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RESEARCH REPORT

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Focused anatomy workshops for clerkships and the USMLE Step 1 examination

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Abstract

Anatomy is essential for understanding healthy and disease states as well as for the successful completion of clinical clerkships and board examinations. This project provided structured workshops aimed to review anatomical concepts for clerkships and Step 1 and provided a means for medical students to assess their anatomical knowledge. We provided six optional anatomy workshops, in which students (1) took a pre-session quiz, (2) faculty reviewed key anatomy of a particular system (e.g., musculoskeletal), (3) students worked through clinical cases in small groups, and (4) students took a post-session quiz and responded to a post-session survey to rate satisfaction of session content and delivery on a five-point Likert scale. One session was excluded due to small sample size ($n = 2$). Results from five workshops, including brachial plexus, musculoskeletal, pelvic, gastrointestinal, and head and neck anatomy, showed that students performed significantly ($p \leq 0.05$) better on the post-session quizzes compared to pre-session quizzes in all sessions. Post-session survey results indicated that students were satisfied with session content and facilitation, would attend future workshops, and would use session materials to study for Step 1. Based on these short-term benefits of the sessions, we plan to continue offering monthly workshops to medical students to increase knowledge retention of key anatomical concepts and increase preparedness for clerkships and Step 1. Future studies will longitudinally follow up with students post-Step 1 and clerkships to determine the long-term benefits of offering these workshops.

KEYWORDS
anatomy, board examinations, clinical clerkships, preparedness, Step 1, undergraduate medical education

INTRODUCTION

Anatomy is a critical component of undergraduate medical education (UME) that serves as a foundation for understanding healthy and disease states. Prior studies have (1) demonstrated the importance of anatomy for success in clinical clerkships,[1,2] (2) identified the high value that physicians place on anatomical knowledge,[1,3] and (3) attempted to develop core anatomy curricula to ensure essential anatomical knowledge is met for clinical clerkships.[1,4–7] However, anatomy has been shown to be the lowest mean score in student

performance among the basic sciences (e.g., biochemistry, genetics, physiology, etc.) upon entering clerkships.[8] Furthermore, across UME, curricular hours dedicated to anatomy have been reduced over the past several years,[9,10] and knowledge retention throughout UME has been shown to be low.[11,12] Although the movement toward integrated curricula[13] has been associated with better knowledge retention, a drop in knowledge retention is still observed when re-testing second-year medical students on first-year concepts.[12,14] This poses a problem for second-year medical students who are preparing to enter clinical clerkships. In addition to preparing for clerkships, second-year medical students must also pass their first United States Medical Licensure Examination (USMLE), Step 1. Step 1 is an examination that assesses the ability to apply basic science concepts to the practice of medicine; it is administered in seven 60-min segments in one eight-hour testing day.[15] The content outline for Step 1 includes a variety of topics spanning from basic biomedical sciences (including anatomy), human development, biostatistics, and social sciences, among others.[16] The importance of anatomy for success in clinical clerkships and on board examinations,[1–7] coupled with the reduced curricular hours for anatomy across UME,[9,10] suggests a potential benefit of offering structured anatomy review sessions to preclinical medical students to aid in their preparation for Step 1 and clerkships.

At the University of Vermont (UVM) Robert Larner, M.D., College of Medicine (LCOM), the Vermont Integrated Curriculum (VIC) organizes the medical curriculum into three levels: Foundations, Clinical Clerkships, and Advanced Integration.[17] The preclinical Foundations curriculum covers the first year and a half of the curriculum and is focused on basic and clinical science education; this is the period during which students complete much of their coursework.[17] Medical students at LCOM take Step 1 after completing the Foundations curriculum during their second year. Following successful completion of Step 1, second-year medical students begin their clerkships. At LCOM, there are required and optional components of the curriculum aimed to prepare students for Step 1. These resources include course work, information and support sessions on Step 1, academic advising, peer tutors, practice examinations from the National Board of Medical Examiners (NBME) and Comprehensive Basic Science Examination (CBSE),[18,19] access to UWorld questions banks,[20] and reviews of specific high-yield topics for Step 1. This article describes the novel addition of specific high-yield review sessions for anatomy as part of the optional resources offered to medical students at LCOM when preparing for Step 1. This proves to be a particularly relevant addition as Step 1 pass rates across medical schools in the United States have dropped from 97% in 2021 to 91% in 2022 and 90% in 2023,[21] suggesting a potential benefit for medical schools to incorporate additional Step 1 review sessions into their curricula. Furthermore, students with backgrounds that are underrepresented in medicine (URM) have a higher risk of failing Step 1 than those who do not identify as URM, which impacts recruitment into residency programs.[22–24] Thus, the goal of this project was to incorporate additional Step 1 review opportunities for medical students on high-yield anatomical concepts, increasing accessibility to Step 1 resources. Specifically, we aimed to provide a structured format to review anatomy relevant to clerkships and Step 1 as well as provide structured opportunities for medical students at LCOM to assess their anatomical knowledge prior to entering clerkships and taking Step 1.

MATERIALS AND METHODS

Ethics statement

The Institutional Review Board Ethics Committee on Human Research at UVM reviewed this study and determined it to be exempt from full review.

Anatomy curriculum at LCOM

Anatomy is integrated into a larger 18-week course, Foundations of Clinical Sciences (FoCS), that first-year medical students take upon matriculation. In FoCS, students integrate several disciplines, including genetics, biochemistry, physiology, imaging, histology, ethics, and anatomy among other topics.[17,25] The anatomy component of FoCS is primarily dissection-based, which has been established as a best practice in UME and beyond.[26–28] Students attend 3-h laboratories in which they dissect a specific part of a donor that corresponds to a specific content block (e.g., back, upper limb, lower limb, thorax, abdomen, pelvis, and head and neck). The anatomy component also includes online modules and lectures covering specific anatomical topics as well as integrative reviews and workshops focusing on application of anatomical knowledge. For a complete description of the anatomy curriculum at LCOM, please refer to the VIC webpage[17] and prior publications.[25]

Educational objectives

1. Provide a structured format to review anatomy relevant to clerkships and Step 1.
2. Provide structured opportunities for medical students to assess their anatomical knowledge prior to entering clerkships and taking Step 1.

