos viewed for practical exam 4 and practical exam 4 grade for lower quartile students, which predicted practical exam 4 score by 21%. | 40 |
| Figure 2-10: Correlations between quiz score and exam score for each exam. Pre-lab quiz score was positively correlated to practical exam scores. | 41 |
| Figure 3-1: Screenshot of 2 consecutive slides in the provided “Equine Terminology” PowerPoint, displaying the format of the PowerPoint files in module 1. | 68 |
| Figure 3-2: Screenshot of 2 consecutive slides in the provided “Bovine Landmarks” PowerPoint in module 2, displaying the format of the PowerPoint files in modules 2 to 4. | 68 |

Figure 3-3: Survey analysis results for Likert scale questions. The graph illustrates mean participant responses on course availability, convenience, material adequacy, and preparation effectiveness, providing key insights into student perspectives. 77

Figure 4-1: Displaying focus area results from the pilot study of class of 2023 graduates. 115

Figure 4-2: Displaying focus area results from the broader population including graduates from the classes of 2018 to 2022. 116

Figure 4-3: Displaying specialization results from the broader population including graduates from the classes of 2018 to 2022. 116

Figure 4-4: Likert Scale responses to the question, “To what extent do you feel that KSU CVM anatomy courses prepared you for the specie(s) you most commonly see in practice?” No statistically significant difference was found between groups (graduating classes)..... 118

Figure 4-5: Box plot comparing the distribution of Likert Scale responses to the question, “To what extent do you feel that KSU CVM anatomy courses prepared you for the specie(s) you most commonly see in practice?” between small animal and exotics clinicians. 118

Figure 4-6: Likert Scale responses to the question, “To what extent do you feel that the knowledge gained from KSU CVM anatomy courses has been directly applicable to your daily veterinary practice?” 120

Figure 4-7: Box plot comparing the distribution of Likert Scale responses to the question, “To what extent do you feel that the knowledge gained from KSU CVM anatomy courses has been directly applicable to your daily veterinary practice?” 120

Figure 4-8: Likert Scale responses to the question, “How often do you apply anatomy knowledge in making clinical decisions?” No statistically significant difference was found between groups (graduating classes or focus area). 121

Figure 4-9: Likert Scale responses to the question, “How confident do you feel in your anatomical knowledge when communicating with clients and colleagues?” No statistically significant difference was found between groups (graduating classes or focus area). 122

Figure 4-10: Box plot comparing the distribution of Likert Scale responses to the question, “How confident do you feel in your anatomical knowledge when communicating with clients and colleagues?” between specialized and non-specialized clinicians. 123

Figure 4-11: Likert Scale responses to the question, “To what extent do you believe your KSU CVM anatomy education has contributed to your success in your veterinary career?” No statistically significant difference was found between groups..... 124

Figure 4-12: Likert Scale responses to the question, “How often do you find yourself recalling the anatomical name of muscles, blood vessels, nerves, etc.?” No statistically significant difference was found between groups (graduating classes or focus area). 125

Figure 4-13: Likert Scale responses to the question, “How well do you think your KSU CVM anatomy education prepared you for clinical practice?” No statistically significant difference was found between groups (graduating classes or focus area). 126

Figure 4-14: Likert Scale responses to the question, “How well do you feel KSU CVM anatomy courses covered topics relevant for clinical practice?” No statistically significant difference was found between groups (graduating classes or focus area). 127

Figure 4-15: Likert Scale responses to the question, “How well do you feel KSU CVM anatomy courses prepared you to conduct effective physical exams in practice?” No statistically significant difference was found between groups (graduating classes or focus area). 128

Figure 4-16: Likert Scale responses to the question, “How well do you feel KSU CVM anatomy courses prepared you to perform effective surgeries in practice?” No statistically significant difference was found between groups (graduating classes or focus area). 129

List of Tables

| | |
|---|-----|
| Table 2-1: An organized summary of variables correlated with R, P-Value, and T-Scores. A P-Value <0.05 is statistically significant. | 38 |
| Table 2-2: Outlining the number of mentions by Class of 2026 students to the statement, “This course in the future should definitely continue doing this.” | 44 |
| Table 2-3: Displaying the identified sub-themes and number of mentions by Class of 2026 students to the statement, “This course in the future should definitely continue doing this.” | 44 |
| Table 2-4: Comparison of LIWC analyses of overall Class of 2026 student responses and responses specifically mentioning pre-lab videos to the statement, “This course in the future should definitely continue doing this.” | 46 |
| Table 3-1: This table shows the number of responses for each category (strongly disagree to strongly agree) for each question, as well as the mean response and standard deviation (SD). | 78 |
| Table 3-2: Displaying the identified broad themes from the thematic analysis of student comments to the statement, “Please provide any additional comments or suggestions you may have to help improve the pre-course for future students.” | 84 |
| Table 3-3: This table shows the Linguistic Inquiry and Word Count (LIWC) Analysis summary. | 86 |
| Table 3-4: This table offers a condensed summary of the narrative, providing clear links between the themes, findings, and the evidence from both the quantitative (Likert-scale and LIWC analysis) and qualitative data (student comments). | 87 |
| Table 4-1: Outlining the main themes identified using Clarke and Braun’s Six Step Data Analysis Process for the pilot study open-ended question, “In your opinion, how can KSU CVM anatomy courses improve?” | 115 |
| Table 4-2: LIWC analysis results of alumni responses to the open-ended question, “In your opinion, how can KSU CVM anatomy courses improve?” | 133 |

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“Step by step, day by day

Lead me on, Lord I pray”

Dedication

I dedicate this work to my family, friends, mentors, and students whose endless support has been constant throughout my academic journey.

Chapter 1 - Introduction and Literature Review

Introduction

Anatomy, defined as the study of the structure and organization of animals (1,2), is a foundational discipline in veterinary medicine, but is often challenging for students. Historically, dissection has been the mainstay of anatomy teaching, but recent curricular shifts have reduced time for anatomy education, requiring rethinking of how veterinary anatomy is taught. Over the last several decades, innovative tools and new theoretical frameworks have emerged that may be useful in framing how anatomy is taught. This dissertation aims to build on these by exploring the use of novel supplemental resources and an alumni survey to improve veterinary anatomy education.

Anatomy can be divided into microscopic and macroscopic anatomy. Gross anatomy, or macroscopic anatomy, is the study of anatomical structures visible to the naked eye (1). Structures like bones, muscles, various bodily systems, as well as nerves and blood vessels are examined by cadaveric dissection. The etymology of the word “anatomy” comes from Greek roots meaning “cutting apart” or disassociation of parts of the body (2). Dissection is thus used to deconstruct an organism to appreciate its internal structure and understand the functions and relationships of its components (1). Veterinary anatomy specifically focuses on the principal domesticated animals as a comprehensive understanding of animal structure and function is essential for mastering both pre-clinical and clinical disciplines of veterinary medicine (2,3). Dissection is crucial for comprehending the anatomy of an animal (4). The study of anatomy, and dissection, is typically done in either a systemic or regional approach. In a systemic approach, focus is on the anatomy of the various body systems (such as circulatory, nervous, skeletal, etc.). In contrast, regional anatomy divides the body into regions (such as forelimb,

thorax, abdomen, etc.), then examines how different systems work together in that region (1).

Regardless of the approach, understanding both the mutual connections and spatial arrangements of gross anatomical structures remains vital for practicing veterinarians (3).

History of Cadaver Use in Medical Anatomy

For centuries, cadavers have played a vital role in medical education, and their usage has been acclaimed as one of the most efficient means of studying the intricacies of the body, both in animals and humans (5). Dissection experience allows hands-on manipulation for better understanding of how the body works and how certain presentations or symptoms can manifest (5,6). In the thirteenth century, the first anatomy laws regulating the use of the bodies of executed persons for anatomical study were established in Italy. Later, these laws were amended to include the use of unclaimed bodies (7,8). In the sixteenth century, cadaveric dissection was performed to compare theoretical anatomical knowledge with the actual structures of the human body, aiming to correct misinformation and expand understanding (5,9). During the eighteenth century, dissections were conducted as part of autopsies to correlate symptoms with post-mortem pathology, enhancing understanding of various diseases and their physiological effects (5). During the twentieth century, anatomical body donation programs, which entail the voluntary decision of a human to donate their body, became increasingly useful (7,10,11). The steady growth of cadavers to teach anatomy marked a significant advancement for the medical field (5,6). Today, dissections continue to serve as a fundamental component of medical training across undergraduate, graduate, professional, and surgical programs (5,6).

History of Cadaver Use in Veterinary Anatomy

The literature on the historical use of cadavers in veterinary education is limited, making it difficult to directly compare veterinary and medical training programs (5). While utilizing animal cadavers presents fewer ethical dilemmas compared to human cadavers, challenges remain including obtaining cadavers, the cost of collecting and storing specimens, and ethical considerations surrounding their use in veterinary medicine (5,12). Veterinary students view anatomy as crucial in preparing them for clinical practice and express enjoyment in practicing clinical techniques on cadaveric specimens (5,12). Additionally, veterinary students have indicated that cadaveric dissection is the most beneficial teaching method for learning anatomy (5,13). As educators search for optimal methods to teach subjects like anatomy, there is a need to explore alternative approaches to supplement cadaver use in veterinary education (5,14). Importantly, innovative educational methods should align with recent curricular transitions where emphasis is increasingly placed on competency-based education and outcomes-based learning.

Transitions in Curricula

In the late 1970s, competency-based medical education (CBME) was introduced, reshaping education to better align with the needs of patients and workplaces (15–17). During the 1980s and 1990s, educational organizations in both the US and UK published documents urging health-profession educators to revise curricula, thus shifting clinical curricula toward outcomes-based education (OBE) (18,19). Veterinary education has followed this pursuit by transitioning from input-based education to OBE, therefore focusing on exit learning outcomes (18). More recently, many member institutions of the Association of American Veterinary Medical Colleges (AAVMC) have transitioned to competency-based veterinary education

(CBVE) with focus on new graduate abilities and competencies (16). A competency is defined as the observable ability of a health professional to perform a task, integrating knowledge, skills, values, and attitudes (16,20). The CBVE Competency Framework includes nine domains: clinical reasoning and decision-making; individual animal care and management; animal population care and management; public health; communication; collaboration; professionalism and professional identity; financial and practice management; and scholarship (16). As a result, veterinary schools are incorporating more clinical and professional skills into first-year teaching, therefore shifting towards practical, hands-on training. This transformation has led to a reduction in the time available for basic science topics, such as anatomy (19). Although, the reduction in dedicated time for basic sciences does not diminish the importance of anatomical knowledge as it applies to multiple of the CBVE domains.

Each competency domain represents a cluster of interrelated skills essential for veterinary graduates (16). Anatomy applies to multiple of these domains including clinical reasoning and decision-making, communication, collaboration, professionalism and professional identity, and scholarship (16). Anatomical knowledge is applied by veterinarians in diverse ways, including during physical examinations, palpation, surgery, diagnostic imaging, treatment planning, communication with clients and colleagues, identifying pathologies, gait analysis, and much more (19). As a result, new graduates are expected to gather and assimilate relevant information about animals, adapt knowledge to varied scenarios and contexts, listen attentively and communicate professionally, engage in self-directed learning, and more (16).

Despite the ongoing importance of anatomy across veterinary practice, changes in curricula and educational approaches have posed challenges for anatomists (19). Due to the reduction in anatomy contact hours as well as transitions to competency-based education and

applied anatomical teaching, anatomists are challenged to remove redundant material and effectively align anatomy curriculum with CBVE outcomes (19). As a result of these curricular transitions in veterinary education, anatomists are exploring novel teaching methods to supplement didactic lecture presentations and cadaveric dissection. These efforts aim to benefit students in their learning, retention, and application of anatomical knowledge. While anatomy education has advanced with the integration of additional resources and technology, challenges persist in effectively blending these ideas with traditional teaching methods and meeting the evolving educational needs of students and the veterinary profession. This dissertation contributes to this endeavor through the development and evaluation of pre-laboratory videos, an ungulate anatomy pre-course, and alumni feedback on anatomy education. These initiatives were aimed at enhancing veterinary anatomy education by improving student performance, reducing cognitive load, and providing clinically relevant applications that align with new graduate competencies.

Advances in Veterinary Anatomy Teaching

Although cadaveric dissection has been the primary anatomy teaching method for centuries, contact hours dedicated to anatomical dissection have decreased over the last several decades (21–23). Because of this, paired with curricular transformations and significant advances in technology, approaches for both teaching and learning anatomy have been revised (21,24). In the 1800s, wax and papier-mâché models were used as additional teaching materials (19). In the 1960s, visual aids used in veterinary anatomy education included chalk and a blackboard, bones, and a projector for showing glass slides (25). Since then, anatomy has been taught via textbooks, illustrations, models, osteological preparations, plastinated specimens, and cadavers (19).

More recently, and through novel uses of technology, veterinary educators have greatly altered instructional techniques with the creation of supplemental resources and educational alternatives (19,25). Traditional methods, such as cadaveric dissection, are now being supplemented with multimedia, problem-based learning (PBL), case-based learning (CBL), three-dimensional (3D) printed models, radiological reconstruction, imagery, augmented reality (AR), virtual reality (VR), drawing, flipped classrooms, and much more (19,21,26,27). PBL and CBL are both student-centered instructional strategies that involve real-world problems to facilitate learning. PBL focuses on open-ended problems with an emphasis on self-directed learning where learners define and discuss the issue, explore related topics, and actively work through solutions. CBL uses specific clinical cases to apply theoretical knowledge in a clinical context under facilitator guidance (28), making this approach useful in basic science courses.

This shift towards clinical application has driven the integration of modern technology into anatomy education, transitioning away from traditional gross anatomy learning and toward a clinically oriented approach. This change aims to include clinical application and relevancy into anatomy learning, therefore providing students with a practical understanding of how anatomical knowledge is applied in veterinary medicine (21,29). As anatomy teaching evolves to include these clinical applications, there has been ongoing development of educational alternatives and supplemental resources to enhance anatomy education and adapt to contemporary changes.

Educational Alternatives

Although cadaveric dissection is the foundation of anatomy education (30), teaching is evolving to include modern technologies. The AAVMC created a handbook outlining best practices for contemporary teaching and promoting educational alternatives for anatomy

instruction (19). Some evidence-based supplemental resources and educational methods included in the handbook and commonly used as a complement in veterinary anatomy courses include: plastination (23,31,32), plastic and 3D models (5,23,33), art-based learning (34), gamification (35), and computer-based learning (CBL) (5,23,36). This non-exhaustive list illustrates how anatomy education is evolving beyond traditional methods, adapting to educational and technological advancements, and embracing diverse teaching tools. Each of these resources has impacted student learning outcomes and improved veterinary anatomy, therefore providing insights into the future of anatomy education. This encourages the exploration and development of innovative teaching methods that enhance student learning. Educators have many options of teaching tools to consider, prompting them to assess which educational methods can best improve learning outcomes for students (19).

This dissertation explores additional evidence-based supplemental resources and innovative teaching approaches to be used alongside cadaveric dissection and advance veterinary anatomy instruction, with focus on online resources and computer-based learning (CBL). Benefits of CBL include accessibility, convenience, personalized learning, and flexibility in allowing students to learn at their own pace (5,36). As students naturally forget some information discussed in class, online lectures and instructional videos provide learners an opportunity to revisit material (23).

Educational Theory

Anatomy education is quickly evolving due to the increased focus on graduate abilities, skills, and competencies, coupled with the expansion of technologies (19). The integration of supplemental resources in veterinary anatomy education highlights the changing pedagogical

landscape and inclusion of innovative teaching methods. However, per the AAVMC handbook, there is a growing need to ensure that new teaching methods, including the use of technology, are backed by evidence proving their effectiveness as educational strategies (19). As the need for further research focused on educational alternatives within veterinary anatomy persists (19), and educators strive to enhance instruction with novel resources, it's essential to explore the educational theories that underpin these innovative approaches. This dissertation explores educational resources that promote active engagement with course material (constructivist approaches), minimize cognitive strain, utilize multimedia technologies to reduce mental integration, and combine audiovisual information. The educational theories below offer a foundational framework for developing and assessing novel teaching methods in veterinary anatomy education. Through their application, this dissertation sought to integrate supplemental resources into anatomy curriculum, therefore enhancing student learning outcomes.

Cognitive Load Theory

Anatomy educators must consider cognitive load theory, which suggests that if the cognitive load is too high, it can overwhelm the limited working memory capacity of the learner (19,37). The theory assumes that the human brain can only handle a limited amount of information at once (38). In health professions education, learners develop expertise by building upon their existing knowledge through a simple-to-complex strategy, where basic concepts are gradually introduced and then combined with more complex material. This approach helps build a strong foundation and deepens understanding over time (38,39).

The cognitive load theory emphasizes the importance of designing instructional materials that optimize cognitive processing by minimizing unnecessary mental effort. Multiple research-

based principles have been reviewed to decrease extraneous load for novice learners (40). Following are principles, taken from Sweller and van Merriënboer, that apply to veterinary anatomy education and the research in this document. First is the split-attention principle which states that learning is hindered when students must divide their attention between multiple sources of information. To enhance learning, information should be integrated so that all necessary elements are presented together, reducing the cognitive effort needed to combine them mentally. Additionally, the modality principle suggests that learning is more effective when information is presented using both visual and auditory channels rather than a single modality. For example, combining spoken explanations with visual aids can reduce cognitive load and enhance understanding and retention (38).

The research in this dissertation aligns with cognitive load theory. By creating resources like pre-laboratory videos, information is consolidated through the integration of visual and auditory elements, such as dissection book instructions, clinical relevance, key terms, and dissection techniques, into a cohesive and engaging format. Additionally, the ungulate anatomy pre-course adheres to the split-attention principle, reducing cognitive load by providing a cohesive resource for use before class begins.

Constructivist Theory

Educational constructivism is a teaching and learning theory that views knowledge and learning as a result of “mental construction” by learners through integration of new information with existing knowledge (39,41–43). It postulates that knowledge is made rather than found and emphasizes that learning is an active, purposeful process (39). In veterinary anatomy education, constructivism highlights the importance of student-centered learning, where instructors are

facilitators through their creation of meaningful experiences, focus on learner understanding, and provision of resources (39). Constructivist principles support the use of supplemental resources like interactive models and technology to facilitate active learning and critical thinking. The goals of constructivist instruction are to foster understanding, critical thinking, cognitive flexibility, practical application, and problem-solving skills (39). Based on the underlying principles of constructivism, that students mentally construct knowledge through active engagement in their learning, there is encouragement for using creative educational methods, such as supplemental resources (42). These resources enhance students' understanding of veterinary anatomy while encouraging critical thinking and problem-solving.

The educational methods in this dissertation, such as pre-laboratory videos and an ungulate anatomy pre-course, are aligned with constructivist theory by focusing on student-centered learning and prioritizing the acquisition of learner knowledge. Because constructivist principles support supplemental resources, these methods encourage students to actively participate in their learning. Additionally, gathering alumni perceptions of their anatomy education aims to ensure graduates are well-prepared for modern veterinary practice, therefore reflecting a student-centered approach.

Dual-Coding Theory

The dual-coding theory highlights the importance of both verbal and visual information in cognition, suggesting that presenting information through both channels enhances learning outcomes (39). This theory postulates the existence of two cognitive subsystems, one for processing of verbal information and the other for nonverbal information processing (39,44). By utilizing both verbal and visual modalities in instruction, educators can enhance understanding,

recognition, recall, and overall learning effectiveness (39). In the context of veterinary anatomy education, this theory emphasizes the effectiveness of utilizing visual aids, such as diagrams, illustrations, and multimedia, alongside verbal explanations to convey complex anatomical concepts. Thus, integrating dual-coding theory into teaching methodologies may assist educators in the planning of learner-centered instruction and the enhancement of veterinary anatomy education. The pre-laboratory videos developed as part of this dissertation capitalize on dual-coding theory by integrating verbal explanations with visual demonstrations of anatomical structures and dissection techniques.

Anatomy Hurdles

Having established the theoretical foundations that inform innovative teaching methodologies in veterinary anatomy education, it's important to address a critical issue: why does anatomy often pose a significant challenge for students? As veterinary anatomy is usually taken in the first year of professional school, academic stressors like heavy workload, competition with peers, unclear instructor expectations, and excessive concern about intelligence compared to other classmates are apparent (45–47). Another significant hurdle encountered by novice veterinary students is unfamiliar subject matter (48). Additionally, the diverse backgrounds of incoming students contribute to varying levels of preparedness, with some individuals feeling inadequately equipped to navigate the academic hurdles of their first year (48,49). First-year veterinary students often lack academic exposure to gross anatomy prior to professional school (50), so educators can help bridge this gap by implementing innovative teaching methods and resources to support their learning journey.

However, to effectively address these challenges, further research involving supplemental resources and retrospective surveys is needed to better understand the specific needs and preferences of veterinary anatomy students. Through the creation of various supplemental resources, and examination of alumni perspectives of their anatomy education, this research aims to uncover key insights into enhancing the learning experience and overcoming the obstacles students face in veterinary anatomy. In an era characterized by the incorporation of digital tools and the expansion of educational alternatives, technology-based resources are now prominent in health professions anatomy education, complementing traditional cadaveric dissection methods (19). Ultimately, while prioritizing student-centered education, educators must strategically integrate and evaluate various teaching tools to ensure their effectiveness in enhancing the educational experience of the learner (19).

Conclusions

In conclusion, the field of veterinary anatomy education is undergoing significant change driven by technological advancements, pedagogical innovations, and the shift towards CBVE. As educators strive to meet the diverse needs of today's learners, more research is needed to develop effective resources that enhance student learning. While traditional methods like cadaveric dissection remain foundational, the integration of supplemental resources and alternative teaching modalities is essential for improving student engagement, understanding, and retention. Through the exploration of alumni perceptions via retrospective surveys, educators can gain valuable insights into the effectiveness of teaching approaches, define the specific needs of veterinary anatomy students, and ensure alignment of veterinary education with contemporary practice. Furthermore, the theoretical frameworks of cognitive load theory, constructivism, and

dual-coding theory provide valuable guidance for designing learner-centered instructional tools that optimize learning outcomes. As the educational landscape continues to evolve, ongoing research and evaluation of teaching methodologies will be crucial for ensuring the effectiveness and relevance of veterinary anatomy education. By embracing innovation and creating evidence-based resources, educators can empower students to develop the anatomical knowledge and skills necessary for successful competency in veterinary practice and beyond.

Moreover, previous literature have highlighted the longstanding role of cadavers in medical and veterinary education, dating back to the thirteenth century, and their continued importance in developing practical anatomical knowledge through hands-on experience. Additionally, veterinary students encounter many challenges, such as academic stress, diverse levels of preparedness or previous experience, and the initial unfamiliarity with complex anatomical concepts. These highlight the need for effective educational strategies and support mechanisms in veterinary anatomy education to help prepare students for the remainder of professional school and successful careers in practice. Despite these challenges, as well as decreased contact hours dedicated to anatomy teaching, anatomy remains a foundational subject for veterinary professionals by providing students with necessary knowledge that is crucial for diagnoses, surgery, communication, medical imagery, physical exams, and maintaining safe medical practice.

Based upon this literature review, three projects were pursued to supplement traditional cadaveric dissection and gain insights into the adequacy of anatomy education in preparing graduates for contemporary practice. First, the development of pre-lab videos aimed to enhance student preparedness and understanding prior to dissection assignments. This project aligns with the educational theory discussed above by acting as a consolidated audiovisual resource focusing

on student-centered education principles. Second, the introduction of a novel pre-course focusing on ungulate anatomy addresses specific educational gaps, as there is a lack of resources geared toward ungulate comparisons. This project aimed to prepare students for terminology, landmarks, skeletal features, and musculature similarities and differences between species. This aligns with the split-attention principle by acting as a single resource to be used prior to the beginning of the semester while also adhering to constructivist approaches. Both of the above projects sought to enhance students' understanding of anatomy and therefore improve academic performance. Lastly, the analysis of alumni perceptions of anatomy education provides important feedback on the efficacy of anatomy teaching methodologies and their alignment with professional practice. Alumni responses can be used to inform future curriculum development and better prepare graduates for the competencies required for modern veterinary careers.

In conclusion, these research projects emphasize a commitment to adapting veterinary anatomy education to current challenges and opportunities, ensuring that graduates are equipped with anatomical knowledge and practical skills essential for successful careers in veterinary medicine. These projects, driven by the evolving landscape of education and diverse veterinary students, contribute evidence-based approaches to continuously improve veterinary anatomy education. Since most educators are doctors, stemming from Latin words meaning "to teach," these individuals play a crucial role in shaping the future of veterinary anatomy education and preparing students to excel in their roles as veterinarians.

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Chapter 2 - Pre-Lab Videos as a Supplemental Teaching Tool in First-Year Veterinary Gross Anatomy

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Abstract

To adapt to an interactive generation of learners, video resources can provide information necessary for lab preparation, describe clinical correlations, and maximize dissection time. In this study, dissection summary videos with embedded quizzes were to be viewed by K-State first-year veterinary students prior to their canine anatomy lab sessions. Videos were created using an iPhone, edited via Camtasia® editing software, and uploaded to the course Canvas® page. Following the conclusion of the Fall 2022 semester, final course grade, practical exam scores (exam), pre-lab video (video) time interaction, pre-lab quiz (quiz) scores, and student perception data were analyzed. Positive, statistically significant correlations were found between number of videos viewed and certain exam scores, with the strongest correlation being for the lower quartile specifically. Significant correlations were also found between average exam score and total number of videos viewed throughout the semester, and final course grade and total time spent viewing all videos. Positive, statistically significant correlations were found between average quiz score and exam score. A thematic analysis of student comments revealed videos appeared to have been a beneficial part of the course, providing students with a valuable resource for preparation, study, and increased understanding and confidence. These findings indicate that providing videos as a supplemental resource is beneficial to veterinary student learning and well perceived. This study also suggests that video views can predict lower quartile student exam score. The correlations in this study are weak, but the statistical significance depicts a positive impact on student practical exam scores.

Keywords: pre-laboratory, videos, anatomy, veterinary anatomy, canine

Introduction

The traditional approach to teaching medical and veterinary Gross Anatomy has been through cadaveric dissection accompanied by lectures (1,2). Dissection is an essential part of an anatomy course as it allows students to grasp the importance of the cadaver, conceptualize multidimensions, appreciate spatial orientation, experience touch-mediated perception, encounter anatomical variation, and learn the essential medical vocabulary (1–4). Since anatomy is a vital subject for all healthcare professions, it is no surprise that it forms the foundation of professional school curricula (1). The fundamental principles of anatomy, often taught via dissection and supplemented with visual aids, are then built upon in later years of professional schooling (1). To adapt to a more “interactive generation” of learners that absorb information in different ways, it is important for anatomists to consider various student learning styles (5). Audiovisual aids and computer assisted learning are user-interactive supplemental resources that provide variability in the presentation of the material and opportunities for clinical correlation (4,6,7). A resource that provides information necessary for lab preparation and encourages repetitive retrieval of the supplied materials is recommended for long-term memory development (6,8). Students favor online learning resources due to their constant availability, the convenience of learning at their preferred pace, the opportunity to revisit forgotten information, and the flexibility to utilize the resource at their chosen, opportune time (1,2,9,10). Anatomy teaching methodology has been strengthened and transformed with more implementation of models, imaging, simulation, and the internet (1). As laboratory dissection time has been reduced, institutions have utilized prosections, plastic models, and online multimedia to enhance student retention (1,5,11,12). Pre-lab videos are a valuable interactive multimedia resource that can inform students about laboratory expectations, how to maximize their dissection time, and provide essential clinical

correlations (1,13). They help students form a mental picture and foundation for what is to be learned during the allotted dissection labs (14).

