Translational Research in Anatomy 23 (2021) 100100

Contents lists available at ScienceDirect

Translational Research in Anatomy

journal homepage: www.elsevier.com/locate/tria

Improving the learning process in anatomy practical sessions of chiropractic program using e-learning tool

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ARTICLE INFO

Keywords:
e-learning tool
Anatomy
Technology-enhanced learning
Chiropractic
Performance

ABSTRACT

Background: To accommodate the increased number of students and shorter learning time, anatomy instructors are increasingly developing web-based learning resources that can fulfil program-specific anatomical learning objectives and replace existing learning environment of the anatomy laboratory sessions. The study evaluated the quantitative change in the performance score in gross anatomy by replacement of face-to-face demonstration with an e-learning tool in practical sessions of chiropractic program.

Materials & methods: This quasi-experimental one-group pre-test and post-test design was employed longitudinally in two consecutive cohorts of semester 2 students. Teacher-led demonstration was used for first two sessions. E-learning tool was used in the next two sessions. Structured OSPE-based pre-test and post-test were held before and after the sessions. Wilcoxon Signed-Rank test was used to find out percentage of students showing improvement in the post-test score. Pearson correlation coefficient between pre-test and post-test scores was also done. A short questionnaire assessed the use of e-learning tools by the students.

Results: The mean difference between the post-test and pre-test score was higher in e-learning tool-led practical sessions. In 2018 cohort, 85.4% and 83.3% of students and 2019 cohort, 95% of students secured higher scores in post-test in two sessions with e-learning tool. In 2018 cohort, 62% and 70% of students and 2019 cohort, 81% and 70% of students secured higher scores in post-test in two sessions with teacher-led demonstration. A lower R^2 coefficient was observed between post-test and pre-test scores in sessions with e-learning tool. Perception analysis indicated that majority of students agreed about e-learning tool allowing them to revise identification of anatomical structures themselves.

Conclusion: The e-learning tool was able to raise the post-test score in a higher percentage of students, indicating improved learning process in practical sessions using e-learning tools. The study would motivate anatomy instructors to use web-based learning tools to identify structures during the laboratory sessions.

1. Introduction

The study of human anatomy and identification of anatomical structures are core components of the health science programs including medicine, nursing, chiropractic, physiotherapy and occupational therapy [1]. Although lecture allows the instructor to present a uniform package of structured information developed around some learning objectives, the learning of anatomy remains passive as students only listen to the projected slides showing the anatomical structures [2]. Interactive laboratory sessions provide an opportunity for the students to appreciate the three-dimensional forms of organs and their inter-relationship to the surrounding structures [3]. Universities are required to arrange for significant investments in space, time, and resources to organise the anatomy laboratory sessions. Integrated curriculum involving the multiple subject disciplines has replaced the traditional basic science curriculum in the pre-clinical phase of most of the health science programs. In an integrated set-up, anatomy curriculum has evolved and offers fewer hours [4]. Anatomy laboratory sessions are now restricted by the limited duration and accommodation of many students in a single group, limiting a student's view and ability to manipulate the specimens or models. In some institutions, the limited access to the teaching and learning resources may further be

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https://doi.org/10.1016/j.tria.2020.100100
Received 26 October 2020; Received in revised form 19 November 2020; Accepted 20 November 2020
Available online 27 November 2020

exacerbated with large admissions into a single cohort to make the programme more financially viable. Apart from the extrinsic factors like resource constraints in providing appropriate numbers of cadavers, specimens and models, some intrinsic factors have also surfaced in the present-day anatomy laboratory teaching [5]. With the advent of the modern curricular demand of integration of basic science with clinical applications, images related to CT and MRI are required to be incorporated in the anatomy laboratory session [6]. To accommodate the challenges from the extrinsic and intrinsic factors, anatomy instructors are increasingly motivated to develop cost-effective, student-friendly web-based learning resources that can fulfil the program-specific anatomical learning objectives and replace the existing learning environment of the anatomy laboratory sessions [1]. In a study done in Ottawa in 2008, the digital photographs of the cadaver were color-coded to maximise the student use of working memory during the learning. The web-based self-learning tool for the first-year health science students was developed as the authors found that existing web-based anatomy learning tool available in the market was more descriptive compared to the needs of health science anatomy curriculum learning objectives. Only 49% of the 275 students who used the online learning tool was available to provide the feedback and two-thirds of them reported that they found the tool useful for the preparation of summative examinations [2]. Davis et al. (2014) in a questionnaire-based study attempted to evaluate the perception of the students and anatomy faculty about the virtual anatomy teaching-learning tool. The study found disharmony between the perceptions of anatomy faculty and medical students about the use of teaching-learning tools. The choice of virtual learning replacing timetabled sessions was preferable by year 2 students (54%) compared to year 1 students (31%) [7].