Advertising the sessions

The location, time, and topic for each session were advertised in several venues. We advertised in the *Weekly Wire*, a newsletter designed to inform medical students of non-curricular events happening on or off the LCOM campus. We also placed the session materials on online curricular and non-curricular calendars for medical students. Word of mouth, whereby student representatives on the project informed their peers about the sessions, was also used.

Study setting and structure

The study was conducted in medical education classrooms at LCOM, where participants could sit in groups of up to six. Each session was one hour in length. Sessions were facilitated as interactive workshops and were prepared by two faculty members at LCOM, both of whom teach in FoCS. The sessions were optional and targeted primarily to medical students in the Class of 2027 during the Fall and Spring semesters of their first year and during the Fall semester of their second year. Students in the initial two years of their training were the targeted audience as these students are in their foundational level training, which emphasizes basic science with clinical application.[17] This is also the timeframe in which students are preparing for Step 1, which is taken in February of their second year.[17] Despite the specific targeting, medical students in any class and at any stage of their training were welcome to attend these optional sessions.

In these workshops, participants were initially given 10 min to complete a pre-session quiz individually. Next, faculty provided a brief review of key anatomical concepts of a particular system, followed by three to seven questions related to the presented anatomy. These questions typically consisted of a brief clinical vignette, followed by multiple-choice-questions (MCQs). Some sessions included open-ended short answer questions as well. Participants were encouraged to work in small groups to answer each question, as interactive learning and group work is a best practice in UME.[29–31] In the final 10 to 15 min of the session, participants completed the post-session quiz and post-session satisfaction survey individually.

Session interest survey

First-year medical students in the Class of 2027 were surveyed to gauge their interest in participating in anatomy review workshops. Respondents were asked questions regarding their interest in attending anatomy review workshops and their preference in the format, frequency, structure, and content of the sessions. The survey consisted of 12 questions, some of which were open-ended, and others were MCQs, allowing for selection of multiple items. This survey was developed and administered using Qualtrics XM version 2020 (Qualtrics, Provo, UT), a web-based survey tool that is available to faculty, staff, and students at UVM. UVM has obtained a subscription to Qualtrics XM which allows all members of the UVM community open access. All survey responses were anonymous.

Pre- and post-session quizzes

Pre- and post-session quizzes consisted of eight to 10 questions, all of which were MCQs. The pre- and post-session quizzes consisted of identical questions, which is consistent with prior studies and recommendations.[11,32,33] The content of the questions included basic anatomy knowledge as well as application of knowledge to clinical scenarios specific to the anatomical system discussed in the workshop. An example of a basic anatomy knowledge question for the brachial plexus session is "Which of the following nerves is a branch of the medial cord?", while an example of an application question is "Wrist drop may result from injury to which of the following nerves?". Please see the Appendix for all quiz questions administered in this study. The content of these quizzes was developed using LCOM Foundations course learning objectives[17,25] and validated using third-party board examination preparation materials, including First Aid for the USMLE Step 1[34] and Clinically Oriented Anatomy, 8th ed.[35] Quizzing was used as a means of assessment strategy as it is supported by the science of learning and retrieval practice.[36,37] All quizzes were created and reviewed by two faculty who teach in the Foundations anatomy curriculum at LCOM. All quizzes were administered via Qualtrics XM version 2020, and all responses were anonymous.

Post-session surveys

The post-session survey consisted of 14 questions intended to obtain participants' perceptions on the content covered in the session, the facilitation of the session, the quality of the session materials, and the likelihood of using session materials as study aids. Post-session surveys included open-ended questions and ratings on a five-point Likert scale of satisfaction. All post-session surveys were administered using Qualtrics XM version 2020, and all responses were anonymous.

Session topics

Session topics were designed to cover anatomical content related to a particular system. The topics presented include: (1) Brachial Plexus, (2) Musculoskeletal (MSK) System, (3) Cardiorespiratory and Renal (CRR) System, (4) Pelvic Anatomy, (5) Gastrointestinal (GI) System, and (6) Head and Neck Anatomy. The sessions were not comprehensive, but, rather, were designed to review anatomical concepts that were not only broad but also relevant to clerkships and Step 1. Extant literature,[1–7] USMLE content outlines,[16] LCOM course content,[17,25] textbooks,[34,35] and published clinical cases were used to inform the design of session materials. Please see Table 1 for the learning objectives of each workshop that was included in the analysis. All session materials were vetted by two faculty members who have several years of experience in teaching anatomy and developing course curricula in UME.

Data collection and statistical analyses

Participants' scores on the pre- and post-session quiz questions were collected at each session. Qualtrics XM version 2020 was used to administer pre- and post-session quizzes as well as post-session surveys. Data from the quizzes and surveys were downloaded into a Microsoft Word document and a Microsoft Excel spreadsheet (Microsoft, Redmond, WA) for analyses. Data in the Excel spreadsheet was imported into

TABLE 1 Learning objectives for each workshop included in the analysis.