Medical School Pre-Lab Videos

Research has demonstrated that dissection videos are a valuable resource in medical anatomy education, as they improve the quality of the course, are well-received by students, and enhance anatomy instruction (2,4,15). In a study conducted by Mahmud et al in 2009, the researchers investigated the effect of dissection videos on first-year medical students' performance on term tests for the gross anatomy course. The study found that although exam grades improved for students who viewed the dissection videos, compared to those who did not, the difference was not statistically significant. This insignificance may be attributed to confounding variables in the study. Dissection videos of the upper limb were shown during class to students dissecting both upper and lower limbs. Students were encouraged to view lower limb dissection videos on their own time, thus self-reports of dissection video views were used for the analysis. These discrepancies may have led to an insignificant finding as it remains uncertain whether upper limb dissection videos provided any benefit to students dissecting lower limbs. It is also unknown if students used the dissection videos in place of other study methods in preparation for exams. The study also collected student perception data which revealed that the majority of students requested regular inclusion of dissection videos in the curriculum (2). Another study conducted by Dilullo et al in 2006 found that medical students perceived the dissection videos to be beneficial for their dissections, structure identification, and examination preparation (15).

Veterinary School Pre-Lab Videos

Limited data are available on the use of pre-lab videos in veterinary school anatomy courses. However, a study conducted by Josephson et al in 2006 suggested that the use of dissection videos in veterinary anatomy led to improved examination scores among students (2,16). A more recent crossover design study in 2014 by Al-Khalili et al found that veterinary students preferred the use of 2D videos in preparation for lab over 3D videos and the standard course reading materials, leading to improved post-dissection quiz performance and a decreased need for lab assistance (14). Supplementing student learning through pre-lab videos provides a homologous resource for all students, preventing contradictory information from multiple sources such as lab instructors. Moreover, students can learn at their own pace by utilizing the pause or rewind buttons, improving their retention and understanding of the material. Finally, and in addition to their documented educational benefits, pre-lab videos may offer a way to combat rising scarcity of veterinary cadavers (14,17) by increasing the number of students taught by a given specimen. The present study is unique due to its extensive collection and analysis of quantitative data, complemented by qualitative student perception data. In contrary to past studies, our study includes pre-lab videos, with embedded quizzes, as a supplemental resource available to all first-year veterinary students in one cohort. The videos were provided throughout the entirety of the semester as an introduction to each dissection activity. By providing these pre-lab videos, our study seeks to explore the effectiveness of the videos and quizzes in enhancing exam scores for the entire cohort as well as upper, middle, and lower quartile students.

Interactive Videos

An optional task that may be incorporated to create an interactive video is a pre-lab quiz. Integrating an embedded pre-lab quiz is one way to assess the impact of student learning through the video on their performance in the class (18). To ensure accessibility to all students, captions may be generated to facilitate understanding. Short annotations that appear when an important definition, structure, or example is explained may improve student knowledge. Data have shown that captions improve comprehension, retention, and attention to videos (19). Additionally, providing brief annotations allows the viewer to visualize how a specific word or structure may be spelled.

Aims of the Current Study

There are two aims of the present study. The first aim of this study was to evaluate the effectiveness of pre-lab dissection videos as a supplementary tool for teaching small animal anatomy at the Kansas State University College of Veterinary Medicine (KSU CVM) through analysis of exam scores. The first hypothesis of the study is that video interaction will improve exam scores. The second aim of the study is to understand the perceived benefit of production of videos as a supplemental resource to facilitate learning of canine veterinary anatomy. The second hypothesis of the study is that student qualitative comments will reveal positive attitudes.

Methods

Creation of Pre-Lab Videos

Videos were created as a supplemental resource to be viewed prior to the beginning of the laboratory sessions. The author's intention was for the videos to provide introductory information to the students of what is expected of them during the lab. Additionally, important

structures to be found and noteworthy clinical correlations were explained. The videos were uploaded to the Canvas® Learning Management System (Instructure Inc., Salt Lake City, UT, USA) for students to view as an introduction before lab, during lab for assistance finding specific structures, after lab as a review of the material learned, and before quizzes or laboratory practical exams as a study tool. The student-to-instructor ratio in the Gross Anatomy I course in the Fall 2022 semester at the KSU CVM was 24:1. To supplement instructor availability and address student inquiries that arose during the allotted dissection time, videos were available to students for use during lab as a method of troubleshooting.

To create the videos, a canine cadaver was first dissected by the course teaching assistant and course coordinator. The prosected specimen then served as an example in the videos.

Miller's Guide to the Dissection of the Dog – 8th edition acted as the course dissection guide. At the beginning of each lab assignment, students were provided with a list of anatomical structures that should be found during the allotted lab time. By following along with the list, videos were generated in which the course coordinator identified the structures, described their significance, and informed the viewer of clinically relevant information when appropriate. Videos were recorded in the KSU CVM anatomy lab using an Apple iPhone 13 Pro Max camera (Cupertino, California, USA, <https://www.apple.com>). Camtasia® (TechSmith Inc., East Lansing, Michigan, USA) was then used to edit and process the videos with captions (see Figure 1) and annotations as needed (see Figure 2). Following the editing process, videos were exported into mp4 format and uploaded onto the course Canvas® page.



Figure 2-1: Screenshot of pre-lab video exhibiting the use of a brief caption to describe the structure of a canine left lung.

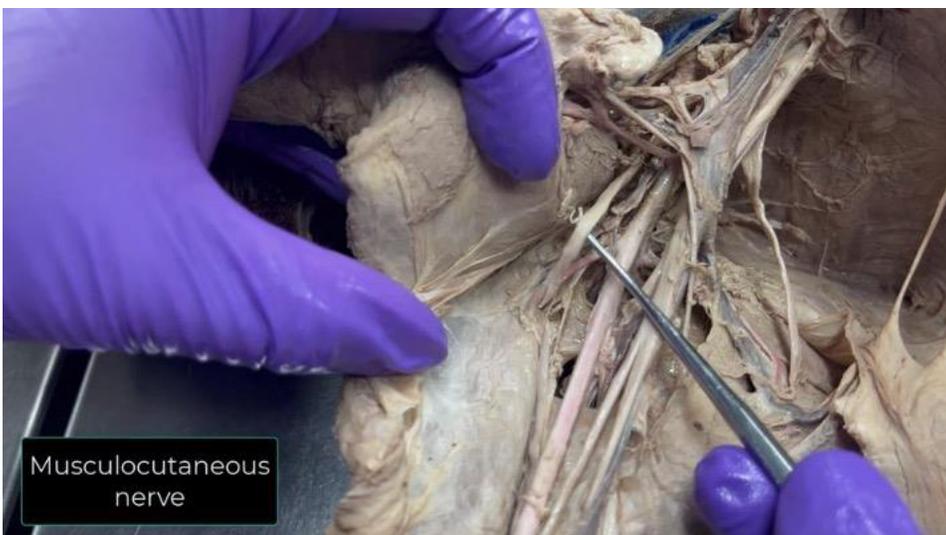


Figure 2-2: Screenshot of pre-lab video demonstrating the use of a short annotation to help students visualize how a specific word or structure may be spelled.

The students were instructed to watch the video and then complete the brief 5-point quiz prior to the beginning of each dissection lab (Monday, Wednesday, Friday afternoons). In this study, pre-lab quizzes were included at the end of the video. Students were instructed to first watch the video, then answer the related 5 quiz questions for a potential to earn 5 points. The

students in this study were directed to watch the videos and complete the quizzes individually, without aid from other classmates. Students were allowed unlimited time to complete the quiz, but they were only allowed one attempt. Following completion, quiz grades were muted, meaning students were not able to view their score or the correct answers immediately following submission. A deadline was enforced to ensure the students completed the quiz before the start of each lab session. After the quiz deadline, the course teaching assistant then amended scores and released the grades, thus allowing students to see the correct answers. The videos and quizzes remained accessible to students following the deadline, meaning they were available for use during lab or as an additional study material. A small number of points associated with the quizzes were assigned to allow students to gain low stakes points to buffer their grades. Quiz questions consisted of multiple choice, true-false, and fill-in-the-blank format (see Figure 3). All components of the cinematography, quiz formation, and grading were performed by the course graduate teaching assistant.

| Question 5 | 1 pts |
|--|-------|
| <p data-bbox="233 1283 764 1314">The vagus nerve supplies _____ innervation.</p> <hr data-bbox="233 1373 1377 1377"/> <p data-bbox="233 1392 440 1423"><input type="radio"/> Parasympathetic</p> <hr data-bbox="233 1436 1377 1440"/> <p data-bbox="233 1455 399 1486"><input type="radio"/> Sympathetic</p> | |

Figure 2-3: An example of a typical quiz question asked in relation to the information discussed in the pre-lab video.

Participants

This study included all 120 first-year Doctor of Veterinary Medicine (DVM) students of the Class of 2026 at the KSU CVM, Manhattan, Kansas, in the Fall 2022 term. At the conclusion of the Fall 2022 semester, an informed consent document with detailed information about their participation in the study was emailed to all 120 students, and all of them consented.

Course Structure

The first-year curriculum at the KSU CVM includes VAP 806, Gross Anatomy I, in which the students are taught the basic principles of canine anatomy. The course includes 3 hours of lecture and 9 hours of lab per week. To maximize student lab time and to prepare them for their daily lab tasks, videos were created and included as part of the Gross Anatomy I course. Each video also included a 5-point embedded quiz to allow the students to demonstrate the knowledge gained by watching the video.

In total, the fall semester included 36 lab periods. Prior to each lab period, the students were asked to view the supplied video and answer the 5-point quiz based on the material discussed in the video. The quizzes were written by the course teaching assistant. The quizzes were available online on the course Canvas® page, were not timed, and students were only allowed one attempt. The quiz questions consisted of multiple choice, fill-in-the-blank, or true-false. Quiz questions were meant to test students' knowledge of material discussed in the video. Many quiz questions were screenshots of structures discussed in the video, or pictures taken from additional resources, to assess students' identification abilities. All videos for the week were uploaded prior to the beginning of the week to grant students ample time to complete the task. Of the 36 lab periods, radiology sessions as well as review labs are included in that total.

Videos were not assembled for radiology or review labs. Radiology labs were taught by radiologists from the KSU CVM Teaching Hospital. Reviews labs were essentially “free” labs in which students were given the opportunity to catch up on their dissections, review already identified structures, or utilize the anatomy staff to answer questions. Additionally, to break up longer videos where more structures were identified, two videos were then created. The topic of lab 17 was reproductive anatomy, which contained both male and female structures. To combat a potentially lengthy video, two videos were created, 17A and 17B, to account for sex differences (see Figure 4). To create the video detailing female reproductive anatomy, the canine prosection dissected by the course teaching assistant and course coordinator was used. For the video outlining male reproductive anatomy, and because the prosection was female, a male cadaver was borrowed from one of the student groups. As a result of this, there were a total of 34 videos created throughout the duration of the semester. There were also 34 quizzes at 5-points each for a total of 170 points. The points associated with the quizzes contributed to the total points in the Gross Anatomy I course. The longest video was 38 minutes and 8 seconds while the shortest video was 6 minutes and 27 seconds (see Figure 4 and Figure 5). Duration of the videos varied based on complexity of the lab assignment, number of structures to be found, and clinical correlations discussed. Students were able to pause, rewind, or rewatch the videos as many times as they saw fit. The purpose of the dissection videos was to identify and briefly describe structures located on the clinically relevant list provided to students at the beginning of each assignment resulting in improved student grades.

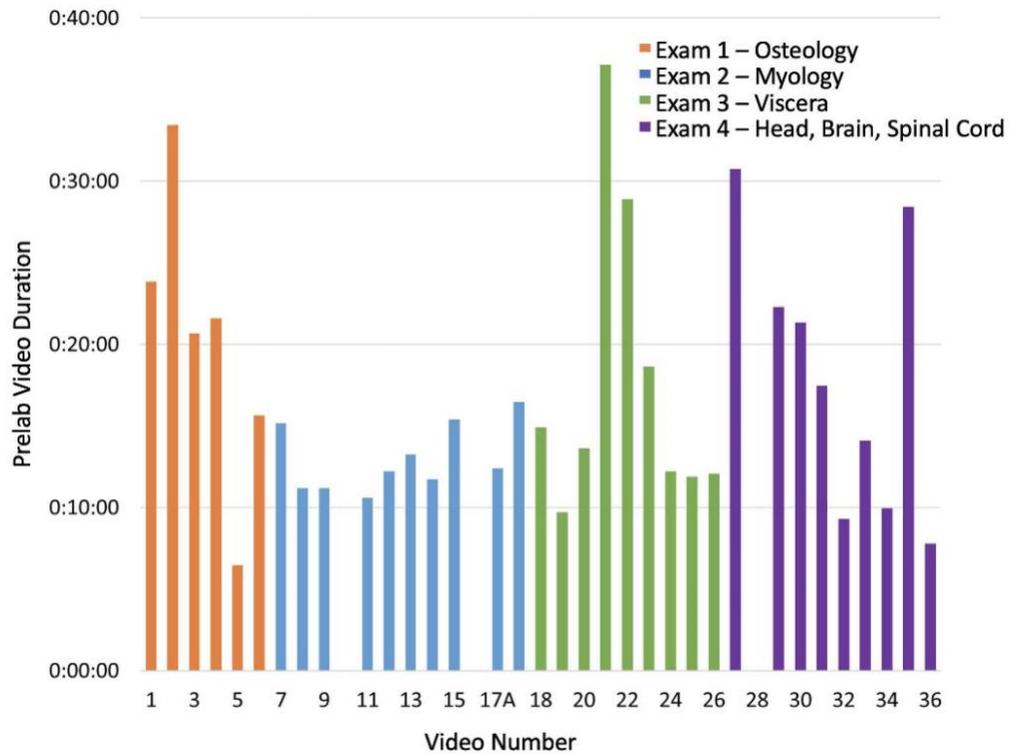


Figure 2-4: Pre-lab video duration and pre-lab video number depicting the length of the 34 pre-lab videos created during the Fall 2022 semester. Gaps in the graph show radiology or review labs in which videos were not created. Video 17 was split into 17A and 17B.

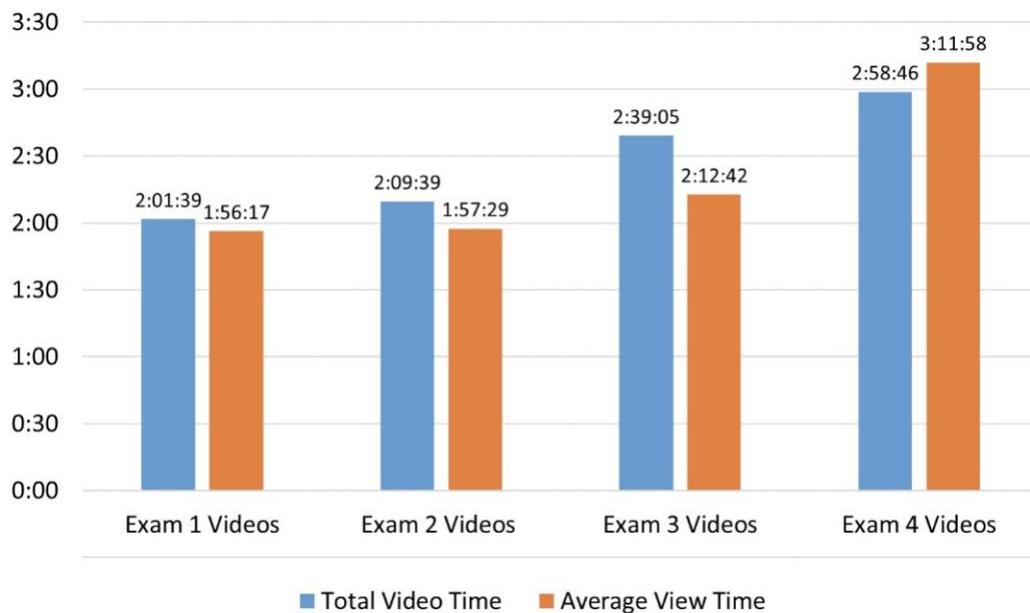


Figure 2-5: Total pre-lab video view time for each practical exam compared to average pre-lab video view time for all 120 students in the Class of 2026.

Study Design

This quasi-experimental, mixed-methods study sought to demonstrate the impact of providing pre-lab videos and quizzes on the target population, the first year DVM student grades at the KSU CVM. The independent variables were quiz score and time spent viewing videos. The dependent variables were course grade and exam scores. Following the conclusion of the Fall 2022 semester, student quiz grades, video time interaction, exam grades, final course grades, and qualitative comments were analyzed.

Statistical Analysis

The Pearson correlation coefficient was used to measure the strength of a linear association between two variables. To determine the statistical significance of the Pearson correlation coefficient, a t-test was performed through calculating the t-score and p-value. A p-value < 0.05 was considered statistically significant. Descriptive statistics were also used to summarize the data set. All analyses were performed using Microsoft Excel (Microsoft Inc, Seattle, WA, USA).

Qualitative Analysis

To analyze student qualitative comments, both a classic thematic analysis and Linguistic Inquiry and Word Count (LIWC) analysis were used. The researchers in this study used Clarke and Braun's Six Step Data Analysis Process consisting of 6 phases used to identify themes and patterns in the data. The phases are 1. Familiarization with the data 2. Coding 3. Searching for themes 4. Reviewing themes 5. Defining and naming themes and 6. Writing up (20). Additionally, the words people use provide psychological cues into their thought processes,

emotional well-being, intentions and motivations (21). Tausczik and Pennebaker created the LIWC analysis to analyze others' language, which thus allows understanding of their thoughts, feelings, personality, and connection with others (Pennebaker Conglomerates, Inc, Austin, TX, USA). Therefore, the researchers in the present study utilized the LIWC-22 program for text analysis of student word use in their qualitative comments.

Ethics Approval

The study protocol was reviewed and approved as exempt by the Institutional Review Board at Kansas State University #IRB-11397.

Results

Class Demographics

During the Fall 2022 semester, the Class of 2026 included 120 first year DVM students. The total class size included 18 males, or 15%, and 102 females, or 85%. Video view time differences were assessed by sex. No discernable, statistically significant differences between sex were noted. Females spent a total of 9 hours, 20 minutes, and 30 seconds watching pre-lab videos. While on average, males spent a total of 9 hours, 6 minutes, and 41 seconds viewing the semester videos (see Figure 6A). Additionally, females had slightly higher average scores for all 4 course practical exams. Females had an average exam score of 79.42% whereas males had an average exam score of 79.01% (see Figure 6B). But again, these meager differences are not statistically significant.

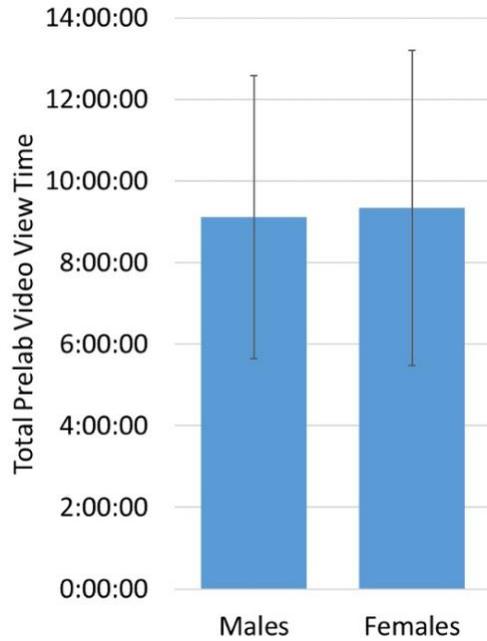


Figure 2-6: Class of 2026 gender differences in total pre-lab video view time during the Fall 2022 semester, which are not statistically significant.

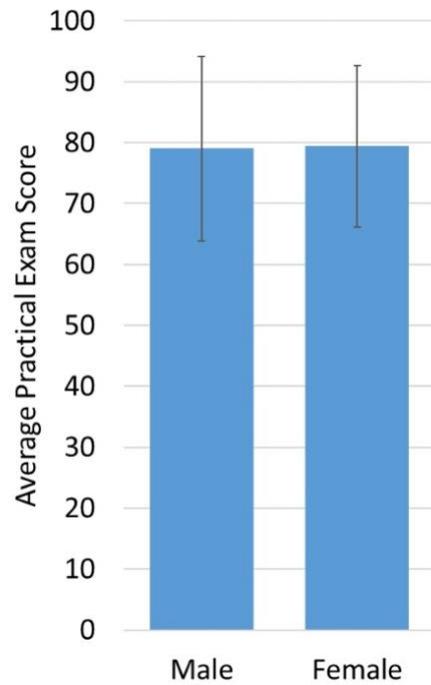


Figure 2-7: Class of 2026 gender differences in average practical exam scores during the Fall 2022 semester, which are not statistically significant.

Average Practical Exam Scores

The Fall 2022 semester included 4 practical exams taken in the Gross Anatomy lab at the KSU CVM. All 4 exams were roaming style, in which students rotated to each station to answer questions relative to canine cadavers. In contrast to the quizzes that were written by the course teaching assistant, the exams were written by the coordinator of the Gross Anatomy I course. Because these exams took place in the lab, they were on paper and mainly consisted of fill-in-the-blank identification questions relating to the cadavers. These exams were timed, in which students had 1 minute 15 seconds per station to answer one question. The exams were 50 questions. As a class, the average practical exam 1 score was 74.54%. The average exam 2 score was 82%, the average exam 3 score was 79.02% and the average exam 4 score was 80.2%. The average final course grade amongst the Class of 2026 was 91.46%.

Average Number of Pre-Lab Videos Viewed

Associated with exam 1 were 6 videos correlated to exam 1 content. Of the Class of 2026, the average number of exam 1 videos viewed was 4.8 videos. Associated with exam 2 were 10 videos correlated to exam content. The average number of exam 2 videos viewed was 7.2 videos. Associated with exam 3 were 9 videos correlated to exam content. The average number of exam 3 videos viewed was 5.9 videos. Finally, associated with exam 4 were 9 videos correlated to exam content. The average number of exam 4 videos viewed was 6.4 videos. Overall, the Fall 2022 semester included 34 videos. On average, the Class of 2026 viewed 24.3 videos. The total time of all 34 videos combined was 9 hours, 31 minutes, and 51 seconds. The average total time spent viewing videos for all 120 students was 9 hours, 18 minutes, and 26 seconds.

Pearson Correlation Coefficients

Video time interaction data, practical exam grades, final course grade, and individual quiz scores were extracted from the course Canvas® page and analyzed for the 120 DVM students in the Class of 2026. The data were compounded into a Microsoft Excel file. Duration time of all 34 videos was inputted. Viewing greater than 74.9% of each video was counted as 1 view. The researchers in the present study consider viewing >74.9% of the video duration as watching the majority of the video, and thus interacting with most of the video content. On average, the Class of 2026 watched 24.3 of the 34 videos with a standard deviation of 7.92.

Pre-Lab Video Significance

The Pearson function in Excel was used to acquire Pearson Correlation Coefficients through analysis of exam score and number of videos viewed, relating to exam content. Positive, statistically significant correlations were found between exam 1 grade and number of exam 1 videos viewed ($R = 0.199$, $P\text{-Value} = 0.029$, $T\text{-Score} = 2.212$), exam 3 grade and number of exam 3 videos viewed ($R = 0.218$, $P\text{-Value} = 0.017$, $T\text{-Score} = 2.421$), and exam 4 grade and number of exam 4 videos viewed ($R = 0.384$, $P\text{-Value} = 0.0000153$, $T\text{-Score} = 4.512$). The strongest correlation of these being exam 4 video views and exam 4 score (see Figure 7). The correlation between exam 2 grade and number of exam 2 videos viewed was positively correlated, but statistically insignificant ($R = 0.130$, $P\text{-Value} = 0.157$, $T\text{-Score} = 1.424$). Positive, statistically significant correlations were also found between average exam score and total number of videos viewed throughout the semester ($R = 0.303$, $P\text{-Value} = 0.000756$, $T\text{-Score} = 3.458$), and final course grade and total time spent viewing all videos ($R = 0.216$, $P\text{-Value} =$

0.018, T-Score = 2.402). See Table 1 for an organized summary of variables correlated and their statistical significance or insignificance (see Table 1).

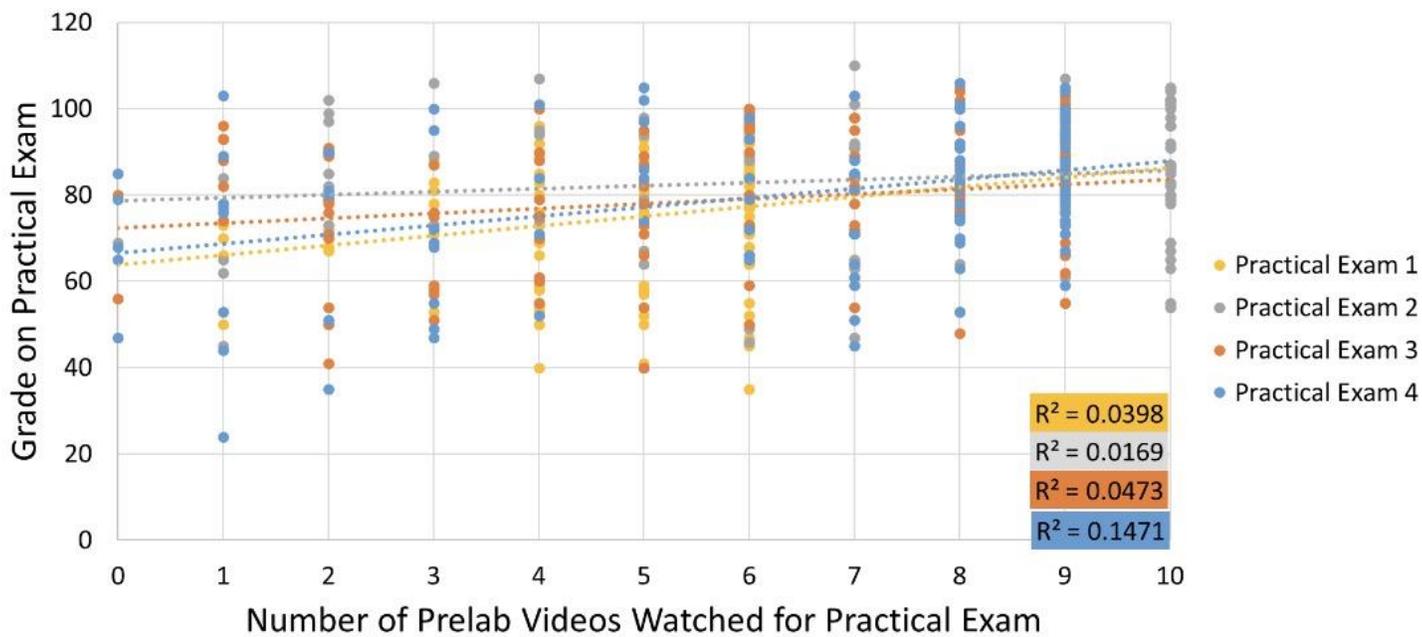


Figure 2-8: Correlations between number of pre-lab videos viewed per each practical exam and practical exam grade. Positive correlations were found for all exams, however, exam 4 had the highest correlation between videos viewed and exam 4 grade.

| Video views and exam scores | Pearson Correlation (R) | P-Value * | T-Score |
|--|--------------------------------|------------------|----------------|
| Exam 1 | 0.199 | 0.029 | 2.212 |
| Exam 2 | 0.130 | 0.157 | 1.424 |
| Exam 3 | 0.218 | 0.017 | 2.421 |
| Exam 4 | 0.384 | 0.0000153 | 4.512 |
| Quiz scores and exam scores | Pearson Correlation (R) | P-Value * | T-Score |
| Exam 1 | 0.389 | 0.0000237 | 4.402 |
| Exam 2 | 0.473 | 0.000000250 | 5.475 |
| Exam 3 | 0.170 | 0.0646 | 1.865 |
| Exam 4 | 0.291 | 0.00157 | 3.237 |
| *P-Value < 0.05 is statistically significant | | | |

Table 2-1: An organized summary of variables correlated with R, P-Value, and T-Scores. A P-Value <0.05 is statistically significant.