The survey of the literature reveals that there is a lack of evidence about whether replacement of classical demonstration on the specimens or models during the anatomy laboratory sessions with the e-learning tools continues to impart effective knowledge base in gross anatomy. Apart from a study by Salajegheh et al. (2016) which found a cohort of medical students using online interactive web pages with the demonstration of radiological images had better scores compared to the students using traditional face-to-face demonstration on X-ray chest, other studies were based on the student perception analysis by questionnaire and not on the performance data [8].

Anatomy education and its application have been an important component of global chiropractic curriculum. A survey of 36 chiropractic colleges revealed that 75% of the institutions had anatomy laboratory demonstrations with 88% of them requiring compulsory attendance of the students in the laboratory sessions [9]. The present study describes the development of an e-learning tool which would help the chiropractic students to identify the anatomical structures in the model and specimen, on their own during the laboratory session as well as anytime anywhere using the e-learning application.

The objective of the present study was to determine the quantitative change in the performance score in areas of gross anatomy by replacement of the face-to-face demonstration by the teachers with the e-learning tool in the selected practicals of the chiropractic program.

2. Materials and methods

Chiropractic program of International Medical University contains anatomy modules in semester 1, semester 2 and semester 3. Students identify the anatomical structures by using the plastic and plastinated models during the anatomy laboratory sessions. A lecture is taken on the related topic about one week before the laboratory session. However, the lecture does not include all the learning objectives of the laboratory session. The learning objectives of the laboratory session is mostly based on the identification of the anatomical structures. The students need lecturers' help to identify the structures during the laboratory session. Sometimes it becomes challenging for the tutor to help all the students attending a session due to the student numbers. The students face challenges in completing the outcome of the session as they need to identify many structures within a laboratory session of fixed duration. The effective use of technology-enhanced learning in the laboratory session would train the chiropractic students to become active learner and will help them to revise the identification of anatomical structures independently at any time and from anywhere.

2.1. Theoretical framework

The learning characteristics of the adult students have been extensively studied and numerous theories have been proposed. Knowles (1984) described adult students as self-directed learners whose knowledge acquisition occurred best when it was exploratory rather than by reading notes or books [10]. Cognitive load theory suggests that the free exploration of a complex environment may generate a heavy working memory load that is detrimental to the learning. This suggestion is particularly important in the case of novice learners, who lack proper schemas to integrate the new information with their prior knowledge [11]. In the present study, online guided instruction to identify the anatomical structures minimized the extraneous cognitive load (which was a hindrance to the student learning) and facilitated interactive learning with greater engagement [12].

2.2. Study period

The study was done among the semester 2 chiropractic students during their Head and Visceral Anatomy module. At the time of studying this module, all students completed at least one semester of University study. The students have already completed the Human Biology module and Limb and Trunk Anatomy module in semester 1. Chiropractic cohort of 02/2018 and 01/2019 were included in the study.

2.3. Study design

The study followed a quasi-experimental one-group pre-test/post-test design longitudinally in the Head and Visceral Anatomy module of 02/2018 and 01/2019 cohort (Fig. 1). The total number of students in 02/2018 class was 53 and in 01/2019 class was 48.

Both the cohorts of students went through two laboratory sessions using teacher-led identification and two laboratory sessions using e-learning tool-led identification. Laboratory session 1 using teacher-led identification was anatomy of the nasal cavity, muscles of mastication and pharynx. Laboratory session 2 using teacher-led identification was anatomy of the lungs, mediastinum, and heart. Laboratory session 3 using e-learning tool-led identification was anatomy of the urinary system. Laboratory session 4 using e-learning tool-led identification was anatomy of the male and female reproductive system. In 02/2018 cohort, 53 students joined the session 1 and 50 students joined the session 2. In 02/2019 cohort, 37 students each joined session 1 and 2. In session 3 and 4, 48 students each joined from 02/2018 cohort and 40 students each joined from 02/2019 cohort. In the sessions with teacher-led identification, the tutor went to each practical station in the laboratory and checked whether the students identified the structures correctly or not. In the sessions with e-learning-tool led identification, students used the video of the narration in the e-learning tool from the iPads or phones to identify the structures. For all the laboratory sessions, pre-test assessment was held just before the laboratory session and post-test assessment was held 7 days after the session. The test questions for all the laboratory sessions carried equal marks. The number of questions on the identification of structures was equal in laboratory sessions using teacher-led identification and the session using e-learning tool-led identification (Appendix A).