Brachial plexus workshop learning objectives
1. Identify the parts of the brachial plexus, including roots, trunks, divisions, cords, and branches
2. Describe the motor and sensory innervation of the terminal branches of the brachial plexus
3. Discus clinical correlates associated with injury to different parts of the brachial plexus
MSK system workshop learning objectives
1. Identify bony structures and locations of fractures on plain radiographs
2. List the muscles that cross and act on the joints of the upper and lower limbs
3. Explain the consequences of injuries to bones, tendons, and ligaments as it relates to nerve and muscle function
Pelvic anatomy workshop learning objectives
1. Describe the vasculature of the pelvis, including the branches of the internal iliac artery
2. Identify the musculature and innervation of the pelvic diaphragm
3. Identify pelvic viscera and external genitalia
GI system workshop learning objectives
1. Review the viscera of the foregut, midgut, and hindgut, including their structure, function, and blood supply
2. Describe blood flow through the portal venous system
3. Describe the parasympathetic and sympathetic innervation of the foregut, midgut, and hindgut
Head and neck anatomy workshop learning objectives
1. List the nerves and vessels of the neck, describing their anatomical locations and areas of distribution
2. Describe the anatomy of the larynx, including cartilages, muscles, and nerves
3. List the cranial nerves, discussing functions and location from which they exit the skull

Note: Learning objectives were included in student correspondences and PowerPoint slides for the workshop and were informed by resources described in the Materials and Methods.

GraphPad Prism, version 9.0, for Windows (GraphPad Prism Software, San Diego, CA), which was used to generate graphs and perform statistical analyses. Results from the CRR System Workshop were excluded due to small sample size ($n=2$). A scheduling conflict likely contributed to the poor attendance for the CRR System Workshop. Thus, the results from five of the six workshops were analyzed. Results were presented as the percent and sum of responses for survey data and the mean and standard deviation (±SD) for quiz score data. Two-tailed paired t-tests were used to determine if there was a statistically significant difference between the mean scores of the pre- and post-session quizzes. Effect sizes (r^2) and 95% confidence intervals (95%CI) are reported for each pair. A p-value of ≤0.05 was considered statistically significant.

RESULTS

Session interest survey

The interest survey was sent to 122 first-year medical students in the Class of 2027 at LCOM, of which 40 responded (33% response rate). This response rate is similar to response rates reported in other studies of preclinical medical students.[38,39] Most respondents indicated they would (19 students, 48%) or may (19 students, 48%) be interested in attending (Figure 1A) anatomy review sessions on a monthly basis (30 students, 75%, Figure 1B). Regarding the structure of the sessions (Figure 1C), a workshop style was the highest-rated option (19 students, 48%), followed by a problem-based format (15 students, 38%). Regarding the preferred format of questions (Figure 1D), MCQ was the highest-rated option (37 students, 93%). Regarding the type of anatomical knowledge covered (Figure 1E), anatomy for Step 1 was the highest-rated option (36 students, 90%), followed by anatomy for current courses (21 students, 53%). Students were queried on the preferred topics to cover and were given the option to select multiple topics. The highest-rated option was MSK system (29 students, 73%), followed by vasculature (27 students, 68%). Students also rated nervous system topics highly, including peripheral nerves and plexuses (23 students, 58%), autonomic and somatic nervous systems (22 students, 55%), and head and neck anatomy (21 students, 53%).

Brachial plexus workshop

Twenty-four first-year medical students in the Class of 2027 attended the Brachial Plexus Workshop. The pre- and post-session quiz consisted of eight MCQs, four of which were basic anatomy knowledge and four of which were application of anatomy knowledge. The mean score on the post-session quiz was 20.6% higher than the pre-session quiz. Table 2 and Figure 2A show the mean, SD, r^2, 95%CI, and p-value for the pre- and post-session quiz.

Musculoskeletal (MSK) system workshop

Twenty first-year medical students in the Class of 2027 attended the MSK System Workshop. The pre- and post-session quiz consisted of eight MCQs, four of which were basic anatomy knowledge and four of which were application of anatomy knowledge. The mean score on the post-session quiz was 26.9% higher than the pre-session quiz. Table 2 and Figure 2B show the mean, SD, r^2, 95%CI, and p-value for the pre- and post-session quiz.

Pelvic anatomy workshop

Thirty-eight first-year medical students in the Class of 2027 attended the Pelvic Anatomy Workshop. The pre- and post-session quiz consisted of 10 MCQs, of which eight were basic anatomy knowledge and two were application of anatomy knowledge. The mean score on the post-session quiz was 14.0% higher than the pre-session quiz. Table 2 and Figure 2C show the mean, SD, r^2, 95%CI, and p-value for the pre- and post-session quiz.