Class Lower Quartile

When dividing the Class of 2026 into upper, two middle, and lower quartiles, a positive, statistically significant correlation was found between exam 1 videos viewed and exam 1 score, for the middle quartile specifically ($R = 0.308$, P-Value = 0.017, T-Score = 2.466). The strongest correlation was found to be exam 4 videos viewed and exam 4 grade, for the lower quartile specifically ($R = 0.454$, P-Value = 0.012, T-Score = 2.694) (see Figure 8). This correlation between exam 4 videos viewed and exam 4 score predicted lower quartile student exam 4 grade by 21% ($R^2 = 0.206$). This suggests that 21% of the variation in exam score may be attributed to the number of videos viewed for exam 4. Additionally, when assessing the lower quartile more closely, those lower quartile students who viewed >50% of exam 4 videos, meaning they viewed >4.5 of the 9 exam 4 videos, scored 14.6% better on exam 4 than those lower quartile students who viewed <50% of exam 4 videos. This is the difference between low performing students and failing students (see Figure 8).

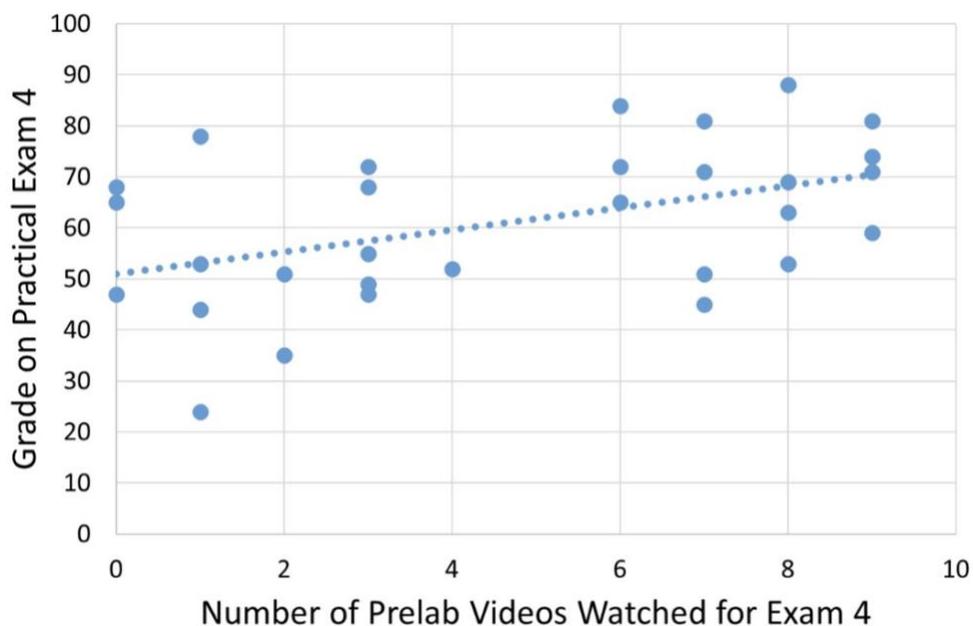


Figure 2-9: Correlations between number of pre-lab videos viewed for practical exam 4 and practical exam 4 grade for lower quartile students, which predicted practical exam 4 score by 21%.

Pre-Lab Quiz Significance

Positive, statistically significant correlations were found between average quiz score and exam score for exam 1 ($R = 0.389$, $P\text{-Value} = 0.0000237$, $T\text{-Score} = 4.402$), exam 2 ($R = 0.473$, $P\text{-Value} = 0.000000250$, $T\text{-Score} = 5.475$), and exam 4 ($R = 0.291$, $P\text{-Value} = 0.00157$, $T\text{-Score} = 3.237$). The strongest correlation of these being exam 2. The correlation between average quiz score for exam 3 material and exam 3 grade was positively correlated, but not statistically significant ($R = 0.170$, $P\text{-Value} = 0.0646$, $T\text{-Score} = 1.865$) (see Figure 9). Additionally, Table 1 provides an organized summary of variables correlated and their statistical significance or insignificance (see Table 1).

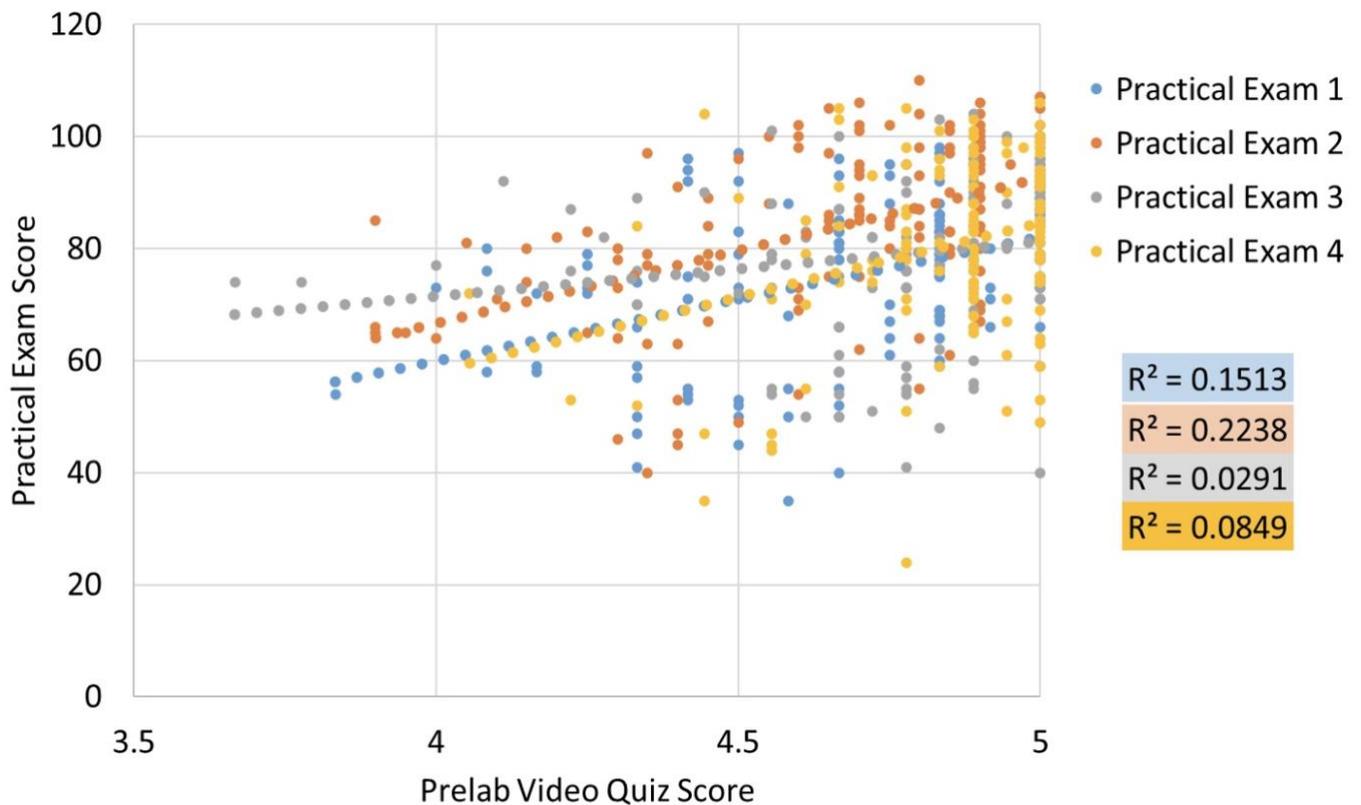


Figure 2-10: Correlations between quiz score and exam score for each exam. Pre-lab quiz score was positively correlated to practical exam scores.

Thematic Analysis

Following completion of the Gross Anatomy 1 course, the course coordinator gathered student responses to a statement, “This course in the future should definitely continue doing this.” The student response rate was 69% out of the class size of 120 students. A thematic analysis of the student responses revealed several themes. The refined themes and their mentions are presented in Table 2 (see Table 2). This quantification helps to highlight the popularity and perceived effectiveness of the different aspects of the course. Game-based learning was mentioned the most, followed by exam blueprints and pre-lab videos. This suggests these aspects

of the course were particularly valued by the students. The video comments were then pulled-out and a thematic analysis of these 14 comments specifically was performed, revealing the following themes:

1. Preparation for Lab Work: Students repeatedly mentioned that the pre-lab videos helped them prepare for their actual lab work. These videos likely provided a preview of what to expect and allowed students to familiarize themselves with the material before diving into the lab work.

2. Study and Revision Tool: A number of students mentioned that they found the pre-lab videos to be useful tools for studying and revision. They could revisit these videos after the lab to reinforce what they had learned.

3. Confidence Boost: Students indicated that the pre-lab videos boosted their confidence before going into the labs. By giving them a clear idea of what to expect, these videos helped students feel more prepared and less anxious about their upcoming lab work.

4. Visual Learning Aid: Some students indicated that having a visual resource like the pre-lab videos was helpful. It suggests that the videos may have catered to visual learners by illustrating the concepts to be covered in the lab.

5. Comprehension and Clarity: Some students implied that the pre-lab videos helped them understand the complex aspects of the lab, enhancing their overall comprehension and clarity of the lab procedures or content.

6. Efficiency: A few students mentioned that pre-lab videos were efficient tools for addressing student questions before lab sessions, indicating that they likely saved time during actual lab sessions.

In the refined summary, the videos appear to have been a highly beneficial part of the course, providing students with a valuable resource for preparation, study, and increased understanding and confidence. Table 3 lists the identified subthemes and their mentions (see Table 3). The videos also catered to different learning styles, which likely contributed to their overall effectiveness. Some of the student responses that specifically mention the videos include: “I appreciate the lab videos especially for reviewing before a practical.” “The dissection videos. They helped a lot to ensure we had a good understanding of what the majority of the structures were that we needed to find in lab.” “I loved the prelab videos, they really helped us to confidently go into the dissection.” “The use of pre-lab videos should be continued. It was a good introduction to the lab and allowed for a helpful study resource as many diagrams are not very exact.”

| Activity | Mentions |
|---|-----------------|
| Game-based learning | 29 |
| Blueprints | 20 |
| Pre-lab videos | 14 |
| Interactive learning tools | 7 |
| Guided learning | 4 |
| Teaching style | 4 |
| Diversity of learning materials/assessments | 6 |
| Real-world applications | 2 |

Table 2-2: Outlining the number of mentions by Class of 2026 students to the statement, “This course in the future should definitely continue doing this.”

| Pre-lab Videos sub-themes | Mentions |
|----------------------------------|-----------------|
| Preparation for Lab Work | 7 |
| Study and Revision Tool | 4 |
| Confidence Boost | 2 |
| Visual Learning Aid | 1 |
| Comprehension and Clarity | 2 |
| Efficiency | 1 |

Table 2-3: Displaying the identified sub-themes and number of mentions by Class of 2026 students to the statement, “This course in the future should definitely continue doing this.”

Linguistic Inquiry and Word Count (LIWC) Analysis

The LIWC software is designed to analyze text for various characteristics, including emotional content, cognitive processes, and linguistic style. By calculating the frequency of

specific words and word categories in a given text, LIWC can provide a quantitative representation of these aspects. Applying this to the overall student responses and responses specifically about pre-lab videos to the statement, “This course in the future should definitely continue doing this,” revealed the following insights. Table 4 also displays a summary of the results from the LIWC analysis (see Table 4).

1. Analytic Thinking: The high score of 74.8 suggests that the students used more words that suggest formal, logical, and hierarchical thinking.

2. Clout: The lower score of 35.78 implies the students didn’t demonstrate much confidence or leadership in their language.

3. Authentic: With a score of 40.59, it can be inferred that students were somewhat authentic and personal in their language.

4. Tone: A high score of 99 suggests a very positive emotional tone in the responses.

5. Word count (WC): There were a total of 1071 words in the responses.

6. Key thematic insights include a high usage of verbs (14.94%) and prepositions (11.86%), a higher use of first-person pronouns (5.51%) which suggests personal experiences, and a considerable degree of cognitive process language (14.57%) which may indicate students are thinking and reflecting on their learning experiences.

In conclusion, the students' comments on the videos were analytical, positive in tone, and demonstrated a moderate level of confidence. They used structured language, reflected on their experiences, and often referred to their present situation.

| | Analysis of Overall Student Responses | Analysis of Responses mentioning Pre-lab videos |
|--------------------------|---------------------------------------|---|
| Analytic thinking | 74.8 | 90.29 |
| Clout | 35.78 | 50.27 |
| Authentic | 40.59 | 15.69 |
| Tone | 99 | 98.2 |
| Word count | 1071 | 175 |
| Prepositions | 11.86 | 13.71 |
| Verbs | 14.94 | 11.43 |
| First-person pronouns | 5.51 | 5.14 |
| <i>Cognitive process</i> | <i>14.57</i> | <i>11.43</i> |

Table 2-4: Comparison of LIWC analyses of overall Class of 2026 student responses and responses specifically mentioning pre-lab videos to the statement, “This course in the future should definitely continue doing this.”

Discussion

In this study, comparing pre-lab video usage and course scores, positive, statistically significant correlations were found between exam grade and number of videos viewed for exams 1, 3, and 4. The strongest correlation of these being exam 4 video views and exam 4 score.

Positive, statistically significant correlations were also found between average exam score and total number of videos viewed throughout the semester, and final course grade and total time spent viewing all videos. The authors speculate that students typically do what is asked of them in the beginning of the semester, leading to a significant correlation between exam 1 videos viewed and exam 1 score. A positively correlated, but statistically insignificant finding for exam 2 videos viewed and exam 2 score may be a result of a drop in student motivation, as exam 2 fell in week 7 of a 17-week semester. But on the contrary, positive, statistically significant correlations between exam 3 and 4 videos viewed and exam 3 and 4 scores may be described as last-ditch efforts by students to utilize the available resources and improve individual course grades.

After dividing the Class of 2026 into upper, middle, and lower quartiles, a positive, statistically significant correlation was found between exam 1 videos viewed and exam 1 score, for the middle quartile specifically. More notably, the strongest correlation was found to be exam 4 video views and exam 4 score, for the lower quartile specifically. This positive, statistically significant correlation also predicted lower quartile student exam 4 grade by 21%. Additionally, it was discovered that those lower quartile students who viewed the majority of exam 4 videos scored better on exam 4 than lower quartile students who did not view most of the provided videos. This is an important finding, and so much so that it is the difference between low performing students and failing students in Gross Anatomy I for the Class of 2026. Lower quartile students typically struggle, requiring more assistance from teaching staff over their middle or upper quartile classmates. These findings suggest that providing supplemental resources, like videos, may strongly benefit lower quartile students, and therefore, minimize failing grades.

Positive, statistically significant correlations were also found between average quiz score and exam score for exams 1, 2 and 4. The strongest correlation of these being exam 2. In this study, although the correlations are positive and statistically significant, they are weak. Although weak correlations were found, due to the high variability between exam scores and video usage amongst 120 students, the statistical significance suggests a positive increase in student exam scores as an outcome of interaction with the supplied videos. Additionally, it is important to keep in mind that video usage is only one factor contributing to student exam performance. Other factors like time spent studying, understanding of the material, test taking abilities, etc. may also partially affect student exam scores. Furthermore, performance on quizzes was found to correlate to exam performance. Statistically significant improvements in exam scores found in this study differ from previously published non-veterinary literature. Statistical significance in lower quartile student exam improvement and the prediction of lower quartile student exam grades has not been found in other literature. However, these findings do align with previous veterinary anatomy literature. Additionally, this study found statistical significance not only for the entire cohort, but middle and lower quartiles specifically. These findings may indicate that pre-lab videos, with embedded quizzes, are a supplemental resource that can be provided to students to complement their learning.

When looking at the percentage of the duration of each video watched by individual students, it should be mentioned that the duration viewed by many students was 100% or above. This indicates that students rewatched the videos, sometimes multiple times over. Although the students were instructed to view the videos prior to each laboratory session, students were also observed viewing videos during lab time as a tool to assist them with completion of their dissection task. It is assumed that students rewatched the videos prior to dissection checklists and

practical exams as a study tool. This is a benefit of providing videos to supplement student learning. Because of online accessibility, students are able to pause, rewind, and rewatch videos to facilitate their understanding and retention.

The qualitative analyses in this study, both thematic and LIWC analyses, found positive student attitudes towards the offered videos. Based on student comments, videos were recognized as one of the top supplemental resources provided in the Gross Anatomy I course. Comments relating to videos demonstrated the following themes: preparation for upcoming labs, a study and revision resource, enhanced confidence, a visual learning resource, comprehension and clarity, and efficiency. Overall, student perceptions revealed videos were a beneficial supplemental resource, providing the Class of 2026 the opportunity to use the videos for preparation and as a study material, increasing understanding and confidence. As a more “interactive generation” of learners may be occupying anatomy classrooms, videos are one resource that can assist visual learners.

Although the qualitative comments in this study were acquired by the course coordinator, it is interesting to note that students voluntarily provided additional, unsolicited positive feedback about the videos on the course graduate teaching assistant’s teaching evaluation. Students expressed their enjoyment of the videos and mentioned their desire for videos to continue to be provided. On the teaching assistant’s evaluation, students wrote anonymized comments about the video production, again voluntarily. The additional comments section of the teaching evaluation contained statements like: “The prelab videos and quizzes are very helpful and effective in preparing for lab.” “I also LOVED having the words in the pre-lab videos, they really helped the words stick so much more in my brain.” “The videos were very helpful to complete the labs as well as look back on to study.” “The pre-lab quizzes were super helpful!”

Although these statements suggest positive student perceptions of the supplied videos, no formal qualitative analysis of these additional comments was performed. These comments taken from the teaching assistant's evaluation should be interpreted as such.

As supplemental resources used to enrich anatomy education are numerous, (i.e., plastinated specimens, virtual programs, Anatomage® tables, Anatomy in Clay®, etc.), the cost of purchasing such gadgets is extravagant. Because of this, many veterinary school budgets may not permit the purchase of such resources. To combat this issue, the anatomy team at the KSU CVM took to creating their own cheaper supplemental resource. In this study, generating videos required purchase of one canine cadaver and a subscription to Camtasia® editing software. Other expenses may include personnel salary, dissection tools, dissection guide, a computer, and a camera. For this study, the course teaching assistant's personal phone was used instead of purchasing an additional video recording device. Video resources provide many benefits, but most notably they are low cost, can be created in-house, are customizable, and may be tailored to course content. Additionally, videos provide a visual demonstration of the material, are easy to use, are accessible, and can smoothly be integrated into a learning management system like Canvas®. Particularly, the findings in the study suggest that video resources, with embedded quizzes, improve student exam scores, are well-perceived by students, and strongly influence lower quartile student performance.

The present study contains correlation data, which is not the same as causal relationships, and the findings should be interpreted accordingly. The results of this study indicate that as the independent variable increases (i.e., video interaction or quiz scores), the dependent variable also increases (i.e., exam scores or final course grade). This study is not indicating that video interaction or quiz scores influence exam scores or final course grade.

Limitations

The present study is limited by its inability to include a control group. The Gross Anatomy I course at the Kansas State University College of Veterinary Medicine underwent significant change between the Class of 2025 and 2026 cohorts. The most notable change being transition to a new course coordinator. This adjustment involved much course revision, so much so that historical cohorts cannot be compared to the Class of 2026. In this study, given that a supplemental resource was provided to students with the intention that it could improve their grade, the resource had to be provided to all 120 students in the cohort. This is one reason for the study to analyze correlation data over causation. Rather than a comparison between experimental and control groups, the study instead analyzes the effect of interaction with the assigned videos and quizzes on practical exam scores.

As a result of the experimental design of this study, it was not a controlled study. This means because the students were instructed to view the videos and complete the quizzes outside of class, the researchers were not actively observing the students as they completed this task. The researchers assume that students performed this task on their own time, either at the KSU CVM complex or home. As a consequence of this, students may have fast forwarded through the video to gain access to the quiz. Because the researchers decided upon viewing >74.9% of the video duration as interacting with the majority of the provided material, fast forwarding thus affected the view time reported, resulting in a “no view” being recorded. Assuming that if the researchers had more control, students may have refrained from skipping through the video, affecting the statistical outcomes of this paper. The lack of control in this study also means the researchers were unable to gather how much time students spent studying, or what other resources they used

to enrich their learning. The present study did not require students to report their time on task, where they completed the videos and quizzes (i.e., at home, on the KSU CVM complex, at the library, other study spot, etc.), or how they interacted with the videos. It should also be noted that exam performance is affected by many factors including study methods, time spent studying, understanding of the material, intelligence, test taking abilities, etc. Inclusion of a control group in future studies may combat this current limitation.

It is worth acknowledging that within some dissection groups, only one member watched the videos. Although the students were instructed to view the assigned videos and complete the quizzes individually, without aid from others, this may indicate that some dissection groups viewed the videos together. It is unknown whether this is the reason for their lack of video interaction, but this finding could affect the statistical outcomes outlined in this paper.

Additionally worth mentioning is the interpretation of the time data collected from Echo360. Time interaction data was extracted, but it is unclear if the time presented demonstrates time spent with the video open or time spent actively playing the video. The time interaction data does not reveal whether students watched the videos at 1X speed, or fast forwarded through them using 1.5 or 2X speed. Regardless of whether the software displays time spent with the video open or time spent actively playing the video, if students watched the video at 1.5X or 2X speed, it is believed the software would adjust the output of time interaction. Irrespective of whether the videos were viewed at an increased speed, the proportion of video viewed would be the same.

This study is also limited by its evaluation of only one cohort of students throughout one semester. To strengthen this study, future directions could include a control group, or a longitudinal study over multiple DVM cohorts may further confirm pre-lab video significance. Moreover, future studies could include analysis of student undergraduate performance, pre-

requisites courses, previous anatomy experience, performance in other first-year DVM courses, etc. to determine if there are other methods of predicting student exam performance, specifically those in the lower quartile. Additionally, rather than utilizing student comments from course evaluations, a formal survey asking specific questions regarding the provided videos and quizzes could be distributed. This would allow for further qualitative analyses of student perception data to gain student judgement.

Conclusions

Positive, statistically significant correlations were found between the number of videos viewed per each exam and exam score. The highest correlation was found between the number of videos viewed for exam 4 material and practical exam 4 grade. Exam 4 video views predicted lower quartile student exam 4 grade by 21%. Importantly, lower quartile students who viewed the majority of exam 4 videos performed 14.6% better on exam 4 than lower quartile students who viewed less than the majority of exam 4 videos. This finding marks the distinction between low performing students and failing students. Furthermore, a higher quiz score was correlated to a higher practical exam score for exams 1, 2, and 4. A higher quiz score could indicate more engagement in the video, resulting in better comprehension of the material. Positive student perceptions also suggest that videos are well-liked by veterinary students, providing a visual demonstration of the material for lab preparation and as a study material, hence increasing understanding and confidence. Overall, the results suggest that videos, with embedded quizzes, positively impact student learning. This study endorses the production of videos as an additional resource to be used by students in laboratory-based courses.

Conflict of Interest

The authors do not have any conflicts of interest to disclose.

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Chapter 3 - The Use of a Novel Winter Break Pre-Course for Transitioning from Canine to Ungulate Anatomy

An anatomy pre-course during semester break

Submitted to Anatomical Sciences Education (ASE):

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The study protocol was reviewed and approved (as exempt) by the Institutional Review Board at Kansas State University #IRB-11396. Informed consent was gathered from all study participants, and they were provided with the necessary information regarding their participation in the study.

Abstract

The transition to health professional school is a pivotal phase for first-year students, marked by significant change. Furthermore, past literature has acknowledged the stress associated with anatomy courses as the content volume is large and students often have limited exposure to gross anatomy prior to professional school. To help students prepare for a new course with unfamiliar material, pre-courses can provide information necessary for transition into courses with considerable content loads. In an effort to assist students with the transition from canine to ungulate veterinary anatomy, this study introduces a novel winter break pre-course focused solely on presenting introductory anatomical terms and structures of ungulate specimens. This online pre-course was available to first year veterinary students at the Kansas State University College of Veterinary Medicine for voluntary and asynchronous interaction during winter break. Subsequent performance in the gross anatomy II course was analyzed as measurable outcomes of the effect of pre-course interaction. Statistical analyses identified positive, statistically significant correlations between pre-course interaction and exam performance in the succeeding gross anatomy II course. Qualitative analyses of student comments found positive perceptions suggesting that the pre-course was convenient and course load was adequate. Constructive feedback included suggestions for more canine review and clinical relevance. Although correlations were found in this study, future studies are needed to consider student feedback and determine whether a pre-course is a strong intervention that can improve veterinary anatomy performance.

Keywords: veterinary, anatomy, pre-course, ungulate anatomy

Introduction

The transition to health professional school including veterinary school represents a significant period of adjustment for first-year students, marked by multiple stressors that can impact mental health and academic performance. Students encounter academic hurdles such as heavy workloads, competition with peers, unclear expectations, and concerns about intelligence relative to other classmates, also called social comparison anxiety (1–3). Notably, gross anatomy courses have been identified as particularly anxiety-inducing for students across various disciplines (7–10). In veterinary school specifically, students are tasked with learning the anatomy of diverse species including carnivores, ungulates, small ruminants, avian species, and more, adding considerable academic pressure (9). Typically, species differences are discussed in a comparative manner, which adds to the course load by highlighting both minor and major differences (9). Another challenge novice health profession students face is new subject matter (4). Furthermore, students enter professional school with a variety of prior knowledge (4), leading to some students not feeling well-prepared to conquer the academic challenges of their first year (5). Across health professions education, the route to professional school is variable with diverse student backgrounds, undergraduate majors, and experiences (11). Given these challenges, professional schools have a responsibility to fully understand their educational requirements' impact on students and to support and assist them when possible (3). One such way is to incorporate supplemental resources, specifically those that prepare students for upcoming anatomical material.

Pre-Course Programs in Health Professions Education

Similar to other health professions education, medical students have acknowledged the large volume of work in their medical education (12). Although the tendency to memorize due to information overload is common among all learners, a “supersaturation” effect can negatively impact how effectively students retain course material (12). In circumstances where students are not provided outcomes and expectations, they quickly become overwhelmed and frustrated at the course load (12). To overcome these issues, pre-matriculation programs have emerged as potential interventions to enhance students’ preparedness without increasing overall curricular hours. For instance, medical students engaging in self-study methods before starting their programs have reported significant benefits (12). At institutions like Lincoln Memorial Osteopathic Medical School, pre-matriculation anatomy boot camps have been beneficial to subsequent exam performance with students presenting significantly higher scores compared to their peers (8). Similarly, Klausner *et al.* investigated the impact of pharmacy preparation courses and found significant differences in cumulative GPAs for cohorts completing such programs, suggesting a positive influence on academic performance (9). Additionally, in the medical education realm, Zhang *et al.* explored a transition course bridging medical school with clinical practice. The findings indicated positive student perceptions evidenced by their satisfaction with the course’s overall usefulness in familiarizing and preparing students for the upcoming semester (10). These examples highlight the effectiveness of preparatory educational methods in mitigating student stress and enhancing academic performance.

