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ORIGINAL ARTICLE

Comparison of online to face-to-face instruction for anatomy review in a third-year clinical course

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ABSTRACT

Objective: This project compared student learning and satisfaction of an anatomy review delivered by a face-to-face lecture (F2FL) and an online learning module (OLM) for third-year doctor of chiropractic students.

Methods: This cohort study compared student learning and satisfaction of a pediatric spinal anatomy review delivered via F2FL (cohort 1, n = 23) and OLM (cohort 2, n = 18) in 2 successive 2019 (pre-COVID) course offerings. Previously validated pre- and post-tests were given. Students completed a survey assessing delivery, comfort with online learning and online learning technology, and preference of F2FL vs OLM of review material. Pre- and post-test results were assessed using repeated-measures analysis of variance.

Results: Testing results showed an improvement with both groups (F2FL 53.7%, $p < .001$ vs OLM 51.8%, $p < .001$), with no significant difference between the F2FL and OLM groups ($p = .53$; $p = .82$). The survey showed: 83.3% of OLM students felt the online method was effective, and 88.9% of the OLM students would prefer online reviews or have no preference between online or face-to-face; meanwhile, 80% of the F2FL group thought the lecture engaging/effective, whereas 60% of the F2FL group would have preferred to have the material presented online.

Conclusion: The OLM was found to be as effective as the F2FL for the content assessed. The majority of students would prefer the online method for future anatomy review content presented in the course. This strategy could be applied to provide review materials in other clinical courses, allowing material to be developed and given by content experts while freeing valuable in-class time.

Key Indexing Terms: Problem-Based Learning; Computer-Assisted Instruction; Chiropractic; Education

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INTRODUCTION

Online/computer-assisted learning has been used extensively in healthcare education in both stand-alone and hybrid formats.[1–6] Anatomy coursework for medical students has traditionally been taught with both the lecture and laboratory portions presented in person; however, technological advances have led to significantly increased use of software and web-based learning.[7]

Evidence supports blended learning in teaching anatomy,[8–12] with the laboratory portion of the course taught face to face.[8,13–17] While face-to-face anatomy classes allow for instructor-student interaction and asking questions in real time, online work in the form of videos or learning modules has its own benefits including the ability to view, pause, or replay content as needed.[18] Online learning in the form of video lectures and quizzes may be beneficial as a complement to on-site classes and increased anatomy learning efficiency[8], and students engaged in a blended learning environment (online digital resources plus face-to-face lectures) has been associated with increased exam performance[9,13] and learning outcomes.[19] Online anatomy resources may be a useful tool to promote computer and digital-based learning efficacy, and in general, medical students have found material presented in this format easy to navigate and use.[1] Additionally, students with positive perceptions of online learning are likelier to be more engaged with the material;[20] similarly, anatomy students have better opinions of online materials if learning outcomes are enhanced.[13]

Given the potential benefits of computer-based instructional materials, an online format may be ideal for providing foundational anatomy review material in clinical courses. Independent learning modules have been shown to improve comprehension of anatomy concepts;[21] thus, providing students who are further along in their clinical education with online anatomy review

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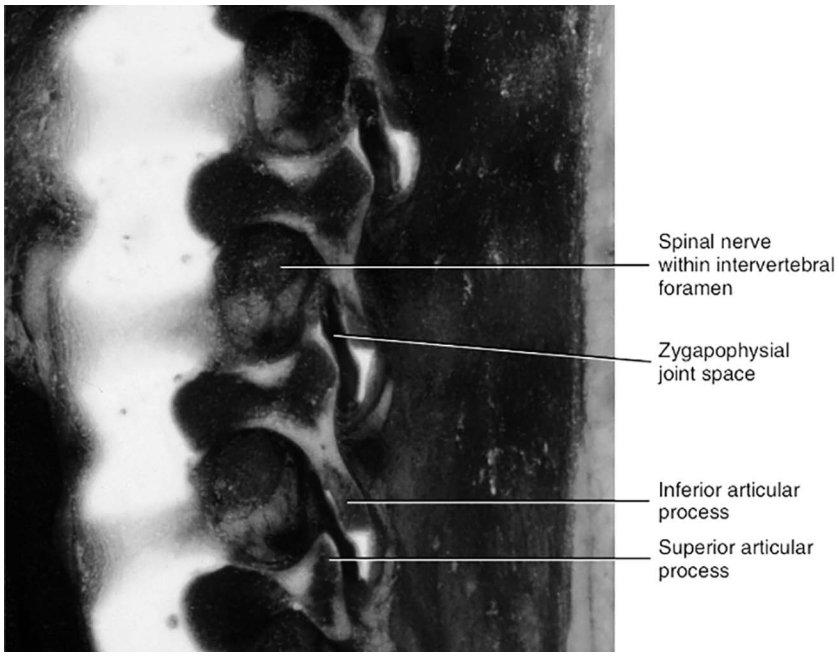