2.4. Study process

At the very beginning, written informed consent from each of the

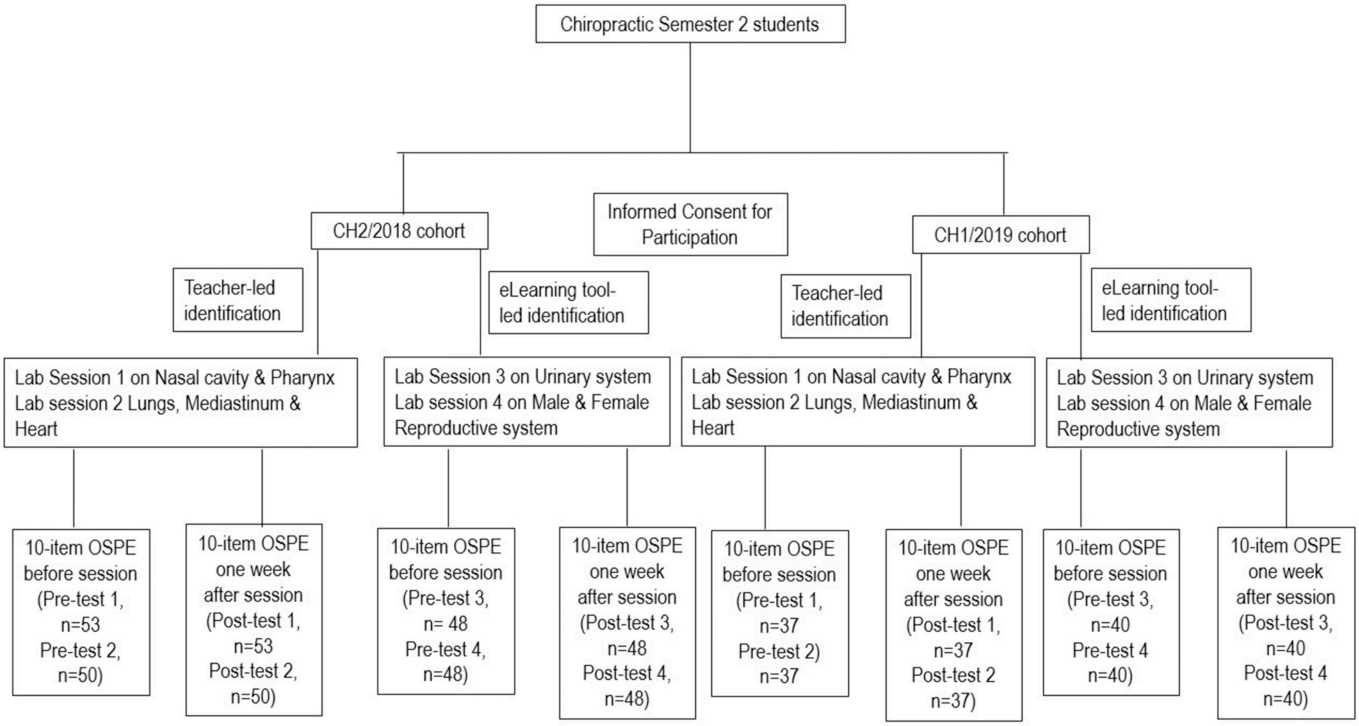

Fig. 1. Flow diagram of the study design.

students of the 02/2018 and 01/2019 cohorts was taken. The condition of the experiment and information about the pre-test and post-test were explained in detail using the study information sheet. The lectures on the related anatomy topics of the laboratory sessions were taken by different lecturers 7–10 days before the sessions. The lecture outcomes were much broader than the lesson outcomes of the laboratory sessions. For example, the lecture on the lungs included surface anatomy, location, gross anatomy, relations, blood supply, lymphatic drainage, nerve supply and bronchopulmonary segments. The lesson outcomes of the laboratory session included surfaces, borders, lobes, relations of surfaces, roots of lung and bronchopulmonary segments. The lesson outcomes prescribed in the chiropractic program booklet were followed in both lecturer-led laboratory sessions and laboratory sessions with e-learning tools. The questions used for pre-test were used again for the post-test. The questions were prepared by the faculty responsible for teaching the topic guided by the lesson outcomes of the laboratory session. The performance score of the pre-test and the post-test of the laboratory sessions 1 and 2 using teacher-led identification and the laboratory sessions 3 and 4 using e-learning tool-led identification were tabulated, and statistical analysis was done to determine the difference between the post-test score and pre-test score. As the post-test was taken 7 days after the laboratory session, any potential increase in the post-test score was hypothesized to be due to the effects related to the quality of either teacher-led identification process or e-learning tool-led identification process.