Preparation for Veterinary Anatomy

In veterinary anatomy education, students are typically taught the anatomy of a variety of species such as canine, bovine, equine, caprine, avian, and more. Canine anatomy is usually

taught in the first semester, followed by ungulate similarities and differences discussed in the second semester. But unlike the dog, not many resources are available to learn ungulate anatomy (13). Additionally, novice first year veterinary students often lack academic exposure to gross anatomy, emphasizing the importance of effective preparatory measures (6). Interestingly, prior undergraduate coursework in anatomy does not always correlate with performance in veterinary school, suggesting that pre-veterinary education might not align with the demands of professional education (7). Students have also acknowledged being rushed and under academic pressure in anatomy courses, providing reason for supportive learning environments (12). One such way to supplement anatomy teaching is with additional instructional guidance through computer-assisted learning (14,15). Technological advancements have prompted the inclusion of such supplemental resources for learning (16,17). Furthermore, previous literature has supported the use of multiple study methods to enhance academic performance (18,19).

In previous studies, students identified the difficulty of anatomical knowledge, content volume, and minimal time dedicated to the subject as problematic factors, but they suggested that additional lectures may mitigate these issues (12). At the Louisiana State University School of Veterinary Medicine, a pre-course was implemented during the summer to help prepare students for canine anatomy. A positive correlation was found between pre-course exam performance and exam grades in the professional anatomy course (7). Additionally, students who participated in the pre-course outperformed their peers in subsequent gross anatomy examinations. Importantly, pre-course participants reported reduced anxiety, indicating the potential psychological benefits of such preparatory measures (6). While literature exploring the effectiveness of pre-courses in veterinary education is limited, these studies still provide valuable insights into the effectiveness of preparatory courses. An additional benefit of pre-courses is the low stress associated with

participation, giving students an opportunity to make errors in a low-stakes setting prior to a high-stakes course (20).

Filling the Void

Despite minor advancements in pre-course offerings, there is a notable gap in veterinary education concerning ungulate anatomy preparatory courses, particularly those offered during semester breaks. This study introduces a novel winter break pre-course at the Kansas State University College of Veterinary Medicine (KSU CVM) focused exclusively on ungulate anatomy. This pre-course is innovative due to its timing and specific focus, diverging from the more common canine anatomy pre-courses. Such courses are important, as research has suggested that even a week-long pre-course can predict performance in a professional veterinary curriculum (9). While much data are centered around pre-matriculation pre-courses, the researchers in this study aimed to provide a resource for matriculated students who may have had little to no ungulate anatomy experience. This pre-course also aimed to introduce students to concepts covered in the subsequent spring semester course, gross anatomy II, focusing on ungulate anatomy. By offering this pre-course as a supplemental resource, our study seeks to explore the effectiveness of the course in enhancing gross anatomy II exam scores.

Aims of Current Study

This study is guided by two specific aims.

1. First, to evaluate the effectiveness of a winter break pre-course as a supplementary tool for introducing ungulate anatomy at the KSU CVM through analysis of measurable outcomes. Aligned with this aim, the first hypothesis posits that students

who interacted with the provided pre-course will have improved performance in the gross anatomy II course.

2. Second, to identify the perceived benefit of providing a winter-break pre-course to facilitate learning of ungulate anatomy. Aligned with this aim, the second hypothesis posits that student qualitative comments will reveal positive perceptions regarding the winter break pre-course. This aim also seeks to identify any perceived gaps in the pre-course material and specific areas for improvement via constructive feedback from students.

Materials and Methods

Gross Anatomy Teaching at the KSU CVM

At the KSU CVM, first-year Doctor of Veterinary Medicine (DVM) students encounter two semesters of gross anatomy. Beginning in the fall semester with gross anatomy I (VAP 806), a six-credit-hour course, students attend didactic lecture presentations three days per week followed by lab sessions also three days per week. During the lab sessions, groups of four to five students dissect a canine cadaver throughout the entirety of the semester using *Miller's Anatomy of the Dog* as their main dissection guide, along with additional course materials such as notes documents and pre-lab videos. Student contact hours for this course include thirty-seven hours of lecture and one hundred thirty-five hours of laboratory.

During the spring semester, students take gross anatomy II (VAP 816), a five-credit-hour course which focuses on comparative ungulate anatomy. Students attend lecture presentations only two days per week, but lab sessions still occur three days per week. Gross anatomy II builds

upon concepts from gross anatomy I. During the lab sessions, student groups of four to five members dissect one side of a bovine, caprine, and equine cadaver throughout the entirety of the semester by regional approach. The other side of the cadaver is simultaneously dissected by another student group, encouraging collaboration between dissection stations. Additionally, student groups alternate weekly between equine and ruminant cadavers. An in-house dissection guide, *Kansas State University's Guide to the Dissection of the Horse and Ruminant*, is the primary resource. In the final week of the course, students are briefly introduced to avian and porcine anatomy. Student contact hours include twenty-seven hours of lecture and one hundred thirty-five hours of laboratory.

Gross Anatomy II Structure

The gross anatomy II course goals included: teaching student's facts and principles of gross anatomy of large domestic animals; helping students to apply what they already know and what they are learning to real anatomical situations and problems; preparing students for their eventual use of anatomical knowledge in their veterinary career; and helping students develop the ability to work effectively and efficiently in a team setting. Various assessments were utilized throughout the course to check if the above outcomes had been met.

The gross anatomy II course in the spring of 2023 included four lecture exams and fourteen weekly lab quizzes. The first three exams were 50 questions at two points each for a total of 100 points. The fourth exam was the cumulative final exam consisting of 80 questions at two points each for a total of 160 points, with 50 questions from exams 1-3 content and 30 questions over new material. Additionally, students completed weekly low-stakes, open resource practice quizzes as well as closed-resource lab quizzes throughout the semester. The lab quizzes

focused mainly on content from the daily dissection assignments, supplemented by previously covered material, integration with lecture content, and review questions on canine anatomy. The course exams and lab quizzes were written by the instructor of record.

Creation of the Winter Break Pre-Course

To introduce students to ungulate anatomy, a novel winter-break pre-course was created as a supplemental resource to be used asynchronously by first-year veterinary students before beginning gross anatomy II in the spring (i.e., during winter break). The pre-course was especially recommended to those students with little to no ungulate experience. Although there are many similarities between canine and ungulate anatomy, the pre-course was intended to introduce students to basic ungulate differences including terminology, palpable landmarks, skeletal features, and musculature. Additionally, the pre-course discussed structures similar between species, variabilities between species, and structures of clinical importance. This allowed participants to review material discussed in gross anatomy I and begin appreciating ungulate similarities or differences. The pre-course was designed to present these fundamental principles that are learned in the beginning weeks of gross anatomy II, then built upon throughout the remainder of the spring semester. Four main topics, terminology, landmarks, skeleton, and musculature were designed into separate modules. Because students dissect an equine, and either a bovine or caprine cadaver, the four pre-course modules each contained three PowerPoint® files dedicated to these species.

Module 1: Terminology

Pre-course module 1, terminology, contained a bovine, caprine, and equine PowerPoint® file outlining specific vocabulary used for each species. The goal of this module was to help students grasp the basic language and terms used to describe male and female ungulates. This material is not usually discussed in gross anatomy II, but understanding this terminology is crucial for effective communication and comprehension throughout the gross anatomy II course. Some example terms included in this module: heifer, steer, kid, doe, foal, mare, stallion, etc. All three module 1 PowerPoints totaled 97 slides.

Module 2: Landmarks

Similarly, module 2, landmarks, contained a bovine, caprine, and equine PowerPoint® file describing palpable external features for each species. The goal of this module was to help students identify similarities and differences between canine and ungulate external landmarks. Furthermore, students were provided with the opportunity to review and reinforce fundamental palpable landmarks covered in gross anatomy I. Landmarks included in this module that are similar between species included: greater tubercle, olecranon, ischiatic tuberosity, and more. Other landmarks that are more ungulate specific included: paralumbar fossa, withers, wattle, cannon bone, throatlatch, etc. All three module 2 PowerPoints totaled 98 slides.

Module 3: Skeleton

Pre-course module 3, skeleton, followed the same pattern with three PowerPoint® files describing skeletal features for each species. The goal of this module was to help students learn and visualize skeletal similarities and differences between species. Some topics included in this

module that are ungulate specific included: nasoincisive notch, splint bone, fetlock joint, pastern joint, etc. All three module 3 PowerPoint® files totaled 106 slides.

Module 4: Musculature

The final module, musculature, followed the same pattern with three PowerPoint® files. The goal of this module was to review muscles discussed in gross anatomy I and appreciate their presentation on an ungulate specimen. Additionally, differences in musculature between species were introduced. Musculature discussed in this module included: omotransversarius, sternozygomaticus, gluteobiceps, fibularius (peroneus) tertius, and more. All three module 4 PowerPoint® files totaled 56 slides.

PowerPoint Design

All twelve PowerPoint® files provided in the pre-course were created using one of two formats. For module 1, terminology, first, an image of the respective species would appear with a question related to vocabulary. Then, on the next slide, the same species and question were presented, but the correct terminology was shown. See Figure 1. For the remaining modules, an image of the respective species with an arrow pointing to a specific structure was displayed. Then, on the next slide, the same species and arrow were presented, but the name of the indicated structure was shown. See Figure 2. Regardless of format, only one term / structure was shown per slide.

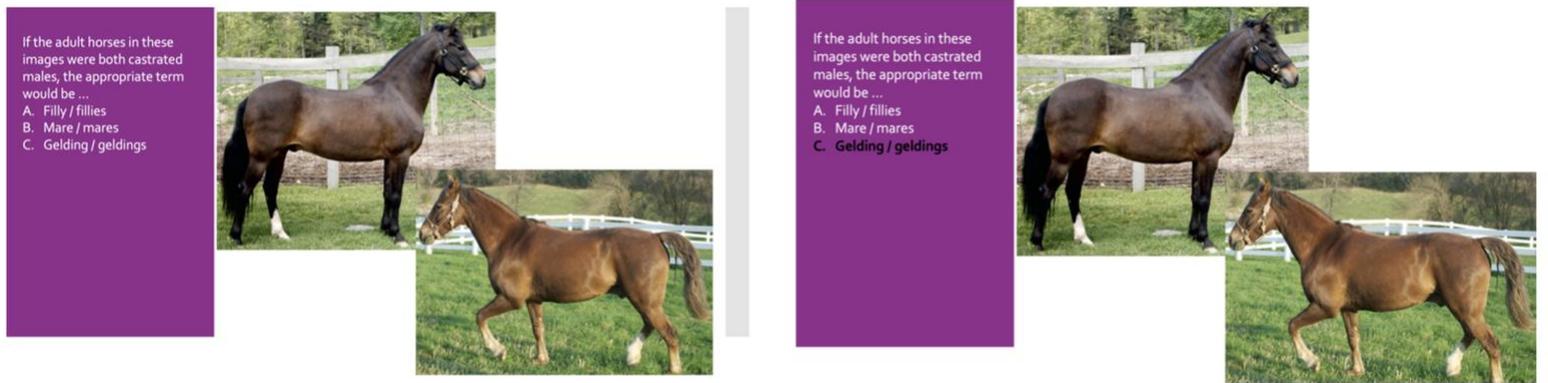


Figure 3-1: Screenshot of 2 consecutive slides in the provided “Equine Terminology” PowerPoint, displaying the format of the PowerPoint files in module 1.



Figure 3-2: Screenshot of 2 consecutive slides in the provided “Bovine Landmarks” PowerPoint in module 2, displaying the format of the PowerPoint files in modules 2 to 4.

Pre-Course Assessment

The pre-course began with a pre-test that was intended to measure student knowledge of ungulate anatomy prior to interaction with the pre-course modules, therefore establishing a baseline. The pre-test was written by the course teaching assistant and contained ten questions. The pre-test was mainly pictorial based with images taken directly from the provided PowerPoints and consisted of multiple choice, true-false, or fill-in-the-blank questions.

After interaction with each module, participants took module quizzes. For example, following review of the three module 1 PowerPoints, participants were prompted to complete the

module 1 quiz to test immediate retention of the material discussed. This pattern continued for the remaining modules with each containing a ten-question quiz consisting of multiple choice, true-false, or fill-in-the-blank questions written by the course teaching assistant. Each of the module quizzes were mainly pictorial based.

At the end of the pre-course, participants were prompted to complete the post-test. The post-test was incorporated to assess student comprehensive, long(er)-term retention of ungulate anatomy discussed in the pre-course. The post-test was written by the course teaching assistant and contained ten pictorial based questions of multiple choice, true-false, or fill-in-the-blank format. The post-test questions were matched to the pre-test questions, but they were not the same. This was done to avoid a re-test effect, which occurs when identical tests are repeatedly administered and an improvement in test score is observed (11).

The pre-course assessment questions predominantly assessed the “Remembering” level of Bloom’s Taxonomy as they focused on recalling factual information, terminology, and anatomical structures. Students were given unlimited time to complete the module quizzes and pre and posttests, but only one attempt was allowed. The Respondus Lockdown Browser (Respondus Inc., Redmond, WA, USA) was enforced and used by students to prevent their access to any additional online resources during the assessments.

Participants

The pre-course was uploaded to the Canvas Learning Management System® (Instructure Inc., Salt Lake City, UT, USA) and offered during the winter break holiday to all 116 first-year students in the Class of 2026 DVM cohort at the KSU CVM, Manhattan, Kansas. Students were provided with the necessary informed consent details, notified that interaction with the pre-

course was voluntary and at their discretion, and informed that the pre-course was not for a grade.

Pre-Course Timeline

On the Monday following the fall semester finals week, December 19th, 2022, the winter-break pre-course became available on Canvas®. Because the pre-course was available online, students were able to work through the material at their own pace. The pre-course was available for exactly four weeks and closed on Monday, January 16th, 2023, the day before the beginning of the spring semester. This deadline was enforced to encourage students to interact with the pre-course prior to the spring semester.

Post-Semester Survey

To intentionally collect student perceptions of the winter break pre-course, customized survey questions were included on the course teaching assistant's end of semester teaching evaluation. In this voluntary survey, four Likert Scale questions and one open-ended question were included. Participants were asked to provide anonymous feedback on the winter break pre-course, specifically addressing aspects such as its availability to future students, convenience in terms of timing during the holiday season, the adequacy of provided materials, and its effectiveness in preparing them for the gross anatomy II course. Responses were measured on a five-point Likert scale ranging from "strongly disagree" to "strongly agree." The open-ended question gathered respondent's perceptions of specific areas needing improvement. The inclusion of this survey was intended to enrich the researchers understanding of how the pre-course was perceived and accepted by participants.

Study Design

This mixed-methods study sought to demonstrate the impact of providing a winter break pre-course on first-year DVM student grades at the KSU CVM. Multiple different quantitative data were collected: student interaction with the pre-course (measured by number of PowerPoint® files downloaded out of twelve), performance in the pre-course (via pre-course pre, posttest, and module quiz performance), and gross anatomy II performance (via exam grades, final course grades, and lab quiz grades). Participants were additionally divided into quartiles based on gross anatomy II final grade to analyze how interaction with the winter break pre-course related to gross anatomy II exam performance across different levels of achievement. The qualitative data in this study included student perception data extracted from the post-semester survey.

Using a mixed-methods approach provides a comprehensive understanding of the effect of the pre-course. The independent variables were interaction with the pre-course, measured by number of PowerPoints downloaded. The dependent variables were pre-course module quiz scores, pre and posttest scores, and gross anatomy II performance. After the conclusion of the winter-break holiday, pre-course PowerPoints downloads, module quiz scores, and pre and posttest scores were extracted from Canvas®. Following the conclusion of the spring 2023 semester, gross anatomy II exam grades, lab quiz grades, final course grades, and qualitative comments were gathered.

Although all participants in this study were provided access to the pre-course, there were slight differences in how the participants accessed the course content. The pre-course materials were the same, but students received either a gated (required completion of specific tasks before

unlocking subsequent materials) or non-gated (open access to all materials) course. No discernable, statistically significant differences were found between the two course offerings, indicating that both pre-courses had a similar impact on student performance. In the context of this study, this finding suggests that the accessibility of the pre-course material did not yield measurable differences in student performance, meaning gating (or not gating) the material had no effect. Because of this, the researchers in this study decided to pool the data and focus on the positive, statistically significant findings as discussed below.

Statistical Analysis

The Pearson correlation coefficient was used to measure the strength of a linear association between two variables. To determine the statistical significance of the Pearson correlation coefficient, a *t*-test was performed through calculating the *t*-score and *p* value. A *p* value < 0.05 was considered statistically significant. Descriptive statistics were also used to summarize the data set. All analyses were performed using Microsoft Excel (Microsoft Inc, Seattle, WA, USA). Pre-course interaction, via PowerPoints downloaded, pre-course module quiz performance, gross anatomy II exam scores, and gross anatomy II lab practical quiz scores were extracted from the course Canvas® page and analyzed for the 99 DVM students in the Class of 2026 that interacted with the winter break pre-course. Additionally, students who interacted with the pre-course were divided into upper, middle two, and lower quartiles based on final grade in the gross anatomy II course. The data were compounded into a Microsoft Excel file. The Pearson function in Excel was used to acquire Pearson Correlation Coefficients through analysis of pre-course interaction and gross anatomy II performance.

Qualitative Analysis

To analyze student qualitative comments to the question, “Please provide any additional comments or suggestions you may have to help improve the pre-course for future students,” both a classic thematic analysis and Linguistic Inquiry and Word Count (LIWC) analysis were used. The researchers in this study used Clarke and Braun’s Six Step Data Analysis Process consisting of six phases as a framework for uncovering recurring themes and patterns within respondent’s suggestions for pre-course enhancements. The phases are 1. Familiarization with the data 2. Coding 3. Searching for themes 4. Reviewing themes 5. Defining and naming themes and 6. Writing up (21).

In addition to the thematic analysis, the LIWC-22 program was used to assess the language used by respondents in their open-ended responses. The LIWC software is designed to analyze text for various characteristics, including emotional content, cognitive processes, and linguistic style. The words people use provide psychological cues into their thought processes, emotional well-being, intentions and motivations (22). Tausczik and Pennebaker created the LIWC analysis to analyze others’ language, which thus allows understanding of their thoughts, feelings, personality, and connection with others (Pennebaker Conglomerates, Inc, Austin, TX, USA). By calculating the frequency of specific words and word categories in a given text, LIWC can provide a quantitative representation of these aspects. In this study, the LIWC analysis was used to give the researchers a better understanding of how the students felt about the adequacy and effectiveness of the pre-course.

Ethics Approval

The study protocol was reviewed and approved as exempt by the Institutional Review Board at Kansas State University #IRB-11396.

Results

Average Gross Anatomy II Exam Scores

For the Class of 2026, the average gross anatomy II exam scores were as follows: Exam 1, 83%; Exam 2, 82%; Exam 3, 79%; and the cumulative final Exam 4, 71%. Despite these exam averages, the average final course grade was 90%. The gross anatomy II course includes multiple low-stakes opportunities, including dissection checklists and weekly online quizzes.

Furthermore, students can earn extra credit through group exam reviews, adjustments to lecture exams, and maintaining dissection station cleanliness. These opportunities likely contribute to the higher overall course grade average despite lower exam averages.

Pre-Course Scores

Of the 116 students in the Class of 2026, 99 (85%) students interacted with the pre-course. For these students that interacted with the pre-course, the average pretest score was 62%. The average module quiz scores were as follows: Module 1, 99%; Module 2, 94%; Module 3, 95%; and Module 4, 84%. The average posttest score was 92%. The average improvement from pretest to posttest was 25%. The average gross anatomy II exam scores for pre-course users were as follows: Exam 1, 84%; Exam 2, 83%; Exam 3, 79%; and the cumulative final Exam 4, 71%.

Pearson Correlation Coefficients

A positive, statistically significant correlation was found between pre-course interaction and exam 1 score for middle quartile students ($R = 0.281$, T-Score = 2.052, P-Value = 0.046). Positive, statistically significant correlations were found between pre-course interaction and exam 4 score for upper quartile ($R = 0.688$, T-Score = 2.843, P-Value = 0.019) and middle quartile students ($R = 0.496$, T-Score = 2.617, P-Value = 0.016). A positive, statistically significant correlation was found between pre-course interaction and average gross anatomy II exam score for upper quartile students ($R = 0.415$ T-Score = 2.137, P-Value = 0.044).

Insignificant correlations were found between average pre-course module quiz score and average gross anatomy II exam score and pre-course interaction and average gross anatomy II lab quiz score.

Likert-Scale Analyses

Among the 116 students in the Class of 2026, the response rate for the first two survey questions was 91 (78%), and for the next two questions, it was 90 (77.5%). The suspected reason for this difference is that one student must have answered the first two questions but then failed to answer the second two questions. Standard deviations ranged from 0.9 to 1.1, suggesting moderate consistency in responses.

Future Pre-Course Availability

The first Likert Scale question stated, “The winter break pre-course should be made available to future students.” Many participants agreed or strongly agreed (84%) that the pre-course should continue to be offered, with the mean response being 4.5 out of 5. These findings reflect a positive perception of the pre-courses value.

Pre-Course Convenience

The second question stated, “Considering the timing of the winter break pre-course (during the holiday season), the course was convenient for me.” Most participants found the timing to be convenient with 79% agreeing or strongly agreeing, and the mean response being 4.3 out of 5. These findings suggest participant approval of the availability of a supplemental resource during the extended winter break.

Pre-Course Material

The third question stated, “The amount of material provided in the winter break pre-course was just right.” The mean response was 4.1 out of 5 and 73% agreed or strongly agreed. These results show that the amount of material provided was sufficient without burdening students during their school break.

Gross Anatomy II Preparation

The final question stated, “Interacting with the winter break pre-course prepared me for VAP 816 Gross Anatomy II.” Participants generally agreed (62%) that the pre-course prepared them for ungulate anatomy. These findings moderately support the efficacy of the provided material while suggesting potential improvements to enhance students’ preparedness for subsequent coursework. See Figure 3 and Table 1.

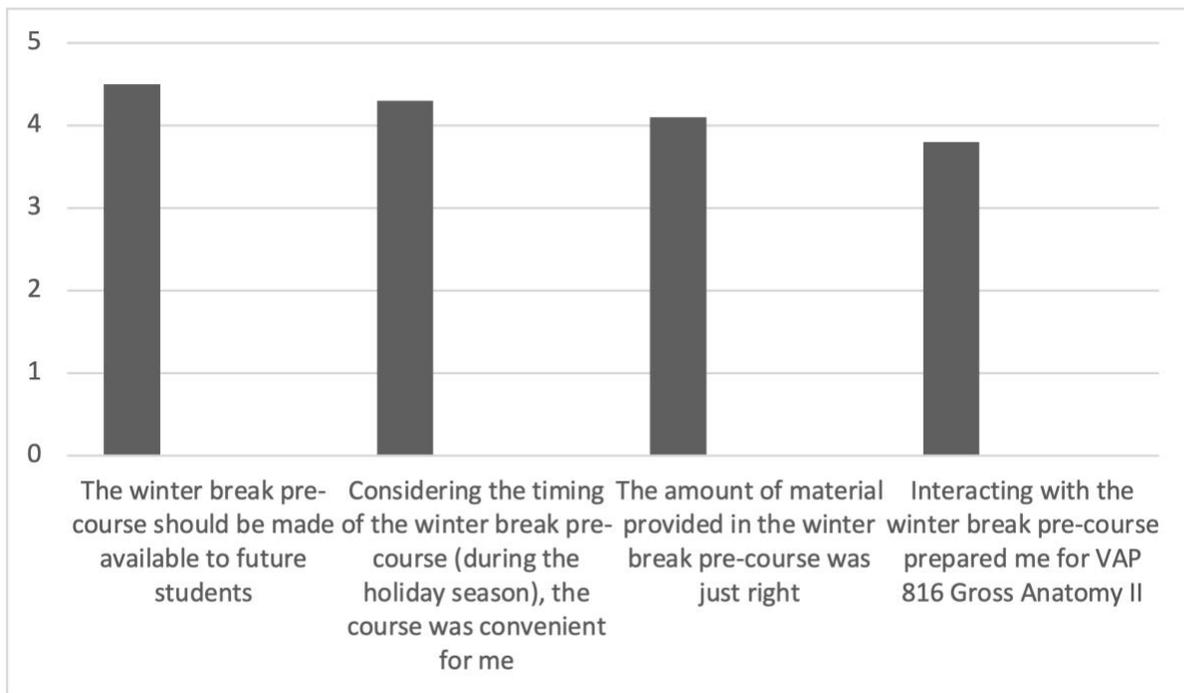


Figure 3-3: Survey analysis results for Likert scale questions. The graph illustrates mean participant responses on course availability, convenience, material adequacy, and preparation effectiveness, providing key insights into student perspectives.

| Survey Question | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree | Mean | SD |
|---|-------------------|----------|---------|-------|----------------|------|-----|
| The winter break pre-course should be made available to future students | 1 | 3 | 11 | 11 | 65 | 4.5 | 0.9 |
| Considering the timing of the winter break pre-course (during the holiday season), the course was convenient for me | 2 | 5 | 12 | 21 | 51 | 4.3 | 1 |
| The amount of material provided in the winter break pre-course was just right | 2 | 6 | 16 | 24 | 42 | 4.1 | 1.1 |
| Interacting with the winter break pre-course prepared me for VAP 816 Gross Anatomy II | 5 | 6 | 23 | 25 | 31 | 3.8 | 1.1 |

Table 3-1: This table shows the number of responses for each category (strongly disagree to strongly agree) for each question, as well as the mean response and standard deviation (SD).

Thematic Analysis

Forty students (40%) answered the open-ended question, “Please provide any additional comments or suggestions you may have to help improve the pre-course for future students.”

Using Clarke and Braun’s Six Step Data Analysis Process to analyze student responses to this statement revealed the following broad themes:

- 1. Prior Knowledge and Challenge Level:** Participants had varying views on the pre-course’s challenge level, with particularly those lacking ungulate experience finding it beneficial. Others with more ungulate experience desired more challenging and in-depth

material, revealing a divide between students with and without prior ungulate exposure.

Some comments related to this theme include:

- “I thought that the pre-course was a great idea, but I think it would be more beneficial if it was more difficult.”
- “I have a strong background in Large Animal, so I didn’t personally find the pre-course immensely helpful. It was basic enough that I knew most of the information already. However, I know many of my small animal friends appreciated it...”
- “Nerves/vessels are a complicated topic so maybe more review of those might help. Otherwise I think it was good, especially for students who don’t have large animal experience or background.”
- “It was a wonderful refresher, but as someone with a little bit of large animal experience, it was not new. I wonder if it would be possible to have a slightly advanced pre-course if you want to do more or to have resources for deeper learning. Overall, I thought it was good and would do it again if given the chance.”

2. Relevance to Anatomy: Students expressed a desire for greater alignment with more in depth topics discussed in gross anatomy II. Respondents emphasized the importance of including species differences and draws to canine anatomy, as gross anatomy II discusses comparative anatomy. Multiple comments related to this theme include:

- “I think the precourse could benefit by adding more material/in-depth material to guide review before class starts.”

- “Love the winter break pre-course to prep! Maybe you could have a little dog review to keep us fresh on that.”
- “Maybe providing some more of the more difficult topics like nerves or specific ruminant and equine differences would be beneficial so we get exposed to it more often and have different resources.”
- “... I also think it could have been very helpful to add a review section on canine anatomy to the pre-course. Just something to refresh for the comparative anatomy portion of Gross II.”

3. Flexibility and Accessibility: Opinions on course flexibility and accessibility were mixed among students. Challenges with the Respondus Lockdown Browser, which required a laptop instead of mobile devices, were noted. Some comments related to this theme include:

- “I heard from multiple students that having the pre course require lockdown browser kept students from doing it because it required the laptop and that was inconvenient compared to just an iPad or phone.”
- “I only wish that I had access to how I performed in the pre-course, but it definitely helped to have that information going into the spring semester. It was also more than manageable over break, as it did not take me more than a few days to complete the modules.”

4. Course Duration: Due to the voluntary, asynchronous nature of the course, student thoughts on the course duration varied. Some students felt the pre-course ended

prematurely, while others intentionally chose not to complete it. Comments related to this theme include:

- “I didn’t finish the precourse but I liked having the option!”
- “I was planning on finishing the Pre course right before school starting but it was already closed.”
- “It’s useful, but I didn’t finish it because I really didn’t want to study during winter break.”