Figure 1 - Parasagittal section of a cadaveric newborn lumbar spine. Notice the large intervertebral foramina and underdeveloped articular processes forming the zygapophysial joints. Images of midsagittal and parasagittal sections of newborn, 3-month-old, 2-year-old, and 10-year-old spines were used in the OLM and F2FL sessions. [Reprinted from Fig. 13-2, Cramer G, Yu SW. Unique anatomic features of the pediatric spine. In: Cramer G, Darby S. *Clinical Anatomy of the Spine, Spinal Cord, and ANS.* 3rd ed. St. Louis: Elsevier/Mosby; 2014:566–585. (with permission)].

materials could assist in reinforcing anatomical knowledge in an easy and nondisruptive manner as they continue with their more applied coursework. While self-contained learning modules and videos for gross anatomy have been used with positive outcomes as supportive materials for both medical[21] and chiropractic students[22] in their initial courses, the effectiveness of online modules for review purposes in clinical courses has not been adequately investigated.

There is evidence that student performance and comprehension are no different between those who received anatomy information face-to-face or via an online or hybrid format.[18,22] Therefore, it is proposed that online anatomy modules presented to students taking clinical courses may be beneficial to not only review foundational material that can be applied to clinical concepts but could also save valuable in-class time in courses that cover an extensive amount of clinical material in a limited amount of time. The purpose of this study was to compare student learning and satisfaction delivered by 2 different methods [i.e., a face-to-face lecture (F2FL) and an online learning module (OLM) both on pediatric spinal anatomy] in a special population course for third-year doctor of chiropractic students.

METHODS

This study used a cohort comparison design that compared student learning and satisfaction of a pediatric spinal anatomy review (Figs. 1 and 2) delivered through a F2FL and OLM. Two successive 2019 (pre-COVID) course offerings were compared: the summer course using the OLM and the fall using the F2FL. This study was approved as an exempt research project by the National University of Health Sciences institutional review board (project #: H-1702).

Participants

Chiropractic students enrolled in a special population course in their seventh trimester of coursework were selected for this study; this course was selected because a review on pediatric spinal anatomy fit within the subject material for the course and several previous administrations of the course had included the pediatric spine material. Participants in the summer 2019 cohort completed the OLM, while the next cohort in fall 2019 was provided the F2FL. The material was provided during the same week in each course. Recruitment and informed consent were not necessary, as all procedures were consistent with standard classroom activities and assessments for improvement of courses. All student information and data were de-identified for data analysis and interpretation. A total of 18 students were enrolled in the summer 2019 course (OLM), and 23 students were enrolled in fall 2019 (F2FL).

Procedures and Outcome Measures

As part of a face to face clinical course on the evaluation and treatment of special populations (e.g., pediatrics and geriatrics), students received either a 1-hour F2FL or weeklong availability of an OLM reviewing the anatomy of the pediatric spine. Both groups received the same handout covering the material, and the same supplemental readings were recommended to both groups. The OLM consisted of 4 videos, made by the same instructor (GC), that together were the same length as the F2FL. An instructor not affiliated with the course (DM) sat in on the F2FL, took the OLM, and completed a "Similarity of Material Assessment" form. This form was constructed for the project and evaluated the similarity of content for the 2 methods of delivery.