2.5. Design of the e-learning tool

At first, the plastic and plastinated models which were already mentioned in the module practical guide were selected. The structures to be identified were selected based on the module practical guide. Images of the plastic and plastinated models were captured with a high-pixel camera. The PowerPoint containing different views of the images of the anatomical structures was prepared. The narration along with the annotation, to identify the structures along with a brief description of the structure, were recorded using Articulate 360 Studio software. If the narration was long it was recorded in two separate parts. The presentation was divided into short segments with each segment comprising of a duration between 3 and 5 min. The ADDIE model was the generic process used during the design of instructions [13]. Following the model, the cognitive level of the semester 2 students, their level of understanding as well as cognitive load were analysed. The length and depth of the lesson outcomes were adjusted accordingly. Serial order of the anatomical structures to be identified during a particular session and creation of storyboard were designed based on the principle of ascending difficulty in the anatomical orientation. Some challenges were faced during the development and implementation phases. Some plastic models at a particular view had many structures. Narration and annotation of too many structures in one frame were not compatible with Articulate Studio software. A lot of trial and repetition of recordings solved the problem. The formative evaluation of the application was done with a cohort of Chinese Medicine semester 2 students, who volunteered to use the application to revise two of their laboratory sessions using the application. The feedback from this cohort of students was captured by a questionnaire. Analysis of the feedback helped to change the recording and annotations. After completion, the application was published in the University Learning Management System (LMS). The HTML file in URL format was sent by WhatsApp to the students 15 min before the practical session. Students were briefed to bring the earphones to reduce the level of noise, which might cause distraction among different groups of students attending the laboratory session.

2.6. Informed consent and ethics approval

The project was approved by the University joint committee on research and ethics. The study information sheet, containing the details of the study, pre-test and post-test and modifications to be made to usual laboratory sessions were explained to the Chiropractic students of 02/2018 and 01/2019 cohorts and the informed consent forms were collected. The students were given the choice to participate in the study. All students in both cohorts agreed to provide informed consent. When all students of the cohort submitted informed consent, an agreement was reached with the programme director and module coordinator to arrange the changes in the laboratory sessions facilitating the use of e-learning tool, pre-test, and post-test.

2.7. Statistical analysis

IBM SPSS statistics version 25 was used for the statistical analysis. Normality of the pre-test and the post-test score was tabulated using the Shapiro-Wilk test. The performance scores of the pre-test and post-test were tabulated, and the statistical analysis was done using the Wilcoxon signed-rank test. The correlation between the pre-test and post-test score of each laboratory session was calculated using the Pearson correlation coefficient.

3. Results

3.1. Difference between post-test and pre-test score

The difference between the mean score of the student group in the post-test and pre-test in each laboratory session was computed. In CH2/2018 cohort, the laboratory session 3 and 4 used the e-learning tool and the laboratory session 1 and 2 used teacher-led identification. The difference between the mean post-test score and pre-test score was higher in the laboratory sessions using e-learning tools (2.1 and 2.5) compared to the similar difference in the laboratory sessions using teacher-led identification (0.7 and 0.7) (Table 1). In the CH2/2018 cohort, the Wilcoxon signed-rank test showed that 62% and 70% of the students scored higher in the post-test compared to the pre-test in the laboratory sessions using teacher-led identification ($P < 0.05$; Table 2). In the laboratory sessions using e-learning tools, the percentage of the students scoring higher in the post-test compared to the pre-test increased to 85.4% and 83.3% ($P < 0.05$; Table 2). Although the statistical test showed a significant difference between the post-test and pre-test score ($P < 0.05$) in both the sessions with teacher-led identification and e-learning tool-led identification, the mean positive ranks of the session 3 and 4 were higher than the similar ranks of the session 1 and 2, indicating a higher difference between the post-test and pre-test score in the sessions using e-learning tools (Table 2).

In CH1/2019 cohort, the difference between the mean post-test score and mean pre-test score in the laboratory sessions 3 and 4 using e-learning tool was higher than the similar difference in the laboratory sessions 1 and 2 using teacher-led identification. The difference between the mean post-test score and the mean pre-test score was 2.1 in session 1 and 1.5 in session 2. The similar difference in the score increased to 2.6 and 3.5 in the sessions using the e-learning tool-led identification (Table 3). The Wilcoxon signed-rank test showed that the percentage of students in CH1/2019 cohort, scoring higher in the post-test compared to the pre-test increased to 95% ($P < 0.05$; Table 4) in the laboratory sessions 3 and 4 using e-learning tool, compared to 81% and 70% ($P < 0.05$; Table 4) in the laboratory sessions 1 and 2 using teacher-led identification. Despite the statistical test showing a significant difference in both experimental types of the sessions, the mean positive ranks of session 3 and 4 were higher than the similar ranks of session 1 and 2, indicating a higher difference between post-test and pre-test score in sessions using e-learning tool (Table 4).