5. Appreciation for the Instructor: Many participants praised the course teaching assistant for clear explanations and supportiveness via the creation of the winter break pre-course as a resource for students. A few comments related to this theme include:

- “... wonderful teacher and the pre-course helped a ton.”
- “... an amazing instructor! I really appreciated her clarity in her explanations.”
- “...does an amazing job at teaching and explaining the material. The pre-course was also very helpful.”

6. Course Improvements: Recommendations for course improvements included addressing common clinical issues within each species, focusing more on horse-related content, and providing additional exposure to bones and joints. Some students also suggested a pre-course review of what was learned in canine anatomy. Some comments related to this theme include:

- “I think it would be more beneficial to do a precourse that reviews what we learned in the dog (muscles, bony prominences) since we are expected to remember it all.”
- “I enjoyed the pre-course material and found it helpful, but I think there could be a few additions made. Possibly common issues within particular species to introduce us to the terminology for different pathologies that affect each species. Examples: Horse-laryngeal hemiplegia Cow-Hardware disease.”
- “Winter break precourse would be even more helpful if it focused on more horse-related things as that is what we learn most in class. Potentially including some bones and joints of the horse so we are exposed to them sooner.”

7. Course Value: Perspectives on the pre-course’s value varied among students, with some finding it helpful and others not perceiving significant benefits. Multiple comments related to this theme include:

- “The pre-course could’ve been more challenging to truly stimulate us to think more about the content and prepare us but otherwise it is a good idea. And I felt that the course was pretty convenient and easy.”
- “I enjoyed the pre-course!”
- “As someone with limited large animal experience this was MUCH appreciated, especially the common terminology. I would highly recommend future students to partake in it.”
- “The precourse material is a great introduction for students that have little large animal background. It seems that it isn’t as effective for students with prior

experience and possibly having more in-depth material could help prepare students for the semester.”

In summary, the analysis indicates that while students appreciated certain aspects of the pre-course, improvements in course load, difficulty of pre-course material, and inclusion of clinical relevance and canine review are desired. While participants with limited ungulate experience found it beneficial, others sought more advanced content. Suggestions also included aligning the pre-course material more closely with gross anatomy II topics and addressing accessibility concerns, such as device compatibility with the Lockdown Browser. See Tables 2 and 4.

| Broad Themes | Key points |
|-------------------------------------|--|
| Prior knowledge and challenge level | <p>Many students, especially those with limited ungulate experience, found the pre-course beneficial in providing them with essential knowledge.</p> <p>For some students, the pre-course material was too easy, and they expressed their desire for more challenging and in-depth topics.</p> <p>These findings suggest that the effectiveness and relevance of the pre-course material may vary depending on student prior knowledge and experience.</p> |
| Relevance to anatomy | <p>Several students mentioned that the material wasn't as relevant to Anatomy II as they would have liked. They suggested including more important species differences and a review of canine anatomy, given the comparative component of Anatomy II.</p> <p>Some students found the pre-course more useful for clinical skills than for Anatomy II.</p> |
| Flexibility and accessibility | <p>Some students were content with the level of flexibility suggesting that the course structure suited their preferences.</p> <p>Other students requested access to all modules at once indicating a preference for a more open, non-gated structure.</p> <p>Some students found the lockdown browser requirement inconvenient as it necessitated a laptop rather than allowing access through mobile devices.</p> |
| Course materials and structure | <p>Some students thought that the course materials could have been more comprehensive or could have been provided earlier.</p> <p>Some also suggested incorporating a short video for each module.</p> |
| Course duration | <p>Some students expressed concerns about the timing of the pre-course occurring during the holiday season.</p> <p>Some students mentioned the pre-course ended before they had the chance to finish it, while others mentioned they intentionally did not complete it due to the holiday break.</p> |
| Appreciation for the instructor | <p>Many students praised the instructor for clear explanations, passion, and supportiveness.</p> |
| Course improvements | <p>Some students requested common clinical presentations of each specie to provide more practical insights and relevance, and more equine focus.</p> <p>Some students requested the pre-course include review material from canine anatomy.</p> |
| Course value | <p>A few students did not find the pre-course valuable or helpful. The perceived value seemed to vary greatly among students, with some finding it indispensable and others not finding it beneficial.</p> |

Table 3-2: Displaying the identified broad themes from the thematic analysis of student comments to the statement, “Please provide any additional comments or suggestions you may have to help improve the pre-course for future students.”

Linguistic Inquiry and Word Count (LIWC) Analysis

Utilizing the LIWC analysis to assess student responses to the open-ended question, “Please provide any additional comments or suggestions you may have to help improve the pre-course for future students,” revealed the following results. See Tables 3 and 4 for a summary.

- 1. Word Count (WC):** There were a total of 1347 words in the responses.
- 2. Analytic Thinking:** A balanced score of 42.86 suggests a thoughtful and analytical approach. Students used words that suggest formal, logical, and hierarchical thinking.
- 3. Clout:** A moderate value of 13.05 indicates a measured and balanced tone. Clout represents the perceived influence or confidence in the text.
- 4. Authenticity:** A higher value of 65.67 indicates a genuine and sincere tone, reflecting the authenticity of expression in the responses.
- 5. Emotional Tone:** A higher value of 90.85 suggests a predominantly positive sentiment, quantifying the overall emotional tone of the text.
- 6.** While emotional tone was positive, no negative emotions (emo_neg: 0) were found in student responses. Cognitive processes (Cogproc) were present at 18.26, indicating a substantial level of cognitive engagement and analytical thought in the responses. The

use of personal pronouns, particularly first-person singular (I), was at 4.68, suggesting a balanced integration of personal perspective without excessive self-focus.

In summary, the LIWC analysis of student responses regarding improvements to the pre-course indicated thoughtful and analytical writing, with authentic and positive tones. Analytical thinking in the feedback indicates thoughtful consideration of pre-course experiences while providing the researchers with constructive feedback for improving the pre-course.

| LIWC Category | Score |
|---------------------------------|--------------|
| Word Count (WC) | 1347 |
| Analytic Thinking | 42.9 |
| Clout | 13.1 |
| Authenticity | 65.7 |
| Emotional Tone | 90.9 |
| Words Per Sentence (WPS) | 19.2 |
| Dictionary Words (Dic) | 87.2 |
| Function Words | 74.9 |
| Personal Pronouns (Ppron) | 14 |
| First Person Singular (I) | 4.68 |
| Cognitive Processes (Cogproc) | 18.3 |
| Positive Emotions (emo_pos) | 1.63 |
| Negative Emotions (emo_neg) | 0 |
| Social References (socrefs) | 4.38 |
| Focus on Past (focuspast) | 0.59 |
| Focus on Present (focuspresent) | 8.46 |

Table 3-3: This table shows the Linguistic Inquiry and Word Count (LIWC) Analysis summary.

| Theme | Findings | Quantitative Evidence | Qualitative Evidence |
|--|--|---|---|
| Value of Pre-course Material | The pre-course material was effective in preparing students for the gross anatomy II course, although there were concerns about the timing and volume of material | Mean score of 4.5 on convenience of timing, and 4.1 on amount of material | Positive student comments on the pre-course material, with concerns about timing and volume |
| Course Structure and Organization | The course structure and organization impacted students' perceived preparedness and eventual performance. High-quality and clear PowerPoint files were beneficial, while heavy course load was a challenge | LIWC "Analytic" score of 42.86, indicating analytical thinking in student responses | Comments on course load, clarity of course materials, and quality of the course structure |
| Instructor Support and Guidance | Instructor support and teaching style contributed positively to student confidence and perceived preparedness | LIWC "Clout" and "Authentic" scores of 13.05 and 65.67, respectively, indicating influence and authenticity | Positive comments on instructor support and teaching style |
| Future Improvements | Suggestions for improvements included course load, timing and volume of pre-course material, and quality consistency across lectures | N/A | Student suggestions for improving the course and pre-course material |

Table 3-4: This table offers a condensed summary of the narrative, providing clear links between the themes, findings, and the evidence from both the quantitative (Likert-scale and LIWC analysis) and qualitative data (student comments).

Discussion

This study was guided by two specific aims: 1. To evaluate the effectiveness of the pre-course 2. To describe the perceived benefit of the pre-course and identify areas for improvement, especially since this was the first offering of this novel pre-course. The study findings suggest that the pre-course was somewhat effective in preparing students for ungulate anatomy, overall was positively perceived by students, and constructive feedback identified areas for improvement. Nonetheless, these findings support the implementation of a winter break pre-course while highlighting the need for revision, repurpose, and restructure of the pre-course for future cohorts to improve the experimental design and address participant constructive feedback.

In this study, comparing the effect of winter break pre-course interaction on gross anatomy II exam scores, some positive, statistically significant correlations were found. For pre-course users in the upper quartile, pre-course interaction was positively correlated to exam 4 score and average gross anatomy II score. For pre-course users in the middle quartile, positive, statistically significant correlations were found between pre-course interaction and exam 1 and 4 score. These findings complement past literature from an osteopathic medical school in which students who completed an anatomy boot camp had better early-semester exam grades than non-anatomy boot camp users (23). Additionally, findings from a pharmacy prep course found that students who completed the pre-course had significantly higher grade point averages in the first and second years of pharmacy school compared to non-pre-course users (24). A veterinary anatomy pre-course also found that pre-course users performed significantly better on the first examination of the semester than non-pre-course users (20). Some of the findings in the present study align with previous literature and may indicate a positive correlation between active engagement with the pre-course material and improved exam performance.

Notably, the absence of correlation for lower quartile students may indicate that this subgroup may not have engaged with the pre-course material to the same extent as their classmates in the upper and middle quartiles. This lack of correlation suggests that their level of interaction with the pre-course content may not have been sufficient to influence their gross anatomy II exam scores. Additionally, the study revealed an interesting pattern in the correlations between winter break pre-course interaction and gross anatomy II exam scores. Despite what was intended to be introductory material included in the pre-course, correlations were observed for exams 1 and 4, but not for exams 2 and 3. One explanation for this may be

that the timing of when the pre-course material became applicable to the exams influenced the observed correlations.

Due to the experimental design, informed consent was collected only from those students who interacted with the pre-course. In this study, given that a supplemental resource was provided to students with the intention that it could help prepare and improve their performance in gross anatomy II, the pre-course had to be provided to all 116 students in the cohort. Because the pre-course was optional and students were instructed to engage with the course at their own discretion, there were 17 students who did not utilize the pre-course. Because of our failure to gather informed consent from these students, we could not assess their performance in gross anatomy II in comparison to pre-course users.

In this study, the Pearson Correlation Coefficient was used to examine potential quantifiable, linear associations between pre-course interaction and gross anatomy II performance. Correlation data does not indicate causation, but instead illustrates that as one variable increases (i.e., interaction with the pre-course via number of PowerPoints downloaded) then the other variable increases (i.e., gross anatomy II exam scores). We are not indicating that pre-course interaction caused increases in exam scores, and it should be noted that exam performance is affected by many factors including study methods, time spent studying, understanding of the material, intelligence, test taking abilities, etc.

When conducting multiple comparisons, the likelihood of making a Type I error increases, leading to the incorrect rejection of a true null hypothesis. In the context of this study and its correlation analyses, the likelihood of encountering a statistical anomaly increases. Therefore, it is important to note that the significance found between pre-course interaction and exam performance may be a statistical anomaly. To overcome this, the alpha value could be

adjusted to 0.01 instead of 0.05., but this reveals no statistical significance found in the present study.

Extensive analysis of student perception data was conducted in this study via survey evaluations, linguistic inquiry, and thematic analysis. The Likert Scale survey results indicate a generally positive reception, with some students strongly advocating for the pre-course's availability to future cohorts. Also, the responses highlight the perceived convenience of the course, as well as its impact on students' preparedness for the subsequent gross anatomy II course. The latter finding aligns with qualitative results from a pre-matriculation pre-course study in which veterinary students reflected that early exposure to anatomy was beneficial (20).

The LIWC analysis further highlights the constructive feedback and analytical thinking of students' responses. Responses regarding improvements to the pre-course were authentic in tone and positive in emotion. In the analysis of student responses, it is notable to mention the use of personal pronouns and absence of negative feedback. Despite the diverse range of suggestions and recommendations provided by students to improve the pre-course, none of the respondents expressed thoughts suggesting that the pre-course was completely irrelevant or unapplicable.

The thematic analysis of student responses provided valuable insights into their perceptions of the winter break pre-course. The qualitative analyses revealed a diverse range of opinions, allowing the researchers in this study to reflect on the good and bad parts of the pre-course. Students with limited ungulate experience appreciated the pre-course's material, while others sought more depth, indicating a diverse perspective influenced by prior knowledge. Students requested greater alignment with the material discussed in gross anatomy II while emphasizing the need for species differences and clinical skills. Students expressed a desire for

improvements in course load, difficulty of content, volume of pre-course material, and inclusion of canine review and clinical relevance.

Overall, qualitative analyses found the pre-course to be a beneficial supplemental resource, providing the Class of 2026 the opportunity to familiarize and prepare for ungulate anatomy. Because this was the first offering of the novel winter break pre-course, the researchers in this study value the student feedback and will use the comments to further reconfigure the pre-course for future implementation.

Limitations

The present study is limited by its inability to include a control group. As previously mentioned, informed consent was collected only from those students who interacted with the pre-course. Because of our failure to gather informed consent from these students, we could not assess their performance in gross anatomy II compared to pre-course users. In future studies, a crucial modification will involve obtaining informed consent from all students, including those who choose not to utilize the pre-course. This approach ensures a comprehensive understanding of the impact of the pre-course on student performance by including both users and non-users in the analysis. Additionally, this is one reason for the study to analyze correlation data over causation. Rather than a comparison between experimental and control groups, the study instead analyzes the effect of interaction with the optional pre-course on exam scores.

Additionally, because the pre-course was available online during winter break, this was not a controlled study. This means because the students were instructed to download the pre-course PowerPoints and complete the module quizzes on their own time, the researchers were not actively observing the students as they completed this task. As a consequence of this, it is

unknown whether students may have utilized outside resources to enhance their performance on the pre-course pretest, module quizzes, or posttest, therefore effecting their performance and the statistical outcomes of this paper. The present study also did not require students to report their time on task. The lack of control in this study means the researchers were unable to gather how much time the students spent studying the pre-course material, or what other resources they used to enrich their learning. In future studies, the researchers want to include more resources than just PowerPoints (i.e., brief lectures, short video descriptions, etc.) to assess which of these was preferred by pre-course users.

An additional limitation of the current study was the implementation of the Respondus Lockdown Browser on the pre-course pretest, module quizzes, and posttest. While intended to maintain a controlled testing environment by preventing access to external resources, the browser introduced a limitation due to its lack of compatibility with iPads or mobile devices. This restriction meant students had to rely on computers for quiz completion, potentially influencing the accessibility and convenience of the pre-course. Future studies should consider alternative assessment methods that are more accessible.

In this study, the researchers did not collect student background data. For example, it would have been beneficial to know how much ungulate experience students had prior to their interaction with the pre-course. The lack of this information hinders the researchers' ability to determine whether variations in students' qualitative responses or quantitative performance were influenced by their pre-existing knowledge, experience, or lack thereof. As seen in student open-ended responses, ungulate experience impacted students' perceived challenge level of the pre-course and their preferences for pre-course material depth. But this is just an observation as prior experience data was not collected. Additionally, students with extensive ungulate exposure might

have different expectations and needs compared to those without prior experience. Future studies will include a survey prior to the pre-course to gather student experience with ungulates, both in clinical practice and the classroom.

Self-selection bias presents a limitation in this study due to the voluntary nature of participation. Self-selection bias occurs when individuals who choose to participate in a study exhibit distinct characteristics, attitudes, or motivations that differentiate them from those who chose not to participate. In the context of this study, the pre-course was optional and student engagement was voluntary. The characteristics of the participants who chose to interact with the pre-course may not be representative of the entire cohort. For instance, those who chose to engage with the pre-course material might have a higher motivation to excel in their studies or more interest in ungulate anatomy. Consequently, the study's findings may primarily reflect the experiences and perspectives of a subgroup of students who are more motivated or invested in their academic performance.

Finally, this study is also limited by its evaluation of only one cohort of students throughout one (inaugural) offering of the pre-course and throughout one semester. To strengthen this study, future directions could include a control group and a longitudinal study over multiple DVM cohorts to confirm pre-course significance. Future studies could include analysis of student undergraduate performance, pre-requisites courses, previous anatomy experience, performance in other first-year DVM courses, etc. to determine if there are other methods of predicting student performance in gross anatomy II.

Conclusions

In conclusion, our study revealed positive, statistically significant correlations between winter break pre-course interaction and gross anatomy II exam scores. Particularly for upper and middle quartile students, pre-course interaction positively influences gross anatomy II exam scores. This suggests that active engagement with the pre-course material is correlated to better exam performance. No statistically significant correlations were found for lower quartile students indicating that their interaction with the pre-course (or lack thereof) had no effect on their gross anatomy II performance. Positive student perceptions did suggest that the pre-course was well-liked by veterinary students, providing the Class of 2026 the opportunity to familiarize and prepare for ungulate anatomy. Overall, the results suggest that a winter-break pre-course is a supplemental resource that may be provided to help prepare students for new material, but future studies are needed to potentially conform to student feedback and determine whether a pre-course is a strong intervention that can improve veterinary anatomy performance.

Future Work

Because this was the first offering of the novel winter break pre-course, the researchers in this study are aware of the need for substantial improvement in experimental design and pre-course material. To improve upon this work, the researchers want to re-configure the pre-course. First, future studies will inquire students of their previous ungulate experience in both clinical settings and study of ungulate anatomy. Second, there will be only one pre-course type with gated modules. Because no discernable differences were found between gated or non-gated modules, the researchers want to offer only one pre-course type. Future pre-courses will include gated modules to ensure that students move through the material in sequential order, much like how material is taught during the regular semester. Next, the current pre-course included

introductory material to help students establish foundational knowledge. This may be one reason for the statistical anomalies found in the present study. In future pre-courses, the material will include introduction to the anatomy of the neck, shoulder, thorax, and abdomen as this is the material that is found on exam 1. This will allow for clear analyses to assess whether pre-course interaction enhanced student performance on exam 1 only. The researchers want to include more resources than just PowerPoints (i.e., brief lectures, short video descriptions, etc.) to assess which of these is preferred by pre-course users in future studies. Future data analyses could include an ANOVA comparison of pre-course users and non-pre-course users as well as Pearson Correlations to compare interaction and gross anatomy II performance. Based on student feedback, future pre-courses will include canine review. Although gross anatomy II is an ungulate anatomy course, it acts like a comparative course in which ungulate anatomy is related to canine material that was previously discussed in gross anatomy I. This provides context for this student request, so future pre-courses will comply with this feedback. Gross anatomy II exams also include canine review questions, so this will allow the researchers to compare pre-course users and nonusers' performance on canine review questions. Finally, future studies will still include student perception analyses. Understanding student perceptions of educational resources is crucial for fostering effective learning environments. As educators to future health professionals, the researchers believe that gathering student perception data provides valuable insights into the impact of the created supplemental resources. Furthermore, these resources may then be tailored to meet students' needs. Knowing how students feel about the resources we provide allows for continuous improvement and ensures that educational materials are not only informative but also engaging and conducive to optimal learning experiences. This commitment

to understanding student perspectives enhances the overall quality of our education and aligns with our student-centered approach to our instructional design.

Conflict of Interest

The authors do not have any conflicts of interest to disclose.

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Chapter 4 - Assessing Veterinarians' Perspectives on the Applicability of Anatomy Education to Clinical Practice

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Abstract

Gross anatomy is a foundational course that equips students with essential skills as practicing veterinarians. However, past literature has debated whether anatomy education is effectively preparing graduates for real-world care with veterinarians often feeling inadequately prepared to apply anatomical knowledge in clinical practice. This study aimed to investigate alumni perceptions of the adequacy, applicability, and relevance of anatomy education at the Kansas State University College of Veterinary Medicine (KSU CVM). The “Anatomy Education Adequacy and Clinical Practice Readiness” questionnaire was designed and distributed to five graduating classes of alumni from the KSU CVM. This reliable survey included binomial, Likert Scale, categorical, and open-ended style questions to purposefully collect descriptive, quantitative, and qualitative data. Median responses were compared between graduating class, clinician focus area, and specialty (residency, PhD, etc.). Respondents revealed positive perceptions of anatomy education, highlighting the consistency and effectiveness of the KSU CVM anatomy curriculum. Some statistically significant differences were found in respondent perceived preparedness for common species, applicability of anatomical knowledge, and confidence when communicating with clients and colleagues. Qualitative analyses of open-ended responses also found positive perceptions of alumni experiences in KSU CVM anatomy courses. Additionally, respondents provided constructive feedback on how to improve anatomy education. These findings emphasize the importance of gathering alumni perceptions to ensure that the curriculum is adequately preparing graduates for real-world application.

Keywords: veterinary, anatomy, survey, clinician, alumni perceptions, anatomy curriculum

Introduction

Gross anatomy has long since been at the forefront of veterinary and medical education by providing learners with foundational knowledge (1,2). Anatomy supplies a basis for physical examination, interpretation of medical imagery, surgery, safe clinical practices, effective communication with clients and colleagues, and is arguably relevant in all aspects of healthcare (1–8). Traditionally, cadaveric dissection, supplemented with prosected specimens, has been the preferred method of teaching anatomy due to its effectiveness in facilitating an in-depth understanding of anatomical structures (3,9–12). Dissection has been a vital teaching tool as students practice teamworking skills, time management, independent learning, and hands-on examination (13). Through understanding of location and function of major structures, students begin to appreciate the spatial and functional relationships between structures (11). A solid understanding of anatomical structures is essential for veterinary graduates as they enter practice, navigating the challenges of diagnosing and treating patients. However, contemporary trends in professional education reveal a concerning decline in contact hours and resources dedicated to anatomy education (2,3,14,15). Both medical and veterinary anatomy have been refined and modernized, specifically to include more clinical and professional skills training (2). Much debate has risen regarding the competency of new graduates and whether traditional and modern teaching practices are preparing students for real-world care (1,2,16,17). Nevertheless, literature regarding the impact of anatomy education on veterinary graduates is lacking (13). Despite these challenges, the importance of anatomy education remains, as evidenced by its critical role in shaping clinical competence.

Past Survey Research

Surveys of students and recent graduates have revealed that many medical and veterinary graduates feel unprepared to effectively apply their anatomical knowledge in clinical settings. These surveys identify a gap between theoretical understanding and practical application, suggesting the need for improved educational approaches (2).

Veterinary

A survey of young veterinary graduates in the UK found only 25% thought their veterinary education prepared them well-enough to handle patients (18). Veterinary anatomy is a fundamental component of veterinary education by providing learners with foundational knowledge that is applicable to multiple aspects of patient care: physical exams, diagnoses, surgery, interpretation of diagnostic imagery, professional communication, and more (19). Therefore, these survey findings highlight the importance of seeking additional feedback that can lead to improvements in anatomy education. Alumni surveys can address potential shortcomings in veterinary education to better prepare graduates for clinical practice. Additionally, as many veterinary schools have transitioned to a competency-based curriculum with focus on new graduate abilities and competencies (20), institutions can gather valuable feedback into aspects of anatomy education that may require improvement to better align with the demands of contemporary veterinary practice.

Medical

For medical graduates, 77% felt their anatomical knowledge prepared them to practice competently (2,21). Although, clinicians have reported a perceived inadequacy in recent medical graduates' anatomical knowledge, with 61% of respondents expressing concerns about

graduates' preparedness for safe medical practice (22). This deficiency in anatomical knowledge has significant implications for patient care and safety (10). Due to the lack of evidence in the veterinary anatomy realm, more studies are needed to explore how efficient anatomy education is in helping to prepare veterinarians for clinical practice and identify any gaps in the curriculum.

Navigating Challenges and Innovations

In healthcare, the number of specialties is on the rise, however, both medical and veterinary graduates usually opt for primary care (2,23,24). Among veterinarians, 92% choose primary care practice, reflecting a preference for first opinion clinics (2). In veterinary education, graduates are expected to demonstrate comprehensive competency across various common species (2,20). While the majority of new graduates favor small animal general practice, the veterinary profession also offers diverse career trajectories, including species-specific or mixed species focuses (2). Recently, the need for additional general practice relevance has been highlighted (2,25–27).

Upon receiving their degree, veterinarians are immediately eligible to begin medical practice (28), emphasizing the significance of anatomical knowledge and gaining feedback from graduates regarding their perceived adequacy of anatomy education. Importantly, inadequate anatomical knowledge effects veterinarian confidence and decision-making (2,28).

In medical education, where doctors focus primarily on the human species, a core anatomy curriculum has been established using the Delphi method (2). Contrarily, limited progress has been made in developing analogous curricula for veterinary education, partly due to the challenge of addressing the diverse needs of multiple species (2). Within the last year, researchers began using the Delphi method to develop a core syllabus for veterinary anatomy

(28). However, from that study, the effectiveness of the determined core foundational anatomical knowledge needed by new graduate veterinarians has not been assessed.

Despite ongoing challenges in aligning veterinary education with the diverse needs of veterinarians handling multiple species, the emergence of competency-based veterinary education (CBVE) offers a promising framework for addressing these complexities. Moving forward, it's crucial to engage with alumni to assess their preparedness for clinical practice and identify areas for continuous improvement in veterinary anatomy education. Additionally, alumni perceptions can help identify areas where adjustments may be needed to optimize the CBVE framework and ensure that future generations of veterinarians are well-prepared for veterinary medicine.

Enhancing Anatomy Education Via Alumni Perceptions

Because of the above findings, it is important for anatomy educators to include evidence-based teaching methodologies (3). To enhance anatomy education, informed decision making can be completed through the analysis of student, teacher (3), and alumni preferences. Student preferences help educators identify effective course design and pedagogical methods best suited for those actively in the classroom (3,7). By tapping into alumni perceptions of anatomy education, educators can evaluate the curriculum, therefore optimizing time, resources, and teaching methods that effectively convey skills and values essential for a successful career in veterinary medicine (3,13). As the field of veterinary medicine is ever evolving, it is important to assess alumni perceptions regarding the applicability, usefulness, and clinical relevancy of anatomy to veterinary careers, ensuring precise preparation of graduates.

Aims of the Current Study

There are three aims of the present study.

1. Evaluation of Alumni Perceptions:

The first aim was to evaluate Kansas State University College of Veterinary Medicine (KSU CVM) alumni perceptions of the relevance, applicability, and effectiveness of anatomy knowledge for clinical practice.

2. Comparative Analysis:

The next aim was to compare the perceptions of veterinarians across different graduating classes, primary focus areas, and specialties to determine if there are significant differences in their views of the adequacy, applicability, and relevance of KSU CVM anatomy education.

3. Curriculum Improvement:

The third aim was to identify any perceived gaps in the curriculum and specific areas for improvement via constructive feedback from alumni.

Methods

Course Structure

At the KSU CVM, first-year Doctor of Veterinary Medicine (DVM) students take two semesters of gross anatomy. In the fall semester, students encounter VAP 806, gross anatomy I, which is a six-credit hour course. This course consists of thirty-seven student contact hours of lecture presentations (three days per week for sixteen weeks) and one hundred thirty-five hours

of laboratory in which groups of four to five students dissect a canine cadaver throughout the entirety of the semester. In the spring semester, students take VAP 816, gross anatomy II, which is a five-credit hour course primarily focusing on ungulate anatomy. Gross anatomy II differs in that students receive lecture presentations two days a week (twenty-seven student contact hours) and groups dissect equine, bovine, and caprine cadavers throughout most of the semester, with fetal porcine and avian dissections in the final week. This comprehensive approach to anatomy education is designed to equip students with the knowledge and skills essential for the remainder of their professional schooling and success in their veterinary careers.