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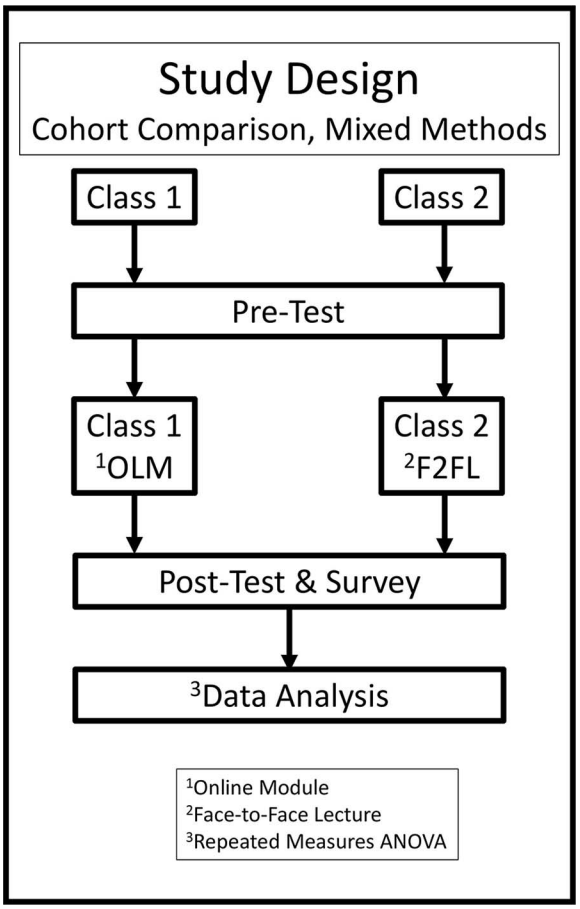

Figure 2 - Study design flowchart.

One week before students were presented with the pediatric spinal anatomy review, they were given a 5-question, multiple-choice pretest. The pretest did not count toward the students' course grades. One week after the lecture or access to the OLM, students were then given a 10-question, multiple choice posttest that was a standard part of the course, and counted toward the students' course grades. The test questions were written by the same instructor (GC) and identical tests were given to each group. Although the same material was covered in the pre- and post-tests, the questions differed in the 2 tests. All tests were administered as paper tests, face to face, to both cohorts. Both the pre- and post-test assessments had been previously evaluated for reliability. Prior to beginning the research study, the questions were administered to 2 cohorts and assessed using point biserial scores and percentage of the class that missed the question. Questions meeting all of the following criteria, used by our institution as indicators of questions that may need revision, were rewritten and re-administered for validation:

- >50% of class missed the question (a potential indicator of a poor performing question).
- >50% of the upper 27% of the class missed the question (when higher performing students miss the question, it can be an indication of a poor question).
- A point biserial of <0.40 (a low point biserial is an indication of an ineffective question).

Based on these criteria, 1 question was rewritten. The questions were then re-administered to an additional 2 cohorts for validation.

After the posttests were administered, surveys were given to each cohort which assessed the method of delivery of the review, comfort with technology, and preference of F2FL and OLM review material. Some of the questions were identical between the 2 surveys; however, several questions were specific to the method of delivery provided and consequently differed. Face and construct validity of the surveys had been assessed by having multiple expert and novice individuals take the survey and provide feedback prior to its administration. Feedback was used to improve the survey.

Statistical Analyses

A two-sample *t* test was used to compare the age differences between the 2 cohorts, and a chi-square test with Yates' continuity correction was used to assess the difference in sex between the F2FL and OLM students. Differences between pre- and post-test results were analyzed using repeated-measures analysis of variance, with F2FL and OLM as groups and the pre- and post-test results as repeated measures. Surveys were descriptively analyzed.

RESULTS

Table 1 shows the group demographics. The OLM course initially had 20 students enrolled; however, 2 unenrolled before the study began. Consequently, 18 enrolled students took the pediatric spine material and completed the course. Chi-square with Yate's continuity correction demonstrated there was no difference between the 2 cohorts related to sex ($p = .07$), and a two-sample *t* test found no difference for age ($p = .43$).

The course content presented to the F2FL and OLM groups was assessed and judged to be the same by the independent instructor.

Results of the pre- and post-tests are also shown in Table 1 and Figure 3. For test results, 1 student in the F2FL did not take the initial pretest, so their data was excluded due to the inability to make a comparison in grades. One student in the OLM was determined to be an outlier after plotting the pre- and post-test data and using the interquartile range (IQR) method for outlier detection from students' posttest results.[23] This student performed worse on the posttest than the pretest, and their posttest score was determined to be a strong outlier based on the formula $Q_1 - 3 \times IQR$, where Q_1 is the first quartile and IQR is the interquartile range. This method was performed using the OLM posttest scores as well as the combined cohorts' posttest scores with identical results. Data analysis was performed both with and without this outlier. Testing results showed an improvement in scores for both groups from pre- to post-test [Fig. 3A; F2FL: 53.7%, $p < .001$ vs OLM: 48.4%, $p < .001$ (OLM: 51.8%, $p < .001$ with outlier removed)], with no significant difference between test results between the F2FL and OLM groups [Fig. 3B, $p = .53$ ($p = .82$ with outlier removed)].