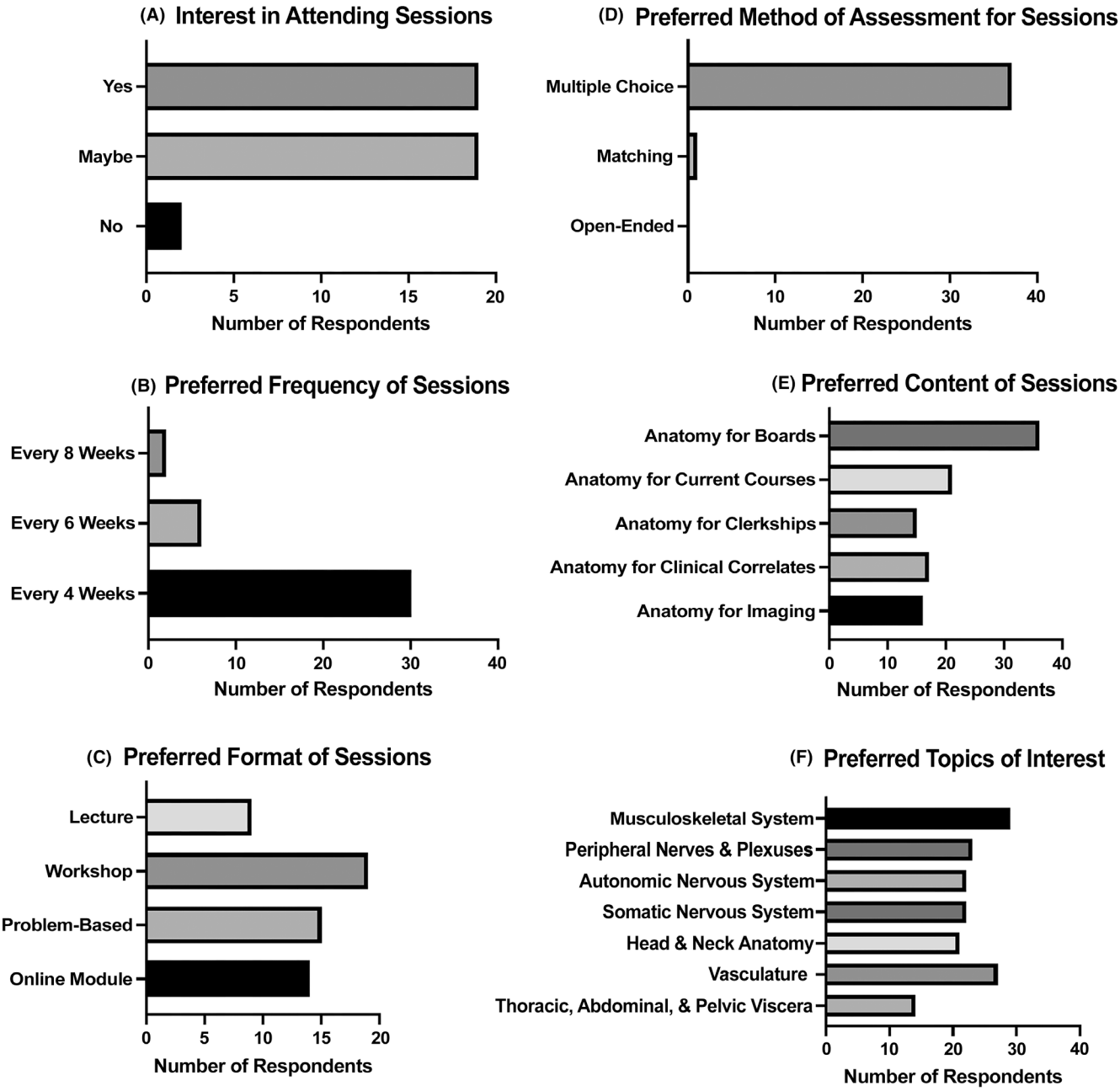

FIGURE 1 Session interest survey responses from 40 first-year medical students. (A) Interest in attending anatomy review sessions. (B) Preferred frequency of sessions. (C) Preferred structure of sessions (students could select multiple options). (D) Preferred question format for sessions. (E) Preferred type of anatomical knowledge covered (students could select multiple options). (F) Topics of interest (students could select multiple options). Data are student responses from an anonymous Qualtrics survey.

Gastrointestinal (GI) system workshop

Twenty-five students (20 first-, 3 second-, and 2 third-year medical students) attended the GI System Workshop. The pre- and post-session quiz consisted of eight MCQs, four of which were basic anatomy knowledge and four of which were application of anatomy knowledge. The mean score on the post-session quiz was 17.2% higher than the pre-session quiz. Table 2 and Figure 2D show the mean, SD, r^2, 95%CI, and p-value for the pre- and post-session quiz.

Head and neck anatomy workshop

Forty-nine students (48 first- and 1 second-year medical students) attended the Head and Neck Anatomy Workshop. The pre- and post-session quiz consisted of eight MCQs, four of which were basic anatomy knowledge and four of which were application of anatomy knowledge. The mean score on the post-session quiz was 29.9% higher than the pre-session quiz. Table 2 and Figure 2E show the mean, SD, r^2, 95%CI, and p-value for the pre- and post-session quiz.

TABLE 2 Pre- and post-session quiz results for each workshop included in the analysis.

Workshop	Pre-session quiz mean ± SD	Post-session quiz mean ± SD	Effect size r^2	95%CI	*p*-value
Brachial plexus	55.9 ± 25.9	76.5 ± 21.8	0.8	12.1, 29.0	<0.01
MSK	57.5 ± 20.2	84.4 ± 15.4	0.8	14.9, 38.9	<0.01
Pelvic	54.9 ± 25.1	68.9 ± 27.6	0.4	−0.9, 28.0	0.05
GI system	61.8 ± 21.0	79.0 ± 15.0	0.5	2.9, 31.0	0.02
Head and neck	60.5 ± 18.8	90.4 ± 5.0	0.8	16.1, 43.7	<0.01

Note: Data are mean (percent) and standard deviation (SD) for each pre- and post-session quiz. Effect sizes (r^2), 95% confidence intervals (95%CI), and *p* values are included for each pair.

Post-session surveys

Figure 3 shows the student responses on the post-session survey for each session. The Pelvic Anatomy Workshop post-session survey is not shown due to poor response rate ($n = 2$). Overall, students were satisfied with session content and facilitation. Table 3 includes a sample of narrative comments from the post-session surveys of several workshops.

DISCUSSION

This project has incorporated focused anatomy workshops as a novel addition to the preparatory resources for Step 1 and clerkships offered to medical students at LCOM. These workshops provided a structured and interactive opportunity to review key anatomical concepts relevant to clerkships and Step 1 and allowed medical students to assess their anatomical knowledge prior to entering clerkships and taking Step 1. Overall, we found improved scores on the post-session quizzes, indicating at least a short-term increase in anatomical knowledge associated with these workshops.