Study Design

This mixed-methods study sought to gather retrospective opinions from KSU CVM alumni via an online Qualtrics® “Anatomy Education Adequacy and Clinical Practice Readiness” questionnaire consisting of binomial, categorical, Likert Scale, and open-ended question style. The binomial and Likert Scale questions were designed to gather quantitative data. Binomial questions required a “yes” or “no” response, while Likert Scale questions generally measured the degree of agreement or disagreement with statements on a one (strongly disagree) to five (strongly agree) numerical scale. Additionally, categorical questions aimed to gather demographic and professional details from respondents, such as their graduation year and primary focus area within their veterinary practice. These categorical questions provide context regarding the backgrounds and specialties of the participants. These quantitative methods are aimed to summarize data and identify patterns and trends in alumni perceptions of their anatomy education. The open-ended question at the end of the survey was intended to collect qualitative data from alumni written responses, offering an in-depth look into their experiences and

perceptions of anatomy education. Following the closure of the survey (after about seven weeks), both quantitative and qualitative responses were analyzed. In this study, a mixed-methods approach combining quantitative and qualitative data collection and analysis was used to provide a comprehensive understanding of alumni perceptions of their experience with KSU CVM anatomy courses.

Sampling Procedures

The target population in this study is DVM alumni from the KSU CVM. Utilizing a purposive sampling approach, a brief Qualtrics® survey was distributed to the sampling frame, KSU CVM alumni who graduated between the years 2018 and 2023, including a six-year span of DVM graduates. The graduating class of 2023 acted as the pilot study, while the graduating classes of 2018 to 2022 acted as the broader population. A list of DVM alumni contact information was acquired through the KSU CVM Office of Alumni & Events. Excluded from this study were alumni not living in the United States, deceased alumni, alumni with no email address found, alumni not currently practicing veterinary medicine, and/or those given honorary DVM degrees from the KSU CVM. This purposively selected sample of DVM graduates from a six-year period will allow for a wide distribution of age, experiences, veterinary specialties, focus areas, and retrospective opinions, of which specialty, focus area, and opinion data were gathered.

Anatomy Education Adequacy and Clinical Practice Readiness Questionnaire

The “Anatomy Education Adequacy and Clinical Practice Readiness” questionnaire, which can be found as supplemental material in Appendix A, was created to analyze clinician’s

retrospective views of veterinary anatomy courses taken during the time of their DVM education at the KSU CVM. The survey was carefully developed to elicit retrospective opinions from respondents regarding their educational experiences and the perceived relevance and applicability of anatomy knowledge to their clinical practice. The questionnaire was comprised entirely of forced response questions, with the exception of the final open-ended question that was voluntary. The beginning of the survey sought to gather categorical data from participants regarding respondents' graduation year, participation in gross anatomy courses at the KSU CVM, current professional status as practicing veterinarians, pursuit of specialty training, and primary focus areas within their veterinary practice. These questions were developed to filter excluded participants and gather categorical data in which respondents would later be grouped during the statistical analysis. The remainder of the questions address various relevant topics and perceptions of the adequacy and applicability of graduate's anatomy education. Additionally, the questionnaire identifies the extent to which respondents believe their KSU CVM anatomy courses prepared them for clinical practice, their confidence levels in applying anatomical knowledge in decision-making and communication with clients and colleagues, as well as their overall success in their veterinary careers attributable to their anatomy education. Respondents were asked to reflect on the frequency of recalling anatomical terms, the adequacy of their anatomy education in preparing them for physical examinations and surgeries, and their suggestions for potential improvements to the KSU anatomy courses. The survey consisted of fifteen questions for the pilot study (graduating class of 2023). Following analysis of the pilot study, an additional question was added to gauge respondents' perceptions of how well KSU CVM anatomy courses prepared them for the species they commonly encounter in practice.

Thus, the questionnaire consisted of sixteen questions for the broader population (graduating classes of 2018 to 2022).

Surveying Procedures and Participant Recruitment

Through the Office of Alumni & Events, alumni email addresses of KSU CVM graduates from the graduating classes of 2018 to 2023 were obtained. A link to the “Anatomy Education Adequacy and Clinical Practice Readiness” Qualtrics® questionnaire, and appropriate informed consent information, were emailed to the respective graduating classes. It should be noted that participation in the survey was entirely voluntary, and respondents were assured that their responses would be kept confidential and used only for research purposes. No identifying information was collected to maintain anonymity and protect participants’ privacy. The Office of Alumni & Events possesses access to graduating class Listservs, so these individuals were responsible for emailing the survey link and corresponding details to KSU CVM alumni. Additionally, the Office of Alumni & Events sent reminder emails approximately every two weeks to prompt alumni to complete the survey, if they had not already done so. In an effort to be user-friendly, this single-mode survey was administered electronically to permit completion of the questionnaire via phone or computer. To optimize response rates, participants were made aware of their chance to win an incentive from the campus store at the KSU CVM. Respondents were approached in a professional manner, emphasizing the significance of their contribution to the study and how their responses would be instrumental in evaluating and potentially refining gross anatomy teaching practices at the KSU CVM. The survey closed after about seven weeks, and randomly selected respondents were promptly awarded their incentive as a token of

appreciation for their participation. Following survey closure, data were exported from Qualtrics® and analyzed.

Survey Improvement

A pilot test was conducted to assess the effectiveness of the survey questions and the clarity of the survey instrument. The pilot test involved administering the survey to alumni from the graduating class of 2023, serving as the pilot study group. Due to the unique circumstances surrounding the pilot study group, including the onset of the COVID-19 pandemic during their anatomy courses and their limited experience as practicing veterinarians, the primary focus of the pilot study was to assess the clarity and effectiveness of the survey questions. This evaluation focused particularly on identifying any logistical issues or potential misunderstandings. Importantly, the pilot test was done prior to full distribution of the survey to five graduating classes. Because the pilot study was intended for analysis of the survey questions, this led to minor improvement and alteration of question items. An additional question was added to the questionnaire to elicit respondents' perceptions of how well KSU CVM anatomy courses prepared them for the species they commonly encounter in practice. Once the necessary revisions were made based on the findings from the pilot test, the survey was then administered to the broader population of KSU CVM alumni from the graduating classes of 2018 to 2022. This larger-scale administration of the survey allowed for the collection of data from a more diverse and representative sample of alumni, encompassing a wider range of experiences and perspectives.

Statistical Analysis

The “Anatomy Education Adequacy and Clinical Practice Readiness” questionnaire used in this study primarily collected ordinal or rank data due to its Likert Scale nature. To analyze these ranked responses, the Kruskal-Wallis test, a non-parametric statistical method also known as a one-way ANOVA on ranks, was used. This test compares the medians of three or more independent groups to detect any significant differences, with the null hypothesis assuming no significant difference. In the present study, the Kruskal-Wallis test was used to compare responses between graduating class (classes of 2018 to 2022) as well as focus area (small animal, mixed animal, equine, food animal, and exotics) without assuming any specific distribution of the data within each group.

An appropriate post-hoc test to use after conducting the Kruskal-Wallis test is Dunn’s test. Dunn’s test is a non-parametric pairwise comparison test designed to determine which groups differ significantly from each other. Using a Bonferroni adjustment, dividing alpha (α) by the total number of tests, comparisons of multiple groups are made while minimizing Type 1 error (29).

The Mann-Whitney U test is a non-parametric statistical test used to determine if there is a significant difference between two independent groups. In this study, it was used for comparing two groups of ordinal data, examining whether there were significant differences between respondents who specialized in a residency, PhD, etc., and those who did not.

A p-value < 0.05 indicated statistical significance for the Kruskal-Wallis test, Dunn’s test, and Mann-Whitney U test. All analyses were performed using Microsoft Excel (Microsoft Inc, Seattle, WA, USA) and XLSTAT (Data Analysis and Statistical Solution for Microsoft Excel, Addinsoft, Paris, France).

Qualitative Analysis

To analyze alumni qualitative open-ended comments regarding potential improvements to KSU CVM anatomy courses, both a classic thematic analysis and Linguistic Inquiry and Word Count (LIWC) analysis were used. The researchers in this study used Clarke and Braun's Six Step Data Analysis Process consisting of six phases as a framework for uncovering recurring themes and patterns within respondent's suggestions for course enhancements. The phases are 1. Familiarization with the data 2. Coding 3. Searching for themes 4. Reviewing themes 5. Defining and naming themes and 6. Writing up (30).

In addition to the thematic analysis, the LIWC-22 program was used to assess the language used by respondents. The words people use provide psychological cues into their thought processes, emotional well-being, intentions and motivations (31). Tausczik and Pennebaker created the LIWC analysis to analyze others' language, which thus allows understanding of their thoughts, feelings, personality, and connection with others (Pennebaker Conglomerates, Inc, Austin, TX, USA). Therefore, the researchers in the present study utilized the LIWC-22 program for text analysis of alumni word use in their qualitative comments.

Ethics Approval

The study protocol was reviewed and approved by the Institutional Review Board at Kansas State University #IRB-11970.

Pilot Study Results

The initial survey consisting of fifteen questions was distributed to the graduating class of 2023 as a pilot study. Sixteen responses were received for a response rate of 13%. Of the sixteen

respondents, 61% indicated they are small animal clinicians, 22% indicated mixed animal, 6% equine, 6% food animal, and 0% exotics. See Figure 1. The final question of the survey was an open-ended question asking, “In your opinion, how can KSU CVM anatomy courses improve?” A thematic analysis was completed to analyze qualitative comments revealing the following themes. Also see Table 1.

- 1. Clinical Relevance and Practical Application:** Respondents indicated a need for descriptions of how anatomy content taught in the first year will translate to fourth-year clinical rotations and real-world practice beyond professional school.
- 2. Enhanced Hands-On Learning and Dissection Techniques:** Because the COVID-19 pandemic shut down the anatomy lab in the spring of 2020 when these respondents would have been in the midst of their large animal anatomy course, responses indicated a need for more dissection time in the anatomy lab.
- 3. Utilize Resources for Enhanced Learning:** Respondents suggested the use of models, videos, and other supplemental resources in addition to the traditional didactic approach.

Overall, qualitative responses from the pilot study were positive, with some suggestions for improvement of KSU CVM anatomy courses. The researchers used the pilot study to test the “Anatomy Education Adequacy and Clinical Practice Readiness” questionnaire, and since there were no logistical issues, they proceeded with distributing the survey to the broader population. As previously mentioned, one new question was designed for the broader population, “To what

extent do you feel that KSU CVM anatomy courses prepared you for the species you most commonly see in practice?”

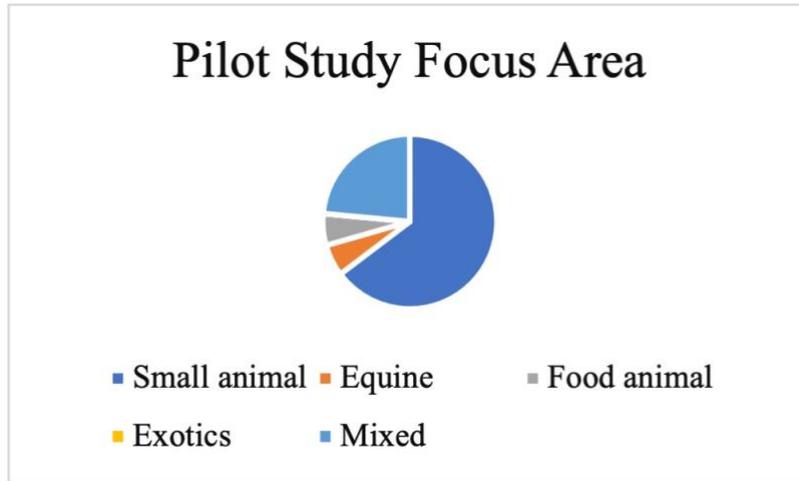


Figure 4-1: Displaying focus area results from the pilot study of class of 2023 graduates.

| Main Theme | Description |
|--|---|
| Clinical Relevance and Practical Application | Need for content and experiences that directly translate to clinical practice, with focus on skills, procedures, and anatomical knowledge relevant to surgery and clinical settings |
| Enhanced Hands-On Learning and Dissection Techniques | A desire for more practical, hands-on experiences in anatomy labs, including increased time with cadavers |
| Utilize Resources for Enhanced Learning | Suggest the use of various resources, such as video materials and discussions on surgical approaches, to supplement traditional learning methods |

Table 4-1: Outlining the main themes identified using Clarke and Braun’s Six Step Data Analysis Process for the pilot study open-ended question, “In your opinion, how can KSU CVM anatomy courses improve?”

Broader Population Quantitative Results

The broader population survey was distributed to approximately 600 alumni from the KSU CVM graduating classes of 2018 to 2022. One-hundred and ten responses were received

for a response rate of 18.5%. Of the respondents, 65% indicated they are small animal clinicians, 21% mixed animal clinicians, 7% exotics clinicians, 4% food animal clinicians, and 3% equine clinicians. See Figure 2. Additionally, when asked, “Are you currently pursuing a specialty / did you previously pursue a specialty? (i.e., residency, PhD, etc.)” 75% of respondents indicated no and only 25% indicated yes. See Figure 3.

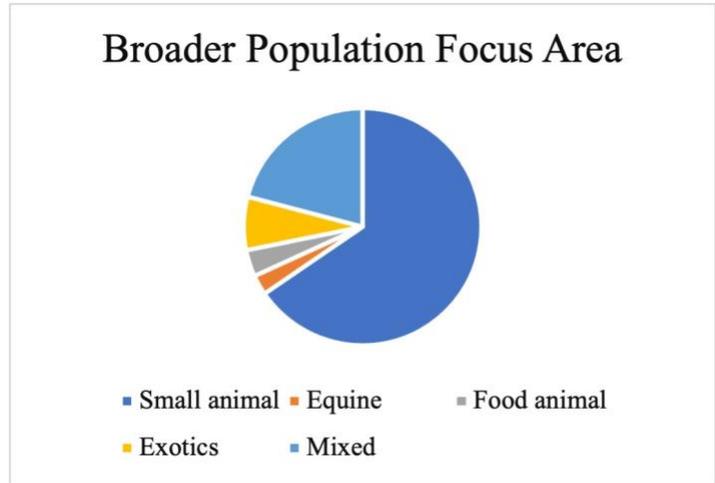


Figure 4-2: Displaying focus area results from the broader population including graduates from the classes of 2018 to 2022.

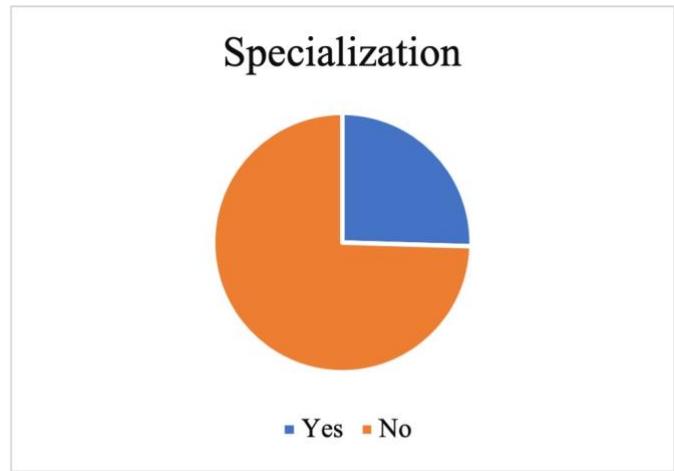


Figure 4-3: Displaying specialization results from the broader population including graduates from the classes of 2018 to 2022.

Species Preparedness

Following the binomial and categorical questions, the first Likert Scale question asked, “To what extent do you feel that KSU CVM anatomy courses prepared you for the specie(s) you most commonly see in practice?” Of the 110 responses, 91 (83%) indicated extremely (15%) or very much (68%). See Figure 4. The mode response was “very much.” The Kruskal-Wallis pairwise comparison across graduating class (class of 2022, 2021, 2020, 2019, and 2018) indicated no statistically significant difference among groups ($P = 0.788$). When comparing across focus area (small animal, mixed animal, equine, food animal, and exotics), the Kruskal-Wallis test indicated a statistically significant difference among groups ($P < 0.001$). Using the Dunn’s post-hoc test to determine which specific groups differed from each other, a statistically significant difference was found between small animal and exotic focused clinicians ($P < 0.001$), but not between any other group comparisons. Comparing respondents who are small animal focused to those who are exotics focused, we observed the following five-number summaries for their Likert Scale responses. For small animal focused clinicians, the minimum value was 3, the first quartile was 4, the median was 4, the third quartile was 4, and the maximum value was 5. In contrast, for the exotics group, the minimum value was 1, the first quartile was 2.5, the median was 3, the third quartile was 4, and the maximum value was 4. This summary suggests that in this study, exotics focused clinicians rated their preparedness to treat exotics species lower compared to small animal clinicians’ preparedness to treat small animal patients, as indicated by the lower median and quartile values. See Figure 5. When comparing between those clinicians who specialized and those who did not, the Mann-Whitney U test found no statistically significant difference between the two groups ($P = 0.841$).

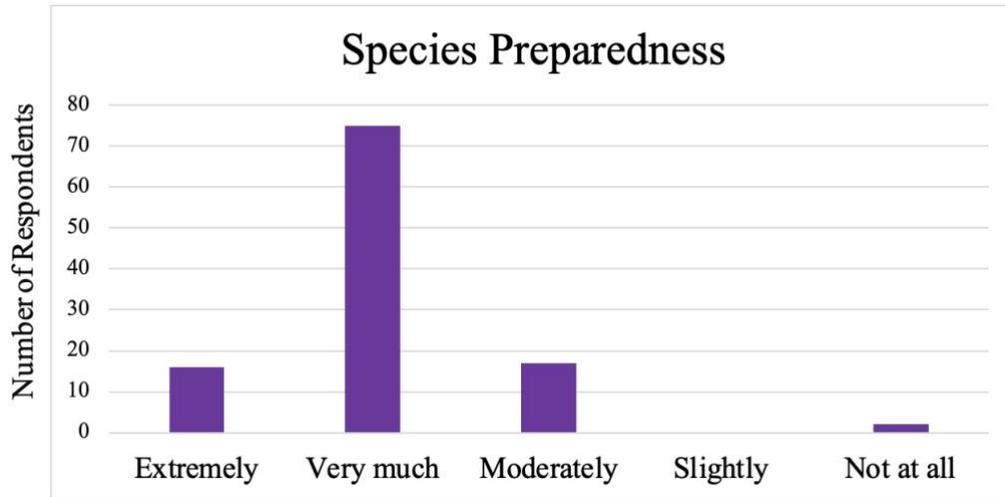


Figure 4-4: Likert Scale responses to the question, “To what extent do you feel that KSU CVM anatomy courses prepared you for the specie(s) you most commonly see in practice?” No statistically significant difference was found between groups (graduating classes).

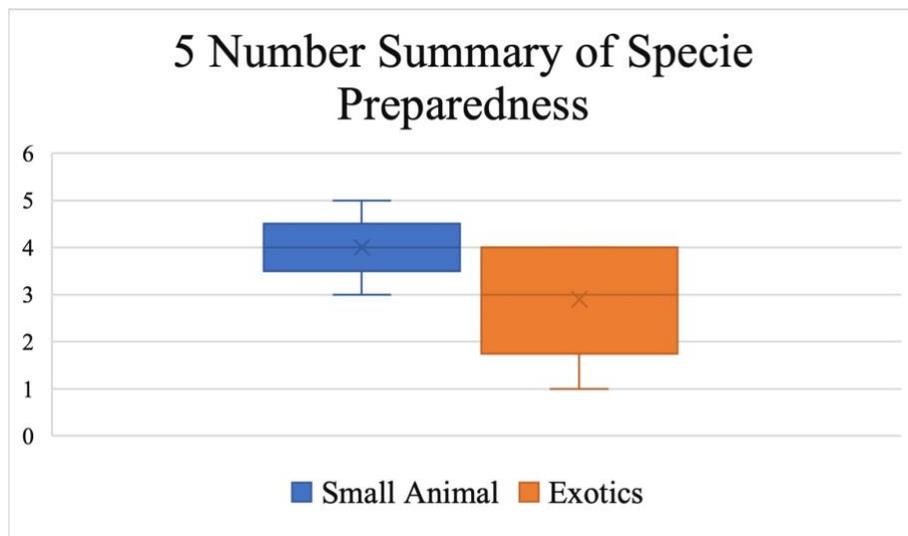


Figure 4-5: Box plot comparing the distribution of Likert Scale responses to the question, “To what extent do you feel that KSU CVM anatomy courses prepared you for the specie(s) you most commonly see in practice?” between small animal and exotics clinicians.

Anatomy Applicability in Practice

The next Likert Scale question asked, “To what extent do you feel that the knowledge gained from KSU CVM anatomy courses has been directly applicable to your daily veterinary practice?” Of the 110 responses, 75 (68%) indicated extremely applicable (21%) or very

applicable (47%). See Figure 6. The mode response was “very applicable.” The Kruskal-Wallis pairwise comparison across graduating class indicated no statistically significant difference among groups ($P = 0.838$). When comparing across focus area, the Kruskal-Wallis test indicated no statistically significant difference among groups ($P = 0.934$). Comparing respondents who specialized to those who did not specialize, we observed the following five-number summaries for their Likert Scale responses to this question, “To what extent do you feel that the knowledge gained from KSU CVM anatomy courses has been directly applicable to your daily veterinary practice?” Among specialized clinicians, the minimum value was 2, the first quartile was 3, the median was 4, the third quartile was 5, and the maximum value was 5. For non-specialized respondents, the minimum value was 2, the first quartile was 3, the median was 4, the third quartile was 4, and the maximum value was 5. These summaries indicate similar distributions but with a slightly different spread in the third quartile. See Figure 7. Further statistical testing using the Mann-Whitney U test confirmed statistically significant differences between the two groups ($P = 0.011$), indicating a difference in perceived applicability of anatomy between clinicians who pursued a specialty and clinicians who did not.

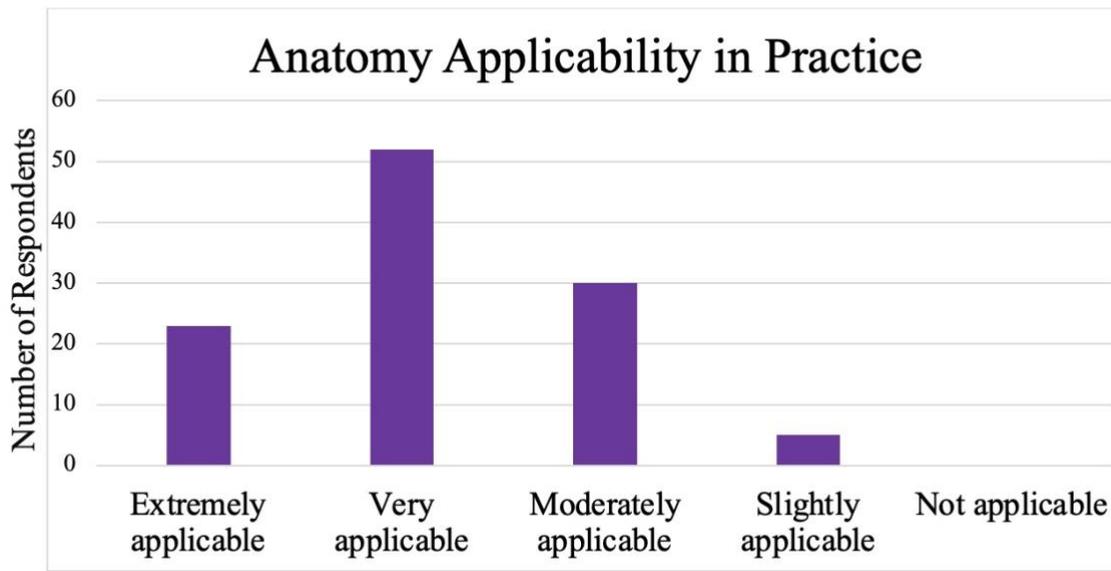


Figure 4-6: Likert Scale responses to the question, “To what extent do you feel that the knowledge gained from KSU CVM anatomy courses has been directly applicable to your daily veterinary practice?”

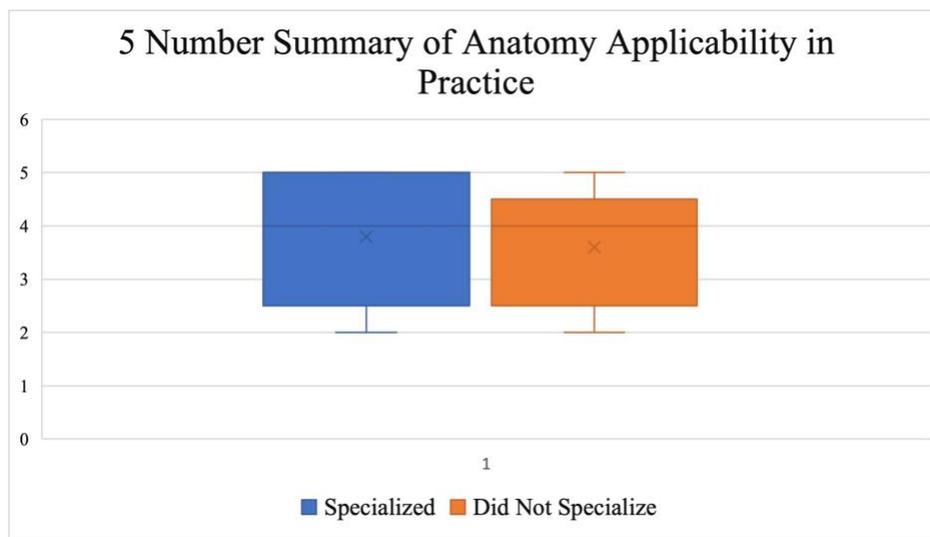


Figure 4-7: Box plot comparing the distribution of Likert Scale responses to the question, “To what extent do you feel that the knowledge gained from KSU CVM anatomy courses has been directly applicable to your daily veterinary practice?”

Clinical Anatomy Application

The 3rd Likert Scale question asked, “How often do you apply anatomy knowledge in making clinical decisions?” Of the 110 responses, 76 (69%) indicated always (20%) or most of

the time (49%). See Figure 8. The mode response was “most of the time.” The Kruskal-Wallis pairwise comparison across graduating class ($P = 0.950$) and focus area ($P = 0.934$) indicated no statistically significant difference among groups. When comparing between those clinicians who specialized and those who did not, the Mann-Whitney U test found no statistically significant difference between the two groups ($P = 0.517$).

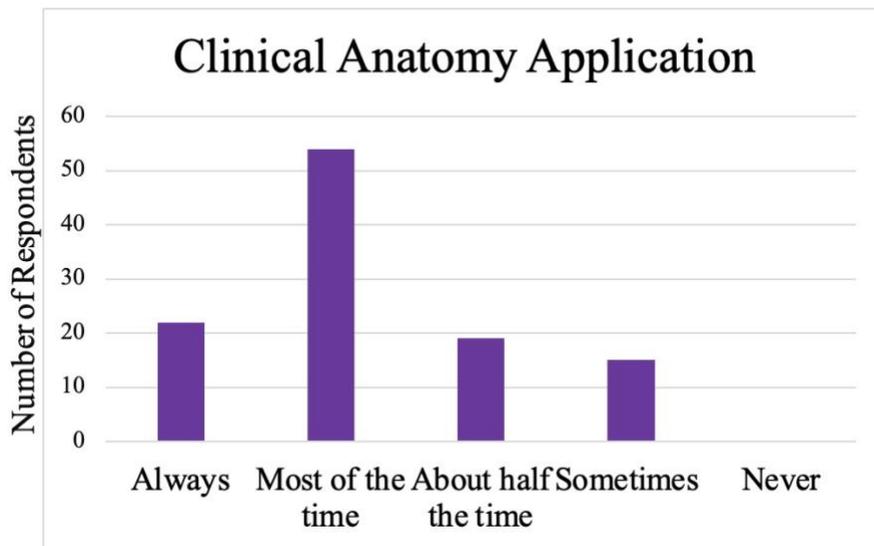


Figure 4-8: Likert Scale responses to the question, “How often do you apply anatomy knowledge in making clinical decisions?” No statistically significant difference was found between groups (graduating classes or focus area).