Surveys were completed by the entire OLM cohort but by only 10 of the 23 students in the F2FL group (see Discussion). Survey results showed: 83.3% of OLM students felt the online method was effective, and 88.9% would prefer (55.6%) online or have no preference (33.3%) between online or face to face; 77.8% of the OLM students would like to see more online

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Table 1 - Group Demographics and Test Results

Group	Term	N (41)	Female (%)	Mean Age (SD)	Pretest Mean (SD)	Posttest Mean (SD)	Difference Mean (SD)	Significance
Online Module (OLM)	Summer 2019	18	5 (27.7%)	26.4 (4.4)	44.4,[a,c] 43.5[d] (25.3,[c] 25.7[d])	92.8[c], 95.3[d] (13.6,[c] 8.7[d])	48.4,[c] 51.8[d] (11.7,[c] 17.0[d])	<.001,[c] <.001[d]
Face-to-Face Lecture (F2FL)	Fall 2019	23	14 (60.9%)	27.7 (5.2)	41.8[b] (22.2)	95.5 (9.6)	53.7 (12.6)	<.001

[a] 1 student in the OLM was an outlier after plotting the difference between their pretest and posttest scores; data analysis was performed both with (superscript c) and without (superscript d) this outlier.
[b] 1 student in the F2FL did not take the initial pretest, so their data was excluded due to the inability to make a comparison in grades.

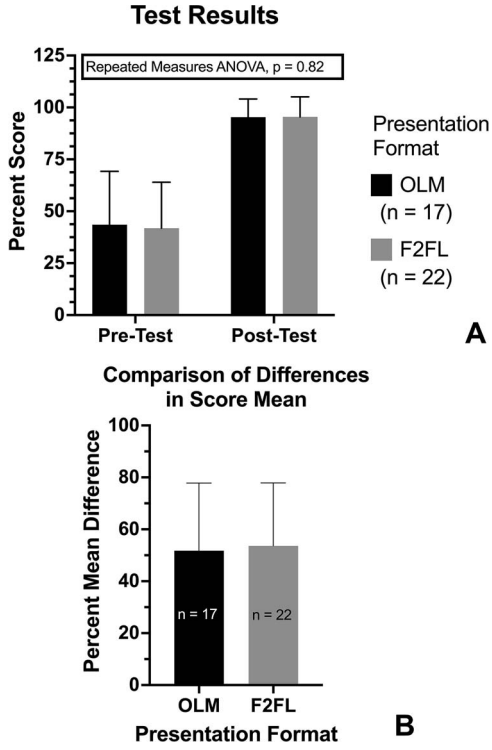

Figure 3 - Pre- vs post-test results for the online module (OLM, 1 outlier removed) and face-to-face lecture (F2FL) groups. The graph in A shows the pre- and post-test results for the OLM and F2FL cohorts. Both groups showed significant improvement following the respective educational session. The graph in B compares the differences of pre- vs post-test results between the 2 cohorts. There was no difference between the 2 delivery methods.

anatomy reviews in clinical education; 80% of the F2FL survey group thought the lecture engaged their attention; 70% felt the F2FL was an effective learning method, though 60% would have preferred to have the material presented online. Figs. 4A–4D provide a comparison between the 2 cohorts for several of the identical questions that were given in both F2FL and OLM surveys.

DISCUSSION

Students instructed with F2FL and OLM performed equally well on postinstruction tests in this study of a pediatric spinal anatomy review for third-year doctor of chiropractic students in a clinical course on special populations that emphasized pediatrics (Fig. 5) and geriatrics. Overall, students enjoyed both methods of instruction and were comfortable with the online format. Given the time limitations in this and similar clinical courses, scheduling challenges of having an anatomist speak in a clinical course given multiple times per year, the low stress environment of online learning,[12] and the ability of having the content expert prepare the OLM, we are convinced that OLM is a useful, and even preferable, delivery method for such anatomy reviews in clinical courses.