The medical students in the Class of 2027 were surveyed in their first year to determine their interest in participating in focused anatomy workshops as an additional review opportunity for Step 1 and clerkships. We targeted medical students in the Class of 2027 during their preclinical Foundations curriculum in order to follow the same group of students longitudinally through their first one and a half years incorporating these additional anatomy review workshops prior to taking Step 1 and entering clerkships at the end of their second year. We found that there was broad interest in participating in interactive anatomy review workshops, which is consistent with active learning and flipped classroom theories that result in better student learning and academic performance.[29–31] Regarding the format of questions in the workshops, students preferred MCQs, which is most likely due to Step 1 being an MCQ examination; thus, students were likely seeking practice questions that would be formatted similar to USMLE standards. While most questions were formatted as MCQs in the workshops, we did incorporate some open-ended short answer questions to ensure questions were asked in a variety of formats. This is also consistent with students indicating they were interested in covering anatomy relevant for Step 1. Specifically, when asked to select topics of interest, students indicated MSK and peripheral nervous system anatomy as well as vasculature as pertinent topics to review, which is consistent with USMLE content outlines[16] as well as what prior studies have classified as "essential anatomy" for clerkships.[1–7] Each workshop covered these high-yield topics, either specifically or integrated them into other session topics. Thus, the format of the workshops is consistent with current medical student preferences, USMLE standards, and best practices in UME.

The mean scores on the post-session quizzes were significantly higher compared to the pre-session quizzes in all five workshops. These data indicate an increase in anatomical knowledge associated with the 60-min workshop, suggesting there is an immediate, short-term benefit to attending these optional sessions. Quizzing was used as a means of assessment strategy as it is supported by the science of learning and retrieval practice.[36,37] Although the pre- and post-session quizzes consisted of identical questions, students did not receive any information regarding their performance on the quizzes and prior publications have used similar approaches.[11,32,33] Therefore, the improvement in the post-session quiz indicates that students retained many of the concepts covered during these workshops. The content of these workshops included material that is covered in the Foundations curriculum; therefore, these sessions provided an opportunity to review and practice retrieval of material, which is essential for learning.[40–42]

To determine the potential long-term benefits on knowledge retention that these sessions may provide, we plan to develop a formative anatomy readiness exam that will include anatomy discussed at each workshop. We plan to offer this exam to students prior to the earliest date that students may take Step 1, which coincides with the conclusion of the monthly anatomy workshops for the Class of 2027. This formative assessment will provide a measure of long-term knowledge retention. We also plan to follow up with the Class of 2027 after they take Step 1 and after completing a portion of their clerkships. Most of the medical students at LCOM take Step 1 in February of their second year and enter clerkships in March. Thus, surveying medical students in Spring 2025 after taking Step 1 and starting their clerkships would be an ideal time to determine if students (1) used the workshop materials to prepare for Step 1 and/or clerkships and (2) felt that the workshops helped prepare them for Step 1 and/or clerkships. Indeed, prior research has found that students who report greater feelings of preparedness for exams tend to outperform those who reported feeling less prepared for exams.[43]

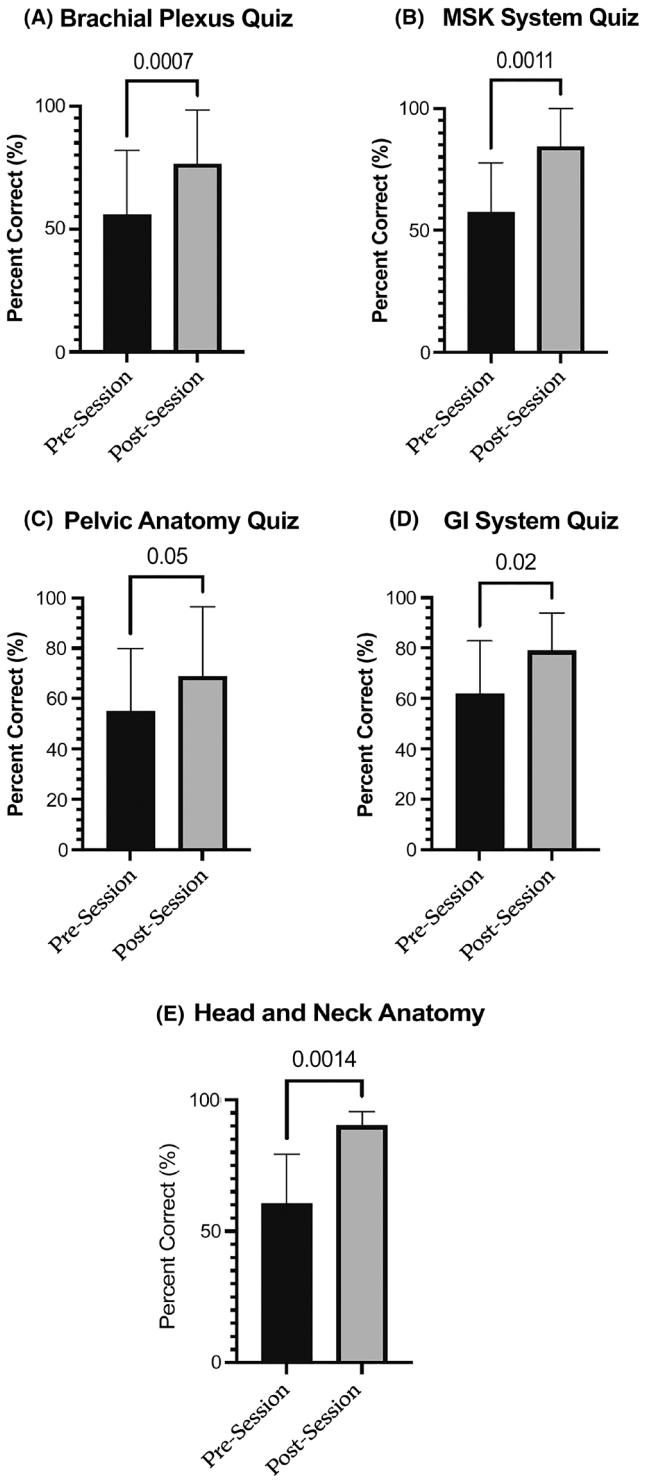

FIGURE 2 Pre- and post-session quiz scores. (A) Brachial plexus quiz. (B) MSK system quiz. (C) Pelvic anatomy quiz. (D) GI system quiz. (E) Head and neck anatomy quiz. Data are mean scores on pre- (black bar) and post-session (gray bar) quizzes with error bars indicating the SD. *p* values are included in the plots. The CRR system workshop was excluded due to small sample size ($n = 2$).