Communication

When asked, “How confident do you feel in your anatomical knowledge when communicating with clients and colleagues?” 85 of the 110 responses (77%) indicated extremely confident (31%) or somewhat confident (46%). See Figure 9. The mode response was “somewhat confident.” The Kruskal-Wallis pairwise comparison across graduating class ($P = 0.667$) and focus area ($P = 0.423$) indicated no statistically significant difference among groups. Comparing respondents who specialized to those who did not specialize, we observed the

following five-number summaries for their Likert Scale responses to this question, “How confident do you feel in your anatomical knowledge when communicating with clients and colleagues?” Among specialized clinicians, the minimum value was 3, the first quartile was 4, the median was 4, the third quartile was 5, and the maximum value was 5. Conversely, for non-specialized clinicians, the minimum value was 2, the first quartile was 3.25, the median was 4, the third quartile was 4.75, and the maximum value was 5. This summary indicates that non-specialized clinicians exhibited a slightly wider spread across quartiles. See Figure 10. Further statistical testing using the Mann-Whitney U test confirmed statistically significant differences between the two groups ($P = 0.036$), indicating a difference in perceived confidence between specialized and non-specialized clinicians when communicating with clients and colleagues.

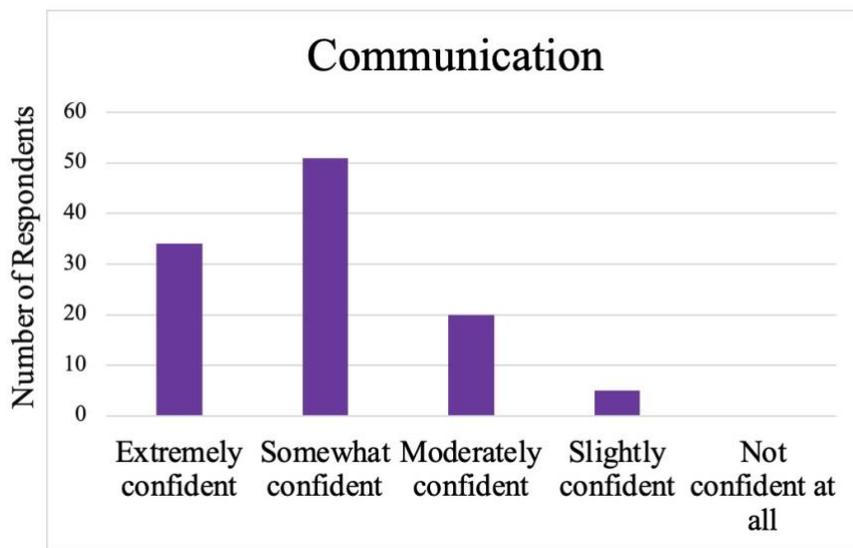


Figure 4-9: Likert Scale responses to the question, “How confident do you feel in your anatomical knowledge when communicating with clients and colleagues?” No statistically significant difference was found between groups (graduating classes or focus area).

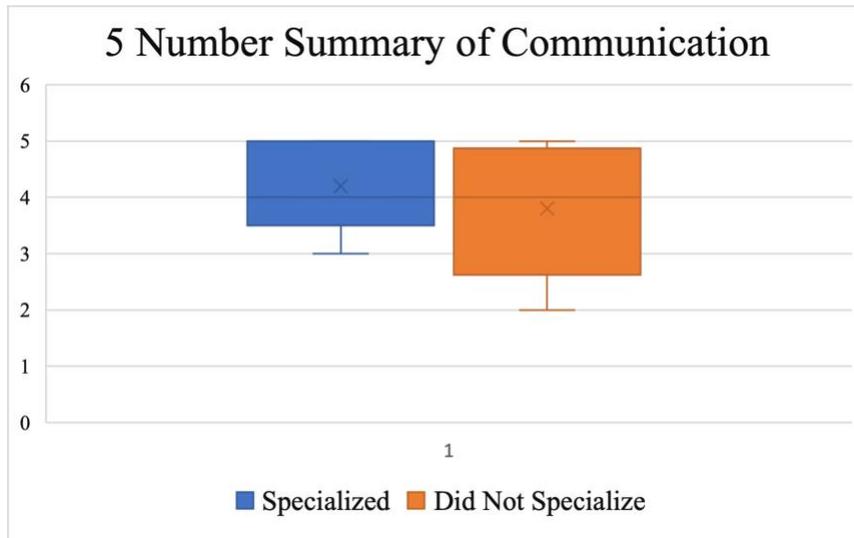


Figure 4-10: Box plot comparing the distribution of Likert Scale responses to the question, “How confident do you feel in your anatomical knowledge when communicating with clients and colleagues?” between specialized and non-specialized clinicians.

Career Success

The next Likert Scale question asked, “To what extent do you believe your KSU CVM anatomy education has contributed to your success in your veterinary career?” Of the 110 responses, 67 (61%) indicated extremely (15%) or very much (46%). See Figure 11. The mode response was “very much.” The Kruskal-Wallis pairwise comparison across graduating class ($P = 0.583$) and focus area ($P = 0.661$) indicated no statistically significant difference among groups. When comparing between those clinicians who specialized and those who did not, the Mann-Whitney U test found no statistically significant difference between the two groups ($P = 0.344$).



Figure 4-11: Likert Scale responses to the question, “To what extent do you believe your KSU CVM anatomy education has contributed to your success in your veterinary career?” No statistically significant difference was found between groups.

Anatomical Names

The next Likert Scale question asked, “How often do you find yourself recalling the anatomical name of muscles, blood vessels, nerves, etc.?” Of the 110 responses, 33 (30%) indicated always (6%) or most of the time (24%). The mode response was “about half the time” with 43 responses (39%). Additionally, 33 respondents indicated sometimes (30%). See Figure 12. The Kruskal-Wallis pairwise comparison across graduating class ($P = 0.432$) and focus area ($P = 0.415$) indicated no statistically significant difference among groups. A comparison between specialized clinicians and non-specialized clinicians using the Mann-Whitney U test did not find a statistically significant difference between the two groups ($P = 0.276$).

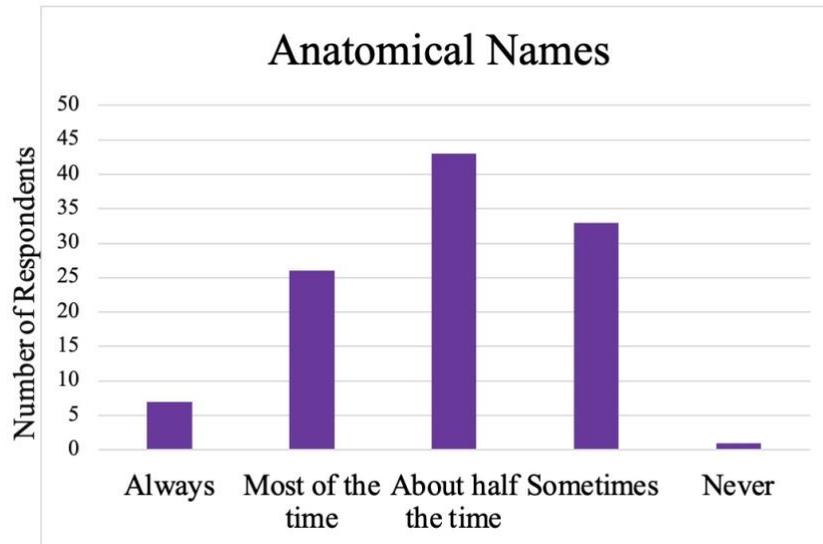


Figure 4-12: Likert Scale responses to the question, “How often do you find yourself recalling the anatomical name of muscles, blood vessels, nerves, etc.?” No statistically significant difference was found between groups (graduating classes or focus area).

Preparation for Practice

The next Likert Scale question asked, “How well do you think your KSU CVM anatomy education prepared you for clinical practice?” 70 of the 110 responses (64%) indicated extremely well (8%) or very well (56%). See Figure 13. The mode response was “very well.” The Kruskal-Wallis pairwise comparison across graduating class ($P = 0.791$) and focus area ($P = 0.472$) indicated no statistically significant difference among groups. When comparing between those clinicians who specialized and those who did not, the Mann-Whitney U test found no statistically significant difference between the two groups ($P = 0.307$).



Figure 4-13: Likert Scale responses to the question, “How well do you think your KSU CVM anatomy education prepared you for clinical practice?” No statistically significant difference was found between groups (graduating classes or focus area).

Clinically Relevant Topics

When asked, “How well do you feel KSU CVM anatomy courses covered topics relevant for clinical practice?” 57 of the 110 responses (52%) indicated extremely well (7%) or very well (45%). See Figure 14. The mode response was “very well.” The Kruskal-Wallis pairwise comparison across graduating class ($P = 0.734$) and focus area ($P = 0.840$) indicated no statistically significant difference among groups. When comparing between those clinicians who specialized and those who did not, the Mann-Whitney U test found no statistically significant difference between the two groups ($P = 0.790$).

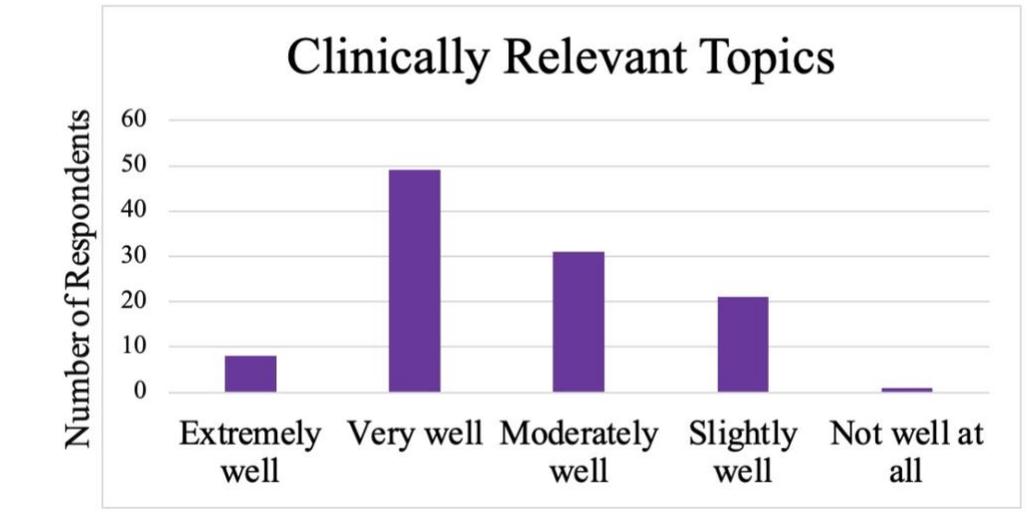


Figure 4-14: Likert Scale responses to the question, “How well do you feel KSU CVM anatomy courses covered topics relevant for clinical practice?” No statistically significant difference was found between groups (graduating classes or focus area).

Physical Exam Preparation

The next Likert Scale question asked, “How well do you feel KSU CVM anatomy courses prepared you to conduct effective physical exams in practice?” 60 of the 110 responses (55%) indicated extremely well (16%) or very well (39%). See Figure 15. The mode response was “very well.” The Kruskal-Wallis pairwise comparison across graduating class ($P = 0.755$) and focus area ($P = 0.742$) indicated no statistically significant difference among groups. A comparison between specialized clinicians and non-specialized clinicians using the Mann-Whitney U test did not find a statistically significant difference between the two groups ($P = 0.957$).

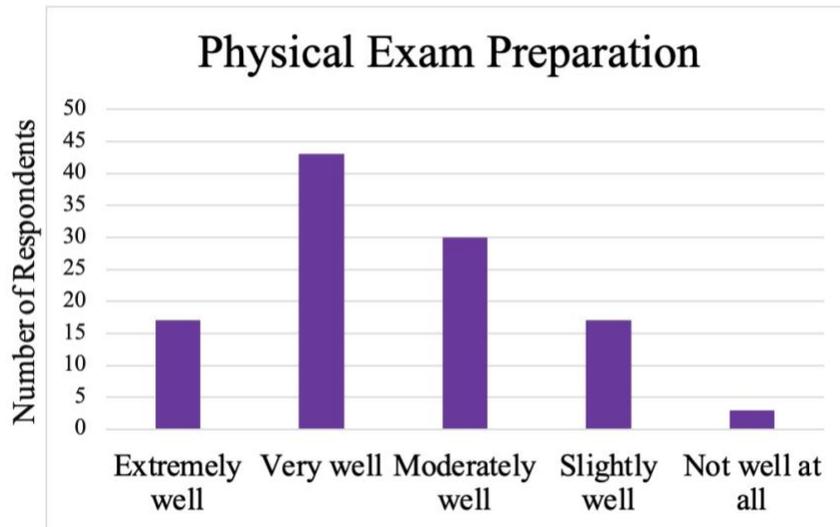


Figure 4-15: Likert Scale responses to the question, “How well do you feel KSU CVM anatomy courses prepared you to conduct effective physical exams in practice?” No statistically significant difference was found between groups (graduating classes or focus area).

Surgery Preparation

The final Likert Scale question asked, “How well do you feel KSU CVM anatomy courses prepared you to perform effective surgeries in practice?” 63 of the 110 responses (57%) indicated extremely well (13%) or very well (45%). See Figure 16. The mode response was “very well.” The Kruskal-Wallis pairwise comparison across graduating class ($P = 0.740$) and focus area ($P = 0.703$) indicated no statistically significant difference among groups. When comparing between those clinicians who specialized and those who did not, the Mann-Whitney U test found no statistically significant difference between the two groups ($P = 0.681$).

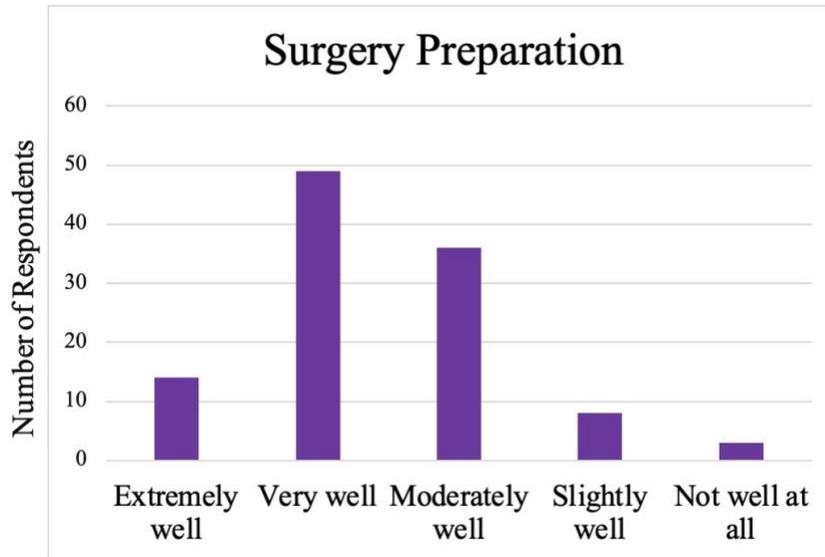


Figure 4-16: Likert Scale responses to the question, “How well do you feel KSU CVM anatomy courses prepared you to perform effective surgeries in practice?” No statistically significant difference was found between groups (graduating classes or focus area).

Broader Population Qualitative Results

Thematic Analysis

The final question of the survey was open-ended style and gathered alumni responses to the question, “In your opinion, how can KSU CVM anatomy courses improve?” Although responding to this question was optional, of the one hundred and ten survey respondents, 90% offered qualitative comments regarding course improvements. A thematic analysis of the alumni responses revealed the following themes:

- 1. Clinical Relevance and Application:** Many respondents emphasized the importance of incorporating clinically relevant information and practical applications into KSU anatomy courses, highlighting the importance of understanding anatomy in real-world veterinary practice. Some comments that related to this theme were: “In addition to cadaver lab learning, add clinically relevant cases to help apply anatomical knowledge.”

“Focusing more on clinically relevant information and adding in clinical correlation.”

“Focus on important clinical concepts.” “More clinical applications, less nitty gritty detail.”

2. Enhancing Surgical Approach Techniques: Respondents indicated a desire for more opportunities to learn surgical approaches, particularly descriptions of surgical landmarks and approaches to common areas. Some comments that related to this theme were: “More connection to surgery/surgical anatomy would be helpful.” “I think I would have liked to have certain landmarks that are critical in surgical procedures highlighted more in depth.” “I would have liked to perform dissection as surgical approaches, not as general dissection. At least doing the surgical approach to all the common surgery sites, then opening them up for general dissection.”

3. Focus on Big Picture Anatomy: Respondents suggested focusing on major clinical concepts rather than detailed anatomy, with an emphasis on what is essential for general veterinary practice. Some comments that related to this theme were: “I think emphasizing the big important structures and explaining why they matter would make it more motivating to learn.” “Focus on big important clinical concepts instead of the minutiae.” “Emphasize things that are important to the general practitioner.”

In the analysis of alumni responses, it is notable to mention the absence of negative feedback regarding anatomy courses at the KSU CVM. Despite the diverse range of suggestions and recommendations provided by alumni to improve anatomy education and enhance the anatomy curriculum, there were no comments indicating dissatisfaction or disappointment with the course content or its relevance. None of the respondents expressed thoughts suggesting that

the anatomy courses were irrelevant or that they do not utilize the knowledge gained in their professional veterinary careers. This absence of negative feedback emphasizes the overall satisfaction and perceived importance of the anatomy education provided at the KSU CVM.

Linguistic Inquiry and Word Count (LIWC) Analysis

The LIWC software is designed to analyze text for various characteristics, including emotional content, cognitive processes, and linguistic style. By calculating the frequency of specific words and word categories in a given text, LIWC can provide a quantitative representation of these aspects. Applying this to alumni responses to the question, “In your opinion, how can KSU CVM anatomy courses improve?” revealed the following insights. See Table 2 for a summary of the results from the LIWC analysis.

1. **Word Count (WC):** There were a total of 2654 words in the responses.

2. **Tone (76.86):** The high tone score suggests that respondents had a positive and optimistic tone overall. This indicates that respondents likely had a favorable view of the courses and see potential for improvement.

3. **Analytic (69.5):** The relatively high analytic score suggests that the responses were more formal, logical, and hierarchical in thinking. This may indicate that respondents had carefully considered the areas for improvement and structured their responses accordingly.

4. **Authentic (51.39):** The authentic score is moderate, indicating that responses were somewhat personal and honest, providing genuine feedback based on respondent experiences.

5. **Cognition (16.96), Insight (5.92), Cause (2.03), Discrepancy (2.26):** The presence of cognitive process words, particularly insight, cause, and discrepancy, suggests that respondents were reflecting on the current state of the courses and identifying areas where there is a gap between the current and desired state.

6. **Work (4.3), Achievement (1.88):** The use of work-related words and achievement words indicates that respondents were focused on the academic and professional aspects of the courses and interested in ways to enhance student success and performance.

7. **Health (3.54):** The presence of health-related words suggests that respondents were considering the physical and mental well-being of students in the context of anatomy courses.

In conclusion, the LIWC analysis highlights a largely positive tone and thoughtful reflection by respondents, specifically focusing on areas for improvement in KSU CVM anatomy courses. Respondents showed authenticity in their responses, providing constructive feedback that may enhance anatomy education for future veterinary cohorts.

| LIWC Category | Score |
|----------------------|--------------|
| Word Count (WC) | 2654 |
| Analytic Thinking | 69.5 |
| Clout | 17.7 |
| Authenticity | 51.39 |
| Emotional Tone | 76.86 |
| Cognition | 16.96 |
| Insight | 5.92 |
| Cause | 2.03 |
| Discrepancy | 2.26 |
| Work | 4.3 |
| Achievement | 1.88 |
| Health | 3.54 |

Table 4-2: LIWC analysis results of alumni responses to the open-ended question, “In your opinion, how can KSU CVM anatomy courses improve?”

Discussion

In this study, analyzing clinician retrospective opinions of KSU CVM anatomy courses revealed overall positive perceptions, with some statistically significant differences found between focus area (small animal, mixed animal, equine, food animal, and exotics) or specialization (clinicians who pursued a residency, PhD, etc., and those who did not). Using the Kruskal-Wallis test to compare responses by graduating class (class of 2022, 2021, 2020, 2019, and 2018) for each Likert Scale question found no statistically significant difference between classes ($P > 0.05$). This finding suggests consistency in perceptions of the anatomy curriculum across five years of alumni. Despite graduating in different years and potentially experiencing variations in teaching methods or curriculum, there were no statistically significant differences in

responses regarding anatomy preparation, applicability, or perceived relevance across graduating classes. This suggests that the quality and effectiveness of the anatomy education provided by the KSU CVM have remained stable and consistent over time.

Additionally, mode responses to each of the questions were in positive range, meaning a 4 or greater out of 5 on the Likert Scale. One exception is to the question, “How often do you find yourself recalling the anatomical name of muscles, blood vessels, nerves, etc.?” in which the mode response was “about half the time,” or a 3 out of 5 on the Likert Scale. These responses indicate that overall, alumni generally had positive perceptions of their anatomy education at the KSU CVM. The quantitative analyses revealed positive perceptions of the relevance, applicability, and effectiveness of anatomical knowledge taught in KSU CVM anatomy courses, fulfilling the first aim of this study. Alumni generally viewed their anatomy education positively, considering it applicable and relevant to their clinical practice. Similar to the present study, the University of Nottingham and the Trent Deanery in Nottingham, United Kingdom found the majority of junior doctors reflected that anatomy had well prepared them for clinical practice and that they were confident they had acquired the appropriate anatomical knowledge (32). However, in the present study, it is worth noting that when respondents were asked about recalling anatomical names, the mode response was slightly lower. This suggests that alumni were less consistent in recalling such details, indicating a potential area for improvement in the curriculum or teaching methods related to memorization and retention of anatomical terminology.

Although responses were positive and consistent by group (graduating class), there was a statistically significant difference found between focus area or specialization. This finding aligns with the second study aim and indicates variations in perceptions of anatomy education among different groups of veterinarians. The first Likert Scale question of the survey asked, “To what

extent do you feel that KSU CVM anatomy courses prepared you for the specie(s) you most commonly see in practice?” A statistically significant difference was found between small animal and exotic focused clinicians ($P < 0.001$). This statistically significant difference indicates that small animal and exotic focused clinicians had differing perceptions of their species preparedness as a result of KSU CVM anatomy courses. The five-number summaries suggest that in this study, exotics focused clinicians rated their preparedness to treat exotics species lower compared to small animal clinicians’ preparedness to treat small animal patients. At the KSU CVM, the gross anatomy I and II courses focus on small and large and food animal specimens respectively, with little to no discussion of exotics species. Therefore, while the perceptions of clinicians who specialize in exotic species are valid, students interested in exotic animals might benefit from enrolling in the specialized anatomy course at the KSU CVM that offers opportunities to dissect these species. Additionally, these findings highlight the need to ensure that anatomy education is adapting to the diverse interests of future veterinarians. Moving forward, the KSU CVM anatomy team can ensure that students are aware of and have access to specialized opportunities related to exotic species, therefore supporting a more inclusive curriculum that reflects the varied goals of first-year students.

For the Likert Scale question, “To what extent do you feel that the knowledge gained from KSU CVM anatomy courses has been directly applicable to your daily veterinary practice?” a statistically significant difference was found in responses between clinicians who pursued a specialty (residency, PhD, etc.) and those who did not. The five-number summaries indicate similar distributions in Likert Scale responses, but with a slightly different spread in the third quartile. Further statistical testing using the Mann-Whitney U test confirmed statistically significant differences between the two groups ($P = 0.011$). Additionally, the notable difference

in the third quartile suggests that specialized clinicians may perceive anatomy knowledge as more directly applicable in their practice compared to non-specialized respondents. One approach to address this finding is to incorporate more diverse clinical scenarios and case studies into the curriculum. By including examples that cover a broader range of veterinary specialties, students can better appreciate the practical relevance of first-year anatomy and how anatomical knowledge may be used across various disciplines.

An additional statistically significant difference was found between specialized and non-specialized clinicians' responses to the question, "How confident do you feel in your anatomical knowledge when communicating with clients and colleagues?" The five-number summaries indicated that non-specialized clinicians exhibited a slightly wider spread across quartiles. Further statistical testing using the Mann-Whitney U test confirmed statistically significant differences between the two groups ($P = 0.036$), indicating a difference in perceived confidence when communicating with clients and colleagues. This means that specialized clinicians exhibited higher confidence levels in communicating anatomical knowledge. This finding could suggest that specialized clinicians have more practice or exposure in this aspect, possibly due to their focused training and additional opportunities for sharpening anatomical communication skills. To address this, first-year anatomy instructors could incorporate additional peer-teaching exercises in which students practice and build confidence in conveying anatomical information effectively.

The qualitative analyses in this study, both thematic and LIWC analyses, found positive alumni attitudes towards respondent's experiences in KSU CVM anatomy courses. Additionally, respondents provided constructive thoughts on how to improve anatomy education for future cohorts, therefore fulfilling the third study aim. The thematic analysis revealed that alumni

desired more illustrations of how each anatomical structure relates to clinical practice. They suggested an enhanced focus on relevant structures that are applicable to clinical practice, including surgery, physical exams, diagnoses, treatment planning, etc. These findings align with previous medical literature. In a study done at the Department of Anatomy (now the Centre for Clinical and Comparative Anatomy), University of Bristol, first and second year medical students illustrated the importance of integrating clinical skills teaching within anatomy courses, with students advocating for practical experiences such as clinical skills practice and venipuncture training (3). Additionally, in a study at the Penn State Milton S. Hershey Medical Center and College of Medicine, regardless of clinical specialty, anatomy was perceived as most important to physical examination and to imaging/diagnostics in the clinic (33). At the University of Nottingham and the Trent Deanery in Nottingham, United Kingdom survey respondents requested that anatomy should be taught in a clinical application manner through the emphasis of anatomy in future clinical examples (32). Clinical context provides much benefit to learners, but it has especially been shown to enhance retention and recall of knowledge and is more inclined to promote a deeper approach to learning (13,34–36).

Overall, the comments in the present study were positive with no comments indicating dissatisfaction or disappointment with the course content or its relevance. The LIWC analysis additionally indicated positive tone in alumni open-ended responses with high analytical thinking and honesty. Based on both the quantitative and qualitative analyses in this study, these findings indicate that alumni had overall positive perceptions of their anatomy experience. Constructive feedback was provided on how the courses can be improved, but alumni did so in a professional, beneficial manner. The KSU CVM anatomy team will take these comments into consideration and discuss how clinical application and relevancy may be incorporated into future courses.

Finally, these findings highlight the importance of aligning anatomy education with contemporary veterinary practice to ensure that graduates are prepared for real-world anatomical application.

Limitations

Due to the voluntary nature of this survey research study, one limitation is self-selection bias. Those respondents who chose to complete the survey may have had particularly positive (or negative) experiences and felt the need to relay their perceptions. As a result, this sample may comprise mostly of alumni with strong opinions and may not accurately represent all KSU CVM alumni. For future alumni surveys, rather than distributing the survey to a certain quantity of participants, random assignment may be used.

The survey was distributed via email Listserv to alumni by the KSU CVM Office of Alumni & Events who had signified that alumni can opt out of receiving emails. This may have additionally led to self-selection bias as those who opted in to receiving emails may have had a particularly positive experience at the KSU CVM. Others who opted out may have had a particularly negative experience and refuse to further associate with the college. To overcome this limitation, a multimodal survey, which uses two or more forms of communication, may be used. In future survey research studies, both electronic and mail surveys could be distributed to reach alumni who opted out of emails.