Because of the extensive nature of gross anatomy course content (e.g., anatomical knowledge, dissection and cadaver

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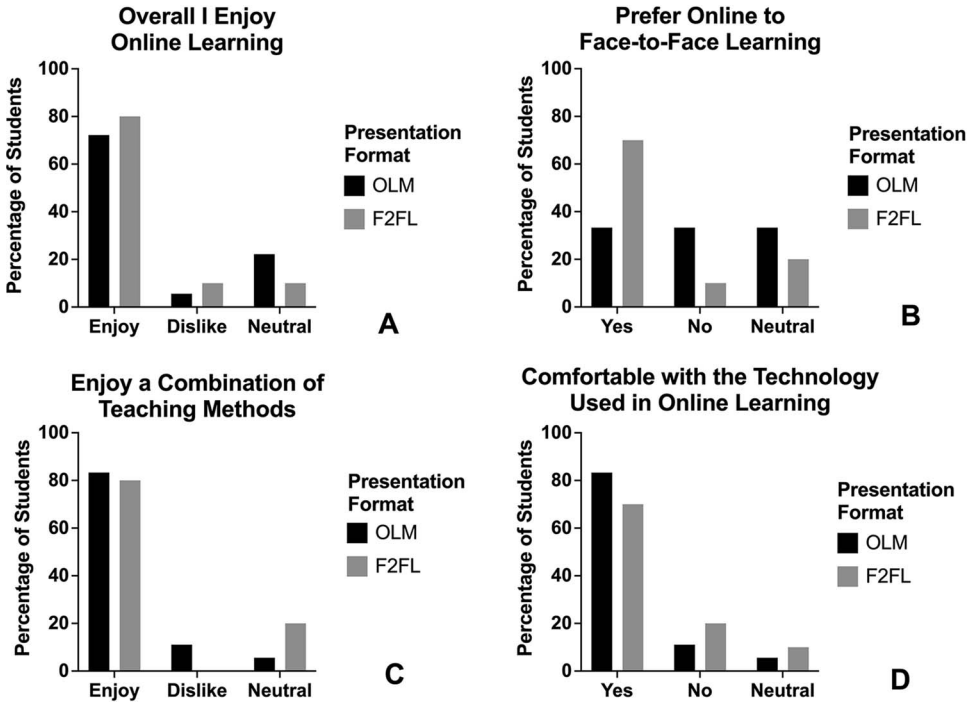

Figure 4 - Results of the face-to-face lecture (F2FL) and online module (OLM) groups for questions that were the same on both surveys. Overall, both groups enjoyed (A), and were comfortable with (B) online learning and the technology (D) involved, and enjoyed a combination of teaching methods (C).

work, anatomical identification, anatomical variants, etc.), an online-only format is not ideal for initial learning of gross anatomy.[13,15,17] Previous studies have demonstrated students feel laboratory components are vital for overall course comprehension,[8,16,17] and lack of practical-based instruction can lead to poorer learning outcomes.[14,24] However, for learning lecture-based material, online or digital resources can be helpful,[10,12,25,26] and have been related to increased comprehension[21] and learning outcomes.[6,9,13,19]

Summary and Applications

Students in the F2FL and OLM groups performed equally well, enjoyed the online format, and felt it would be a good approach to future reviews of basic science content in clinical courses. The students in the F2FL group also indicated the material could have been offered in an OLM (Fig. 4A–C), even though at the time (prepandemic) they felt somewhat less comfortable with the technology used in online learning (Fig. 4D). The OLM approach used in this study could be used for providing anatomic review material in other clinical courses (i.e., orthopedics, cardiology, gastrointestinal-genitourinary, special senses, etc.). The OLMs could be quite brief, with 5- to 15-minute segments used during the introduction component of various topics. For example, a 15-minute online anatomy review of the knee could be posted to a course's learning management site in an orthopedics course before lectures and labs on teaching pathologic conditions and orthopedic tests of the knee. An advantage of the OLM method is that this approach allows the basic science material to be developed and delivered by content experts while freeing valuable in-class time in clinical courses for more experiential learning and for the introduction of new clinical concepts (vs. reinforcement of previously learned materials).

Limitations

The relatively low number of subjects in the groups may not have revealed potential differences. However, the strong results indicate that the numbers of subjects were adequate for the study. There may also be differences in summer and fall cohorts, but we have no indication that the groups differed meaningfully or in a way that would impact the results, as student cohorts might have had slight differences between them regardless of when the course was taken.