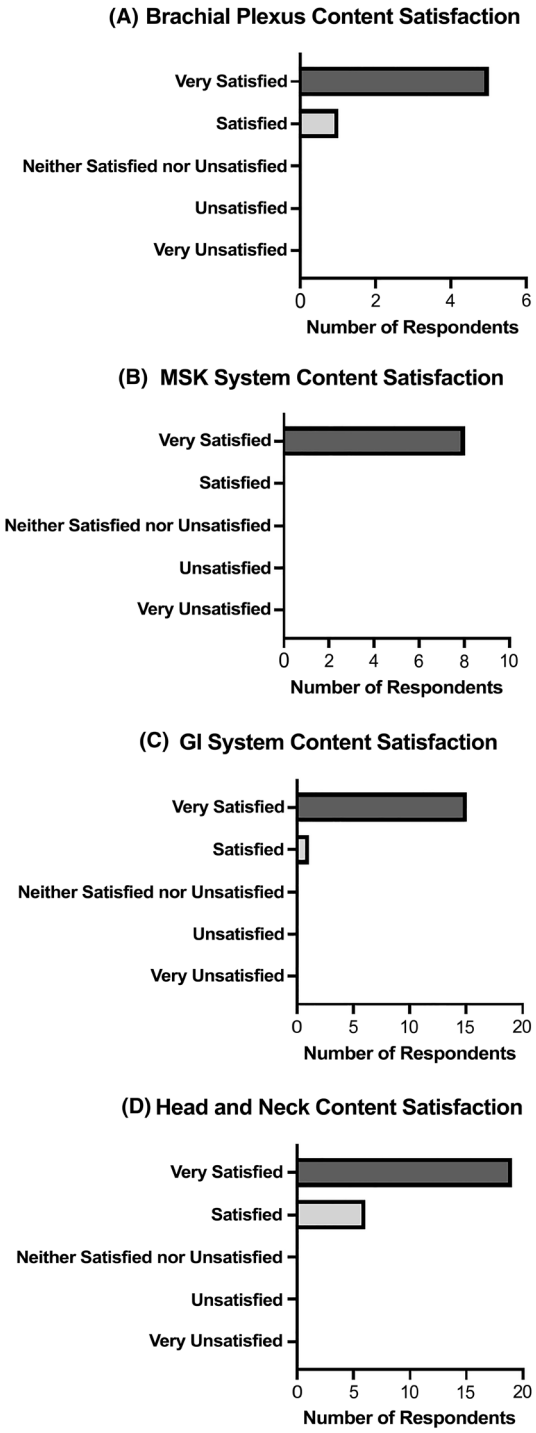

FIGURE 3 Post-session survey responses. (A) Brachial plexus survey. (B) MSK system survey. (C) GI system survey. (D) Head and neck anatomy survey. Data are presented on a 5-point Likert scale for satisfaction. The pelvic anatomy survey was excluded due to poor response rate ($n = 2$).

This underscores the importance of offering these workshops to provide students a structured review and a means of assessing their knowledge prior to taking Step 1.

The post-session surveys indicated that students were generally satisfied with the content and delivery of the sessions and planned to use the session materials to study and prepare for Step 1. The focused nature of these workshops is likely to be part of the reason that medical students reported high satisfaction with the workshops,

TABLE 3 Qualitative feedback from students regarding various workshops.

I thought it [the workshop] was extremely helpful in terms of review
I liked the opportunity to answer questions and think about what I know and don't know
I always appreciated [the] review of high-yield material!
I like that it was a very fast but very concise review of the content
This was a wonderful review of the material from back in FoCS [anatomy curricula]
I like the review slides and questions—I think it'll be helpful to be able to use these slides in the future
Helpful for brushing off some of the rust on anatomy knowledge; questions were interesting and helped me apply concepts
I really like how much content we were able to cover in a short time. It was helpful to hear all the words again and it reminded me of how much we have learned

Note: Data are narrative responses from open-ended post-session survey questions asking the students what they found helpful about the sessions. This is a compilation of comments from various workshops.

as prior work has shown that medical students prefer resources that are focused on high-yield content.[43,44] Furthermore, these sessions provide an opportunity to connect anatomical concepts with clinical correlates, which has been shown to be a challenge for medical students in their preclinical years.[45] This highlights the importance of these workshops as an additional opportunity to review, practice retrieval, and improve connections between basic science and clinical conditions. Indeed, integrating anatomy with clinical concepts has been shown to be important in deepening student knowledge, motivation, and professional skills.[46–48] Based on the overwhelmingly positive feedback on these sessions, we plan to continue offering these workshops; we have even expanded session topics to include neurology sessions as well. It is important to note that these sessions are optional and not an official part of the UME curriculum at LCOM; however, they are offered as a new addition to the optional Step 1 review resources offered to medical students at LCOM.

Several limitations of the current study exist that must be considered when interpreting the results. First, because these were optional sessions and all participation in the quizzes and surveys were optional, attendance at each session was variable, with sample sizes ranging from 20 to 49. The workshops that had sample sizes under 30 (Brachial Plexus, MSK System, and GI System) were likely underpowered. Although the majority of students who attended these workshops were in the Class of 2027, several students from other classes did attend these workshops. Additionally, within the Class of 2027, different students attended different sessions. Therefore, our sample is somewhat heterogenous. Furthermore, we must acknowledge the potential bias in the students who attend these optional workshops in that they may have more interest in anatomy or a greater degree of intrinsic motivation. In addition, Step 1 is pass/fail, which may impact students' perception of its importance and how much they study and prepare for it. However, the workshops offered are not entirely specific to Step 1 content; thus, preparation for clerkships and retention of anatomical knowledge may still be driving factors for attending these sessions. Finally, as we have not yet followed up with medical students long term, we can only speculate on the potential long-term benefits that these sessions may provide. However, our planned future work with this cohort of medical students, briefly described above, will address this limitation.