An additional limitation comes from the inclusion of multiple years of alumni. Over the years, many institutional changes took place, such as faculty leadership, changes in instructor, curriculum design, teaching methods, lab construction, lab access, number of cadavers, etc. Each

of these underlying factors may have influenced alumni perceptions. Regardless, the consistency across graduating classes should be appreciated, indicating little effect of these changes.

As mentioned earlier, a limitation of this study is the single mode Qualtrics® survey distributed via email. This method targets participants who have access to a cellular device, iPad, laptop computer, internet, email, etc. To overcome this limitation, a mixed-mode survey design may be used in the future to give respondents the opportunity to participate in a way that best-suits their preferences (37). Using a mixed-mode design may also improve response rate and survey coverage.

Another limitation is the potential for recall bias. Because the participants included in this study would have taken anatomy in the years 2014 to 2020, alumni may not accurately remember their experiences, affecting the reliability of the data collected. To address this limitation, the present study included alumni across five years of graduating classes. The consistency across their responses indicates minimal effect of participants abilities to recall their anatomy experiences.

Conclusion

In this study, analyzing veterinary graduates' perceptions of KSU CVM anatomy courses revealed positive perceptions. Across various alumni groups, like graduating class, there was notable consistency in responses. The Kruskal-Wallis test showed no statistically significant differences between graduating classes, suggesting a consistent and effective anatomy curriculum over time. However, statistically significant differences were found between focus areas and specializations. These findings suggest that clinicians focused on exotics felt less prepared to treat exotics species than their small animal focused colleague's preparedness to treat

small animal patients. This finding identifies a gap in the curriculum that primarily emphasizes small and large animal anatomy. Additionally, specialized clinicians rated the applicability of their anatomical knowledge and their confidence in communicating this knowledge higher than non-specialized clinicians. This finding suggests benefits in including more practical clinical scenarios in the curriculum to allow more practice with anatomical application. In the present study, the qualitative analyses further supported these findings, with alumni expressing overall satisfaction with their anatomy education. Respondents did provide constructive feedback aimed at enhancing the clinical relevance of the course. The main areas for improvement include incorporating more content relevant to exotic species and practical applications of anatomy in clinical settings, surgeries, diagnoses, etc. These findings emphasize the importance of continually checking in with alumni to ensure that the curriculum is adequately preparing graduates for their real-world careers. Moving forward, it may be valuable to establish regular feedback loops with alumni to provide continuous insight into the curriculum's effectiveness. Furthermore, the "Anatomy Education Adequacy and Clinical Practice Readiness" questionnaire developed in this study could be adapted and utilized not only at K-State, but also at other institutions to assess and refine anatomy education practices on a broader scale. By gathering alumni perceptions, curriculum may be adapted to meet contemporary needs of diverse veterinary careers. At the KSU CVM, the anatomy team will use these findings to discuss enhancements to anatomy education, ensuring that students learn anatomical knowledge that meets the evolving needs of the veterinary profession.

Conflict of Interest

The authors do not have any conflicts of interest to disclose.

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Chapter 5 - Enhancing Educational Practices Across Disciplines

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Introduction

Crafting an effective teaching experience parallels the art of carpentry as both require a diverse and well-equipped toolbox. Just as a carpenter needs various tools to create a masterpiece, educators recognized for their teaching excellence possess an intricate toolbox that includes active learning techniques, inclusive teaching practices, community-building morals, and engaging instruction. Much like a carpenter meticulously plans and measures before cutting into wood, pre-laboratory videos provide students with a detailed and visual understanding, serving as an outline to help prepare for upcoming laboratory sessions. Not only do they simplify complex concepts but also significantly enhance teaching and learning (Chan & Fok 2009; Onyeaka et al. 2022; Ouyang et al. 2018). In the same way that precise measurements contribute to the success of a carpentry project, pre-laboratory videos lay the groundwork for a successful hands-on experience in the lab. By providing students with a clear roadmap, these videos act as foundational tools, ensuring that students are well-prepared and equipped to tackle the intricacies of the lab. In both cases, these tools serve as foundational elements that contribute to the overall success and quality of the end product – be it a finely crafted piece of woodwork or a comprehensive educational experience.

Creating Optimal Pre-Lab Videos

The applicability of pre-lab videos spans across a variety of STEM (Science, Technology, Engineering, and Mathematics) laboratory-based disciplines including biology, chemistry, physics, anatomy, physiology, kinesiology, and engineering. For optimal effectiveness, these videos should align with the student learning outcomes, aiming to inform, excite, and prepare students for their upcoming laboratory activities.

Effective pre-lab videos must have well-defined learning outcomes. Additionally, the creation of the video doesn't have to be complex as basic tools like smartphones are adequate. To maintain student interest in the pre-lab videos, it is recommended to produce concise, segmented videos lasting no more than approximately 10 minutes. The incorporation of cue statements can retain the viewer's focus and emphasize essential concepts and real-world connections.

The next step is editing. Various resources like Camtasia, Apple iMovie, Vimeo, or Adobe Premiere Pro can be used. To facilitate student comprehension of the material, short annotations can be embedded to elucidate key points. Research indicates that such captions improve comprehension, retention, and attention (Gernsbacher 2015). Brief annotations also assist in visualizing the spelling of specific terms or structures.

Once editing is complete, the videos should be uploaded in a timely fashion, allowing accessibility before lab sessions. One of the main benefits of pre-lab videos is the ability for

students to view the videos anywhere and at any time. Furthermore, uploading pre-lab videos to an online platform (e.g., YouTube, Echo 360, Panopto, etc.) grants students the convenience of watching the videos repeatedly if they desire.

An optional task for students that may be incorporated within the video is a pre-lab quiz. This way one can assess the impact of video on student learning (Onyeaka et al. 2022). Completion of the pre-lab quiz before the laboratory session begins is recommended to keep the students on track. Assigning a small number of points associated with the pre-lab quizzes allows students to accumulate “low stakes” points, potentially benefitting their overall grade.

Benefits of Pre-lab Videos

1. Enhancing Preparedness for Laboratory Sessions:

Research in anatomy education indicates that pre-lab videos allow students to create spatial awareness, understand laboratory objectives, and recognize dissection techniques, thereby maximizing their lab time (DiLullo et al. 2006; Saxena et al. 2008). Due to the large volume of material in laboratory courses, pre-lab videos are beneficial to students as they help establish an understanding of the upcoming laboratory tasks. Evidence suggests that viewing these videos before lab sessions enhances students' confidence and preparedness (Greene 2020), a trend likely applicable to other STEM disciplines.

2. Improving Academic Performance:

The most beneficial aspect of incorporation of pre-lab videos is their positive effect on student grades. Multiple studies in anatomy education show that even limited use of these videos can improve quiz and exam scores (Al-Khalili & Coppoc 2014; DiLullo et al. 2006; Greene 2020; Topping 2014). Research in our lab has found positive, statistically significant correlations between number of pre-lab videos viewed and certain exam scores, with the strongest correlation being for the lower quartile specifically. Significant correlations were also found between average exam score and total number of pre-lab videos viewed throughout the semester, and final course grade and total time spent viewing all pre-lab videos. Positive, statistically significant correlations were found between average pre-lab quiz score and exam score. Furthermore, a thematic analysis of student comments revealed pre-lab videos appeared to have been a beneficial part of the course, providing students with a valuable resource for preparation, study, and increased understanding and confidence (Hansen, Basel, Curtis, & Malreddy, in press). Such visual aids cater to diverse learning styles, allowing students to engage with content more interactively and effectively, especially beneficial for visual learners.

3. Accessibility and Flexibility:

Because pre-lab videos are available online, students have the flexibility of viewing the videos at their convenience. They can pause, rewind, or rewatch the videos to further their understanding of the material. The integration of pre-lab quizzes, due before lab sessions, encourages ongoing engagement with the videos. In our lab, we have observed students utilizing the pre-lab videos during lab time as a method of troubleshooting (Hansen, Basel, Curtis, &

Malreddy, in press). These videos also serve as a valuable resource for students who miss classes, offering them an opportunity to preview missed material.

Disadvantages

Despite their benefits, pre-laboratory videos are not without drawbacks:

- 1. Time-Consuming Production:** Creating quality videos requires significant time and effort. But this can be mitigated by collaborative efforts among faculty, sharing resources across departments, or even incorporating student-generated content as part of their learning process.
- 2. Technology Dependence:** Over-reliance on videos could lead to reduced hands-on learning experiences. This can be balanced by using videos as a supplementary tool rather than a replacement for practical sessions.
- 3. Potential Misinterpretation:** Without proper guidance, students might misinterpret video content and therefore, it's crucial to accompany videos with guided discussions, Q&A sessions, or even detailed notes.

Conclusions

Pre-laboratory videos are more than just a teaching aid; they represent a strategic approach to education that aligns with modern learning styles. While offering clear advantages, they require careful implementation to maximize their potential and avoid pitfalls. In an era where digital learning tools are increasingly prevalent, pre-lab videos stand out as a valuable resource for enhancing student engagement and understanding.

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Advocating for Student Preparedness with the Implementation of a Pre-Course

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Introduction

Ensuring a successful educational experience for our students is akin to the art of culinary development, where thoughtful preparation is fundamental. Just as a chef with pre-developed culinary skills meticulously selects ingredients and carefully plans before creating a masterpiece, educators must equip students with the foundational knowledge and skills necessary for their academic success. This parallels the concept of pre-courses, which serve as innovative ingredients and preparatory tools in the educational kitchen. Much like a chef assembles ingredients before cooking, pre-courses lay the groundwork for students, offering them a solid foundation to build upon.

It has been acknowledged that students across diverse disciplines encounter academic stressors, including heavy workloads, unclear expectations, competition with peers, and new subject matter (Hafen et al. 2008; 2006; Collins and Foote 2005; Laakkonen and Nevgi 2014). Just like novice chefs following a recipe, novice students may feel daunted by the academic challenges ahead. In the same way that a recipe provides preparatory instructions before cooking, pre-courses offer essential groundwork for students entering courses with unfamiliar subject matter. By providing students with terminology, background information, and introductory

material to a course, pre-courses ensure that students are well-prepared and equipped to tackle the complexities of new material with enhanced confidence.

Designing Effective Pre-Courses

Pre-courses can be utilized in a variety of disciplines such as biology, engineering, psychology, economics, anatomy and physiology, etc. For optimal effectiveness, the pre-course purpose should be clearly defined with student learning outcomes that inform, excite, and prepare students for their upcoming course material. Consider the needs of the students who will be taking the pre-course and tailor the content to suit their backgrounds, interests, and skill levels. Following defined student learning outcomes in a pre-course ensures alignment with the main course objectives, providing clarity, focus, and relevance to the content covered.

After the student learning outcomes have been defined, the creation of the pre-course does not have to be complex. PowerPoints, brief lectures or lecture videos, images, diagrams, quizzes, and interactive activities can be utilized to deliver prelude course content. Ensure that instructions for completing pre-course activities are clear and concise to avoid confusion or frustration.

Online, asynchronous pre-courses offer cost-effective and flexible options, enabling students to progress through the material at their own pace. Additionally, students can pause, rewind, or revisit course content repeatedly if they desire. In-person pre-courses are also effective but require on-site faculty/staff and may inadvertently favor students geographically close to campus.

Strategic timing is crucial for pre-course implementation. Pre-courses can be an optional activity during the summer (prior to courses offered during the fall semester) or during the winter break intersession (prior to courses offered during the spring semester). For summer courses, a brief pre-course may be offered in the weeks leading up to the first day of class. The pre-course can be non-graded but consider including opportunities for students to assess their own understanding and progress through self-assessment quizzes. This allows students to practice with the new material without academic pressure and worrying about their performance, while also identifying areas of improvement in their learning.

To assess the impact of the pre-course, consider collecting student performance and perception data. In our large animal anatomy course, positive, statistically significant correlations were found between pre-course interaction and certain exam scores (Hansen, Basel, & Malreddy, under review). Extensive analysis of student perception data was conducted and found a generally positive reception, with a majority of students strongly advocating for the pre-course's availability to future cohorts (Hansen, Basel, & Malreddy, under review). By gathering student opinions, the pre-course design can be refined to fit learning styles and difficult subject matter.

Advantages of Pre-Courses

1. Enhancing Student Preparedness:

Pre-courses provide students with foundational knowledge, skills, and terminology relevant to the upcoming course material. By familiarizing students with key concepts and topics

in advance, pre-courses help alleviate anxiety and build confidence, ensuring that students enter the course better prepared to engage with complex subject matter.

2. Improving Academic Performance:

One main benefit of pre-course implementation is the positive effect on student grades. At the Louisiana State School of Veterinary Medicine, a veterinary anatomy pre-course correlated with improved exam grades and reduced anxiety (McNulty and Lazarus 2018). Similarly, at Lincoln Memorial Osteopathic Medical School, pre-matriculation anatomy boot camps led to higher gross anatomy exam scores (Herling et al. 2017). Pharmacy preparation courses have also been shown to boost cumulative GPAs (Klausner et al. 2019). These findings highlight the valuable role pre-courses play in promoting academic success and student confidence.

3. Accessibility and Flexibility:

Both in-person and online pre-courses offer accessibility and flexibility to cater to diverse student needs. In-person pre-courses provide face-to-face interaction with potentially a new professor, elicit immediate instructor support, and builds relationships. Conversely, online pre-courses offer the convenience of anytime, anywhere access, allowing students to progress at their own pace and revisit materials as needed. This flexibility accommodates various learning styles and schedules, promoting student engagement and autonomy.

Disadvantages

Despite their benefits, pre-courses are not without drawbacks:

- 1. Time-Consuming Creation:** Designing and implementing pre-courses require significant time, effort, and resources from instructors and institutions. Developing high-quality pre-course content, organizing sessions, and providing support to students demands additional workload, potentially conflicting with other faculty and staff responsibilities.
- 2. Access Challenges:** Both in-person and online pre-courses may create access challenges such as geographic location, internet connectivity, technology, and affordability to name a few. These factors may impede on a students' ability to participate in the pre-course, and therefore hinder their educational opportunities.
- 3. Pre-Course Dependence:** If a student performs well in the pre-course, they may depend too heavily on the introductory material, leading to gaps in students' understanding of the main course material. While pre-courses can provide valuable preparation, they may not fully substitute for comprehensive instruction during the main course.

Conclusions

Pre-courses are a supplemental resource that provide foundational knowledge to prepare students for new course material. Pre-courses help improve student confidence and knowledge prior to beginning a course, acting as a valuable resource for enhancing student understanding. Offering students a modern approach to course preparation has clear advantages, but careful creation and implementation are needed to maximize educational benefits.

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How Unlocking the Power of Alumni Surveys Can Drive Educational Improvement

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Introduction

In the retail industry, having a clear understanding of the audience is vital for retailers to customize their products and services to match the needs of customers. Retailers collect feedback from customers via surveys to gain insights into their demands, preferences, satisfaction levels, and areas for improvement. Retailers then use this information to connect with customers and strategically enhance product development and customer service, thus customizing shopping experiences (AxisCards 2024). Through satisfaction surveys of past customers, retailers utilize perception data to meet the needs of future customers. Similarly, gathering opinion data from alumni may then help educators to provide customized learning for current and future students. Educators can gather perceptions from alumni on the adequacy and applicability of their undergraduate, graduate, or professional education. Alumni surveys can help educators determine whether students were taught skills that are required of professionals today. Alumni perceptions offer invaluable insights that drive continuous improvement within educational institutions. By listening to the voices of graduates, institutions can continuously adapt their curriculum and instruction, ensuring they remain relevant and impactful for generations to come.

Designing Effective Surveys

Much research has been done about how to effectively design a survey instrument (Kasunic 2005), but the following tips were specifically beneficial to us in our design of an alumni survey distributed to Doctor of Veterinary Medicine graduates (Hansen, Basel, & Malreddy, under review). Nonetheless, the following tips should be applicable to other disciplines.

When designing alumni surveys, it is crucial to first think about the desired outcomes and expected responses. By defining the survey objectives, researchers can ensure that the survey questions are clear, concise, and relevant to alumni, eliciting the expected responses. Additionally, structuring the survey in a logical sequence ensures respondent engagement and flow.

Designing the survey requires careful consideration of how to appropriately ask unbiased questions without probing or leading language. Question stems should avoid jargon or complex language that may confuse participants. It's important to include a diverse range of question types to gather comprehensive data, such as binomial, multiple-choice, and Likert scales for quantitative analysis, or open-ended questions for qualitative insights and personal experiences. Qualitative data may be analyzed using Clarke and Braun's Six-Step Data Analysis Process, or by utilizing a purchasable program like the Linguistic Inquiry and Word Count (LIWC) analysis (Braun and Clarke 2006; Tausczik and Pennebaker 2010). There are many other methods for performing qualitative analyses, but both of these have been useful in our experience of analyzing veterinary student qualitative data.

Consider a multi-mode survey to invite a variety of respondents to participate in the survey. Mixing modes (i.e., utilizing online, mail, telephone, and interview-type surveys) is a popular method to ensure that most members of the target population have the opportunity to be sampled (Dillman et al. 2014). Respondents also get to choose their preferred method, enhancing the response rate.

To understand the sampling population, gather demographic and descriptive data. Include questions about graduation year, primary major, highest obtained degree, current occupation, geographic location, etc. These data can help in understanding the composition of the respondent pool and identify any demographic trends or patterns in survey responses.

Prior to distribution of the survey to a large sample, pre-testing via a pilot study has many benefits. Pilot studies may be used to analyze the survey items to identify logistical issues or problematic questions. If survey items need to be revised, edits can be made before full distribution. Once pilot study data have been collected, internal consistency (via Cronbach's alpha) and validity of the survey items can be calculated. Based on the reliability and validity results, survey items may be further refined to improve clarity, relevance, and consistency.

Benefits of Surveying Alumni

Past literature has identified advantages of survey questionnaires, such as their cost-effectiveness and ability to gather information from large populations (Wilson 2010). Specifically regarding alumni surveys, the following benefits are the author's opinions.

1. Constructive Feedback:

Alumni surveys are important as the respondents have already completed their educational program and can thus provide valuable observations on how well their education prepared them for real-world applications. This feedback can identify strengths or weaknesses in particular courses, curriculum, programs, etc. Institutions and instructors may utilize the survey findings to adjust educational practices, improving education for future students.

2. Identifying Gaps:

Alumni can offer valuable insights into educational gaps that would have benefited their careers. Students have a wide variety of goals and aspirations, and the way they apply their education in the workforce varies greatly. Surveys can elicit responses about specific skills or knowledge that were lacking. This information helps institutions address these gaps by potentially adding new courses or modifying existing ones to better prepare students for their careers. Institutions can then continuously improve, ensuring a curriculum that is both applicable and relevant to industry needs.

3. Maintaining Relationships:

After graduation, alumni may often feel that their institution has forgotten them. Seeking alumni perceptions keeps them connected to the institution. Gathering their feedback shows that their opinions are valued and that their alma mater is committed to evolving and improving

based on their experiences. Surveys give respondents a voice, allowing participants to share personal perceptions of their education following application in the real-world.

Disadvantages:

Despite their benefits, alumni surveys are not without drawbacks:

- 1. Time-Consuming Production:** Creating a quality survey that gathers the desired response requires significant time and effort. Development of the survey, pilot testing, data collection, data analysis, etc. may take multiple months. However, this can be mitigated by collaborative efforts among faculty and equal distribution of responsibilities.
- 2. Unwarranted Responses:** If the survey is anonymous in nature, respondents may feel inclined to provide rude, falsely negative opinions. Participants might use anonymity as a shield to vent frustrations unrelated to the survey's purpose, leading to irrelevant or unconstructive responses.
- 3. Recall Bias:** Because alumni have already completed their educational program, there is a potential for recall bias as retrospective surveys ask them to remember their experiences, coursework, and other details from the past. To overcome this drawback, longitudinal studies, which track the same individual over time, may be conducted.

Conclusions

Surveying alumni is a strategic approach to gathering feedback from individuals who have completed their degree program and are applying their knowledge in the real world. The survey responses may be used to continually improve educational programs, curriculum, and

teaching methods. While surveys may provide invaluable insights into alumni experiences, they require careful development and implementation to maximize their potential and gather constructive feedback that may be used to adapt to industry and graduate needs. Acting on this feedback is crucial for institutions to evolve and meet the changing demands of the professional world.

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Chapter 6 - Conclusion

Throughout this dissertation, the exploration of veterinary anatomy education has revealed a mix of traditional methods and novel ideas that are shaping the educational landscape. The introduction highlighted the importance of anatomy in shaping clinical competence for veterinarians. Anatomy is a foundational subject for health professions education, equipping students with knowledge that is necessary for surgery, physical exams, medical imagery, communication, diagnoses, and much more. For centuries, cadaveric dissection has been the primary method of teaching anatomy alongside didactic lecture presentations. Although, veterinary education has shifted towards outcomes-based education, more specifically a competency-based approach in recent years. As a result, veterinary colleges are including more clinical and professional skills while reducing contact hours dedicated to basic sciences like anatomy. Due to these changes, anatomists are driven to explore novel teaching methods that benefit students in their learning, retention, and application of anatomical knowledge. Many advancements have taken place in veterinary anatomy education with the development and inclusion of multimedia, models, game-based education, art-based learning, and much more. These evidence-based practices have evolved veterinary anatomy education by emphasizing student-centered learning.

By keeping educational theory in mind, this dissertation explored three projects aimed at supplementing traditional teaching methods and addressing current challenges in veterinary anatomy education. First, the development of pre-lab videos was a proactive approach to enhancing student preparedness and understanding before cadaveric dissection assignments. In this study, correlations were found between video views and academic performance. These findings suggest that increased interaction with audiovisual resources improved student exam

performance. Additionally, qualitative analyses highlighted positive perceptions towards the pre-lab videos, emphasizing their role in enhancing student preparation, confidence, and comprehension. These findings are consistent with educational theories which advocate for managing cognitive load, integrating information effectively, utilizing audiovisual resources, enhancing active engagement, and focusing on student-centered learning.

Second, the implementation of a novel pre-course dedicated to ungulate anatomy aimed to address an educational gap by describing distinctive anatomical variations among ungulates. This study found correlations between engagement with the winter break pre-course and academic performance. Overall, student perceptions were favorable, highlighting the pre-course as a valuable tool for familiarizing and preparing veterinary students for ungulate anatomy. These findings align with educational theories such as cognitive load theory and constructivist approaches by encouraging active engagement and demonstrating how preparatory resources may reduce cognitive strain while enhancing student performance and readiness for veterinary anatomy.

Lastly, the analysis of alumni surveys provided invaluable insights into the effectiveness of veterinary anatomy teaching methodologies and the relevance of anatomy education to current practice. This study found consistent feedback indicating a high quality and effective curriculum over time. Alumni expressed overall satisfaction with their anatomy education but also identified areas for improvement, specifically by including more clinical relevance and practical application for future cohorts. The study findings highlight the significance of prioritizing student-centered education where focus is on the student and their active role in their own learning process. This study also emphasizes the importance of integrating clinical relevance into

anatomy courses and the potential need for ongoing curriculum enhancements to better prepare students for diverse veterinary specialties and the complexities of modern veterinary medicine.

These studies indicate that proactive use of online supplemental resources enhances veterinary anatomy education, especially in an age where students are technologically savvy and interactive learners. These findings highlight the importance of including additional resources to supplement cadaveric dissection and optimize student preparation and learning outcomes. These resources not only correlated with improved comprehension and academic performance, but also aligned with educational theories advocating for cognitive load management, active learning, and student-centered approaches. The positive reception and perceived benefits of these resources among students supports the inclusion of additional resources to facilitate learning. Additionally, these resources contribute to developing competencies essential for veterinary practice readiness. This dissertation also highlights the ongoing need for curriculum enhancements to meet evolving educational demands. By adopting innovative educational methods, incorporating feedback from alumni, and aligning teaching practices with educational theories, veterinary educators can improve the learning environment and successfully prepare students for the remainder of professional school and the challenges of practice.

Looking forward, veterinary anatomy education will benefit from combining traditional methods with innovative, evidence-based approaches. While cadaveric dissection remains fundamental, the use of supplemental resources and evidence-based practices will continue to play a crucial role in enhancing student engagement and retention, reducing cognitive strain, and improving clinical relevance. As veterinary education continues to evolve, future directions will include further research to refine the approaches discussed in this dissertation. Educators can enhance veterinary anatomy by continuously improving educational resources, assessing their

influence on student learning outcomes, and adjusting teaching methods to better align with the demands of veterinary medical professions. By embracing technological advancements, evidence-based practices, and student-centered approaches, educators can ensure that veterinary anatomy education remains effective in preparing future veterinarians for successful careers.

In conclusion, this dissertation has highlighted the impact of integrating innovative educational resources with traditional approaches in veterinary anatomy education. Continuing to explore these methods will assist educators in preparing veterinarians with essential anatomical knowledge, critical thinking abilities, and practical competencies needed for veterinary practice. The resources developed in this dissertation may be adapted by other institutions to improve veterinary anatomy education and advance the field of effective anatomy teaching tools. Continuing to incorporate supplemental resources and alumni insights in education will provide ongoing opportunities to learn about student preferences, enhance teaching methods, and advance curriculum development. This can deepen educators' understanding of students' needs and preferences and refine strategies to better prepare learners for real-world challenges.

Appendix A - Anatomy Education Adequacy and Clinical Practice

Readiness Questionnaire

1. What year did you graduate from the KSU CVM?
Class of 2018, Class of 2019, Class of 2020, Class of 2021, Class of 2022, Class of 2023
2. Did you take gross anatomy at the KSU CVM?
Yes or no
3. At the present time, are you a practicing veterinarian?
Yes or no
4. Are you currently pursuing / did you previous pursue a specialty (i.e., residency, PhD, etc)?
Yes or no
5. What is your primary focus area within your current veterinary practice?
Small animal | Equine | Food animal | Exotics | Mixed
6. To what extent do you feel that KSU CVM anatomy courses prepared you for the specie(s) you most commonly see in practice?
Not at All | Slightly | Moderately | Very Much | Extremely
7. To what extent do you feel that the knowledge gained from KSU CVM anatomy courses has been directly applicable to your daily veterinary practice?
Not Applicable | Slightly Applicable | Moderately Applicable | Very Applicable | Extremely Applicable
8. How often do you apply anatomy knowledge in making clinical decisions?
Never | Sometimes | About half the time | Most of the time | Always

9. How confident do you feel in your anatomical knowledge when communicating with clients and colleagues?
- Not Confident at All | Slightly Confident | Moderately Confident | Somewhat Confident | Extremely Confident
10. To what extent do you believe your KSU CVM anatomy education has contributed to your success in your veterinary career?
- Not at All | Slightly | Moderately | Very Much | Extremely
11. How often do you find yourself recalling the anatomical names of muscles, blood vessels, nerves, etc?
- Never | Sometimes | About half the time | Most of the time | Always
12. How well do you think your KSU CVM anatomy education prepared you for clinical practice?
- Not Well at All | Slightly Well | Moderately Well | Very Well | Extremely Well
13. How well do you feel KSU CVM anatomy courses covered topics relevant for clinical practice?
- Not Well at All | Slightly Well | Moderately Well | Very Well | Extremely Well
14. How well do you feel KSU CVM anatomy courses prepared you to conduct effective physical exams in practice?
- Not Well at All | Slightly Well | Moderately Well | Very Well | Extremely Well
15. How well do you feel KSU CVM anatomy prepared you to perform effective surgeries in practice?
- Not Well at All | Slightly Well | Moderately Well | Very Well | Extremely Well
16. In your opinion, how can KSU anatomy courses improve?