The OLM was the only online learning used in the F2F Special Populations course. Consequently, the novelty of the OLM may have influenced the responses of the students on the survey. The effects of perceived novelty on student survey responses were not assessed. In addition, this study was conducted pre-COVID19 pandemic and the survey responses related to comfort with online learning would likely have increased in both groups after the pandemic. However, the preference for F2FL vs OLM may have differed postpandemic, and the rapid, complete shift to online learning may have caused some students to have become disillusioned with online learning. A future study could assess this issue. The pandemic also emphasized the importance of having high-quality online materials readily available,[8] and lessons learned during the pandemic included carefully preparing online materials and identifying which materials are best presented online and which are best presented face to face (e.g., laboratories).[13–17] The OLM pediatric spinal anatomy review materials of this study were consistent with lessons learned from the pandemic. The Special Populations course is continuing in

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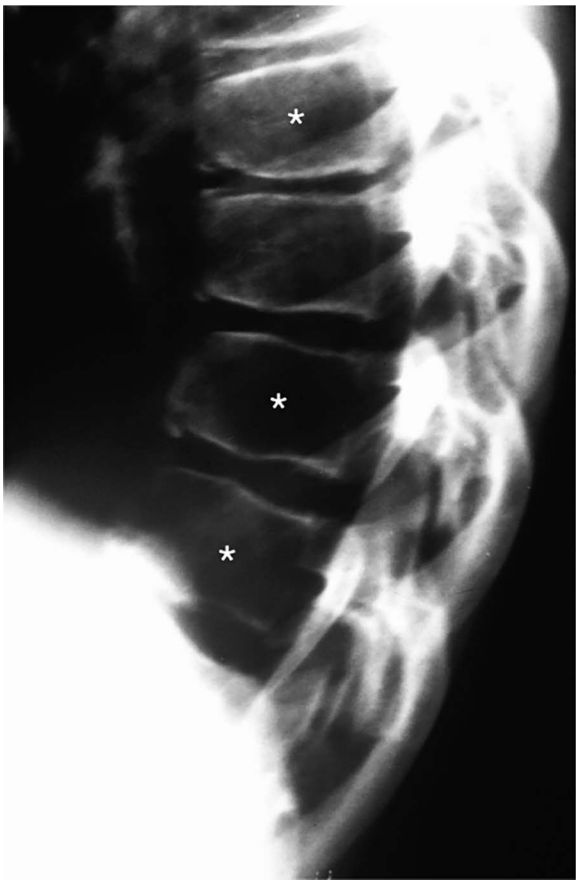

Figure 5 - Lateral thoracic x-ray of an adolescent with Scheuermann's disease (idiopathic juvenile kyphosis of the spine). Notice the roughened bony superior and inferior end plates, particularly of those vertebrae indicated by the asterisks. This condition was one of several discussed during the pediatric spine OLM and F2FL sessions. [Reprinted from Figs. 13–18, Cramer G, Yu SW. 2014 Unique anatomic features of the pediatric spine. In: Cramer G, Darby S. *Clinical Anatomy of the Spine, Spinal Cord, and ANS*. 3rd ed. St. Louis: Elsevier/Mosby; 2014:566–585 (with permission)].

the F2F format, with no current plans to change the format. The OLM anatomy review module will remain as an online module.

There was a low response to the survey in the F2FL group. The online survey was optional after the students completed the posttest, and the survey may not have been sufficiently emphasized as students completed the posttest. Yet, the survey results supplied rich information that provided important context to the study.

CONCLUSIONS

Pre- and post-tests and survey results indicated that OLM was as effective as F2FL in providing anatomy review material on the pediatric spine in a clinical course given to third-year doctor of chiropractic students. Students were highly satisfied with the online method of instruction. In the future, OLM could potentially be used to provide additional review materials fundamental to other clinical courses. The OLM method allows material to be developed and delivered by content experts while also freeing valuable in-class time to be used for more experiential learning in clinical courses.

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Author Contributions

Concept Development: TG, GC. Design: TG, CO, GC. Supervision: GC. Data collection/processing: TG, DM, JP, CO, GC. Analysis/interpretation: JF, GC. Literature search: JF, GC. Writing: JF, GC. Critical review: JF, TG, DM, JP, CO, GC.

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