CONCLUSIONS

In summary, we have successfully integrated focused anatomy workshops as an additional resource to help students prepare for Step 1 and clerkships. Quiz scores from the sessions indicate an immediate benefit to participating in these workshops, whereas long-term benefits are still to be determined. Student satisfaction with workshop content and facilitation has been overwhelmingly positive. We plan to continue offering these monthly workshops to medical students to increase knowledge retention of key anatomical concepts and increase preparedness for clerkships and Boards.

AUTHOR CONTRIBUTIONS

Anna Ricci: Conceptualization; data curation; formal analysis; investigation; methodology; project administration; resources; supervision; validation; visualization; writing – original draft; writing – review and editing. **Ian Minearo:** Conceptualization; data curation; investigation; methodology; resources; visualization; writing – review and editing. **Abigail Hielscher:** Conceptualization; data curation; formal analysis; investigation; methodology; project administration; resources; supervision; validation; visualization; writing – original draft; writing – review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data is available upon request and at the discretion of the authors.

ETHICS STATEMENT

The authors are committed to upholding the rigorous ethical standards of their research.

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REFERENCES

1. Keim SA, Harmon DJ, Martindale JR, Lopez EN, Sanky C, Brooks WS, et al. Essential anatomy for core clerkships: a clinical perspective. Anat Sci Educ. 2023;16(5):943–57.
2. Leveritt S, McKnight G, Edwards K, Pratten M, Merrick D. What anatomy is clinically useful and when should we be teaching it? Anat Sci Educ. 2012;9(5):468–75.
3. Orsbon CP, Kaiser RS, Ross CF. Physician opinions about an anatomy core curriculum: a case for medical imaging and vertical integration. Anat Sci Educ. 2014;7(4):251–61.
4. McHanwell S, Davies DC, Morris J, Parkin I, Whiten S, Atkinson M, et al. A core syllabus in anatomy for medical students—adding common sense to need to know. Eur J Anat. 2007;11:3–18.
5. Webb AL, Green RA, Woodley SJ. The development of a core syllabus for teaching musculoskeletal anatomy of the vertebral column and limbs to medical students. Clin Anat. 2019;32:974–1007.
6. Moxham BJ, Stephens S, Sharma A, Loukas M. A core syllabus for the teaching of gross anatomy of the thorax to medical students. Clin Anat. 2020;33:300–15.
7. Tubbs RS, Sorenson EP, Sharma A, Benninger B, Norton N, Loukas M, et al. The development of a core syllabus for the teaching of head and neck anatomy to medical students. Clin Anat. 2014;27:321–30.
8. Norris ME, Cachia MA, Johnson MI, Martin CM, Rogers KA. Are clerks proficient in the basic sciences? Assessment of third-year medical students' basic science knowledge prior to and at the completion of core clerkship rotations. Med Sci Educ. 2021;31:709–22.
9. McBride JM, Drake RL. National survey on anatomical sciences in medical education. Anat Sci Educ. 2018;11:7–14.
10. Chan AYCC, Stapper CPM, Bleys RLAW, van Leeuwen M, ten Cate O. Are we facing the end of gross anatomy teaching as we have known it for centuries? Adv Med Educ Pract. 2022;13:1243–50.
11. Custers EJFM. Long-term retention of basic science knowledge: a review study. Adv Health Sci Educ Theory Pract. 2010;15(1):109–28.
12. Weggemans MM, Custers EJFM, ten Cate OTJ. Unprepared retesting of first year knowledge: how much do second year medical students remember? Med Sci Educ. 2017;27:597–605.
13. Brauer DG, Ferguson KJ. The integrated curriculum in medical education: AMEE guide no. 96. Med Teach. 2015;37(4):312–22.
14. Doomernik DE, van Goor H, Kooloos JGM, Ten Broek RP. Longitudinal retention of anatomical knowledge in second-year medical students. Anat Sci Educ. 2017;10(3):242–8.
15. The Federation of State Medical Boards of the United States, Inc. (FSMB) and the National Board of Medical Examiners (NBME). USMLE step 1 overview; 2024 [cited 2024 Jul 23]. Available from: https://www.usmle.org/step-exams/step-1#:~:text=Step%201%20is%20a%20one,form%20will%20not%20exceed%20280
16. The Federation of State Medical Boards of the United States, Inc. (FSMB) and the National Board of Medical Examiners (NBME). USMLE content outline; 2024 [cited 2024 Feb 6]. Available from: https://www.usmle.org/sites/default/files/2022-01/USMLE_Content_Outline_0.pdf
17. The University of Vermont Robert Larner, M.D., College of Medicine. Vermont integrated curriculum; 2024. [cited 2024 Feb 6]. Available from: https://www.med.uvm.edu/mededucation/level1
18. National Board of Medical Examiners (NBME). NMBE self-assessment; 2024 [cited 2024 Jul 23]. Available from: https://www.nbme.org/examinees/self-assessments
19. National Board of Medical Examiners (NBME). Comprehensive basic science subject exam—content outline; 2024 [cited 2024 Jul 23]. Available from: https://www.nbme.org/subject-exams/comprehensive/basic-science
20. UWorld. Step 1; 2024 [cited 2024 Jul 23]. Available from: https://medical.uworld.com/usmle/usmle-step-1/
21. United States Medical Licensing Examination (USMLE). Performance data; 2024 [cited 2024 Jul 1]. Available from: https://www.usmle.org/performance-data
22. Williams M, Kim EJ, Pappas K, Uwemedimo O, Marrast L, Pekmezaris R, et al. The impact of United States medical licensing exam (USMLE) step 1 cutoff scores on recruitment in medicine: a retrospective cross-sectional study. Health Sci Rep. 2020;3(2):e2161.
23. Edmond MB, Deschenes JL, Eckler M, Wenzel RP. Racial bias in using step 1 scores to grant internal medicine residency interviews. Acad Med. 2001;76(12):1253–6.
24. DeCarvalho H, Lindner I, Sengupta A, Rajput V, Raskin G. Enhancing medical student diversity through a premedical program: a Caribbean school case study. Educ Health. 2018;31(1):48–51.
25. Brown W, Afshari S, Zhou M, Lythgoe J, Walsh R, Hielscher AC. Living and post-mortem CT scans in the gross anatomy lab: a study investigating differences in first-year medical students' exam performance and perceptions. Anat Sci Educ. 2024;17(3):468–82.
26. Estai M, Bunt S. Best teaching practices in anatomy education: a critical review. Ann Anat. 2016;208:151–7.
27. Arráez-Aybar L, Buneo-López JL, Moxham BJ. Anatomists' views on human body dissection and donation: an international survey. Ann Anat. 2014;196:476–86.
28. Antipova V, Niedermair JF, Siwetz M, Fellner FA, Löffler S, Manhal S, et al. Undergraduate medical student perceptions and learning outcomes related to anatomy training using Thiel- and ethanol-glycerin-embalmed tissues. Anat Sci Educ. 2023;16(6):1144–57.
29. Mehta S, Schukow CP, Takrani A, Ritchie RP, Wilkins CA, Faner MA. Understanding student characteristics in the development of active learning strategies. Med Sci Educ. 2022;32:615–26.
30. Hew KF, Lo CK. Flipped classroom improves student learning in health professions education: a meta-analysis. BMC Med Educ. 2018;18:38.
31. Grant LL, Opperman MJ, Schiller B, Chastain J, Richardson JD, Eckel C, et al. Medical student engagement in a virtual learning environment positively correlates with course performance and satisfaction in psychiatry. Med Sci Educ. 2021;31:1133–40.
32. Luetsch K, Burrows J. Certainty rating in pre- and post-tests of study modules in an online clinical pharmacy course—a pilot study to evaluate teaching and learning. BMC Med Educ. 2016;16:267.
33. Torre DM, Daley B. AM last page: common evaluation designs in medical education I. Acad Med. 2013;88(11):1784.
34. Le T, Bhushan V, Sochat M, Chavda Y, Kallianos K, Abrams J, et al. First aid for the USMLE Step 1 2019: a student-to-student guide. New York, NY: McGraw Hill Education; 2019.
35. Moore KL, Dalley AF, Agur AMR. Clinically oriented anatomy, 7th ed. Philadelphia, PA: Wolters Kluwer Health Lippincott Williams and Wilkins; 2014.
36. Sumeracki MA, Nebel CL, Kaminske AN, Kuepper-Tetzel CE. Turning roadblocks into speed bumps: a call for implementation reform in science communication about retrieval practice. Educ Psychol Rev. 2024;36:22.
37. Brown PC. Make it stick: the science of successful learning. Cambridge, MA: The Belknap Press of Harvard University Press; 2014.
38. Shahrvini B, Baxter SL, Coffey CS, MacDonald BV, Lander L. Pre-clinical remote undergraduate medical education during the covid-19 pandemic: a survey study. BMC Med Educ. 2021;21:13.
39. Joubert G, Steinberg WJ, Van der Merwe L. Medical students as research participants: student experiences, questionnaire response rates and preferred modes. Afr J Health Prof Educ. 2022;14(3):106–10.

40. Donker SCM, Vorstenbosch MATM, Gerhardus MJT, Thijssen DHJ. Retrieval practice and spaced learning: preventing loss of knowledge in Dutch medical sciences students in an ecologically valid setting. BMC Med Educ. 2022;22:65.
41. Trumble E, Lodge J, Mandrusiak A, Forbes R. Systematic review of distributed practice and retrieval practice in health professions education. Adv Health Sci Educ Theory Pract. 2024;29(2):689–714.
42. Madan CR. Using evidence-based learning strategies to improve medical education. Med Sci Educ. 2023;33(3):773–6.
43. Bauzon J, Alver A, Ravikumar V, Devera A, Mikhael T, Nauman R, et al. The impact of educational resources and perceived preparedness on medical education performance. Med Sci Educ. 2021;31:1319–26.
44. Taylor JA, Shaw CM, Tan SA, Falcone JL. Are the kids alright? Review books and the internet as the most common study resources for the general surgery clerkship. Am J Surg. 2017;215(1):191–5.
45. Lopez H, Goldman E, Gaughan J, Phadtare S. From anatomical knowledge to clinical comprehension: a peer-oriented learning session to help medical students make the leap. Med Sci Educ. 2017;27:177–81.
46. Hammer N, Hepp P, Löffler S, Schleifenbaum S, Steinke H, Klima S. Teaching surgical exposures to undergraduate medical students: an integration concept for anatomical and surgical education. Arch Orthop Trauma Surg. 2015;135(6):795–803.
47. Klima S, Hepp P, Löffler S, Comwall J, Hammer N. A novel phased-concept course for the delivery of anatomy and orthopedics training in medical education. Anat Sci Educ. 2017;10(4):372–82.
48. Kranz A, Bechmann I, Feja C, Kohlhaw KR, Bürkigt T, Lippross L, et al. Implementation of clinical references for undergraduates in anatomy. Ann Anat. 2017;210:164–9.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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