3.2. Pre-test post-test correlation

Pre-test post-test correlation coefficient was measured to estimate the relationship between the pre-test and post-test score of the laboratory sessions. A uniformly higher range of post-test score would not correlate well with the pre-test score. In CH2/2018 cohort, a higher range of post-test score compared to the pre-test score in the laboratory sessions using e-learning tools reduced the Pearson correlation coefficient (r = 0.338, session 3) (r = 0.198, session 4). However, the similar correlation coefficient was higher in the laboratory sessions using teacher-led identification (r = 0.681, session 1) (r = 0.947, session 2) due to the smaller difference between the post-test score and pre-test score (Table 5). In CH1/2019 cohort, the Pearson correlation coefficient was found to be lower (r = 0.318, session 3) (r = 0.566, session 4) in the laboratory sessions using e-learning tools. The similar correlation coefficient in the laboratory sessions using teacher-led identification was 0.617 (session 1) and 0.52 (session 2) (Table 6).

3.3. Student perception analysis

The questionnaire to assess the use of the e-learning tool was answered by 90.5% of CH2/2018 cohort and 100% of CH1/2019 students who participated in the study and appeared in the pre-test and the post-test. The analysis of the response of the students indicated that the students liked to use the e-learning tool as it allowed them to revise the identification of anatomical structures themselves (mean response 3.68 and 3.72) and at their convenience (mean response 3.68 and 3.8) (Table 7).

4. Discussion

4.1. e-learning tool and identification of structures

In chiropractic education, a synergy exists between the clinical application and retention of anatomical knowledge reflecting the ability to differentially diagnose the patients with the application of students' anatomical knowledge [14]. Technology-enhanced learning (TEL) helps the students to accommodate their perceptual and cognitive differences. Addition of the TEL to the face-to-face teaching of anatomy or the self-directed learning to revise anatomy course material has been proven to increase the student engagement and improve educational outcomes [15,16]. The use of the e-learning tool to annotate and narrate the anatomical structures in this study helped the chiropractic students to revise the identification of anatomical structures during the laboratory sessions. They were also able to use the tool outside the laboratory sessions to revise their anatomy knowledge. The evidence of the improved knowledge was reflected in the findings of this study with a higher percentage of students scoring better in the post-test compared to the pre-test in the laboratory sessions using e-learning tool-led identification. The study compared the effect of identification of anatomical structures using the e-learning tool with the similar effect of identification of the structures using the teacher-led demonstration and the results showed that the identification using the e-learning tool was able to increase the difference between the post-test and pre-test score in consecutive two cohorts. A recent study which evaluated the

Table 1
Mean score (±SD) of test done by students before and after the practical sessions (CH218 cohort).

	Lecturer-led						e-Learning-led				
	n	Mean	SD	Range			n	Mean	SD	Range	
				Min	Max					Min	Max
Pre-test 1	53	4.6	2.2	0	9	Pre-test 3	48	5.1	1.7	2.5	9
Post-test 1	53	5.3	2.2	0	10	Post-test 3	48	7.2	1.8	3.5	10
Pre-test 2	50	7.1	1.9	2	10	Pre-test 4	48	3.4	1.8	0	7.5
Post-test 2	50	7.8	1.4	4	10	Post-test 4	48	5.9	2.2	0	10

Table 2
Number of students scoring higher in post-test compared to pre-test in the practical sessions (Wilcoxon Signed-Rank test) (CH218 cohort).

	Lecturer-led						e-Learning-led				
	N	Percent of total	Mean + ve Rank	Z-statistics	P-value		n	Percent of total	Mean + ve Rank	Z-statistics	P-value
Post-test1- Pre-test 1	31	62%	20.31	−2.653	0.008[a]	Post-test- Pre-test 3	41	85.4%	22.61	−5.048	0.000[a]
Post-test2 Pre-test2	35	70%	19.24	−4.953	0.000[a]	Post-test- Pre-test 4	44	83.3%	25.34	−4.766	0.000[a]

[a] Indicates significant differences (*P* < *0.05*).

Table 3
Mean score (±SD) of test done by students before and after the practical sessions (CH119 cohort).

	Lecturer-led						e-Learning-led				
	n	Mean	SD	Range			n	Mean	SD	Range	
				Min	Max					Min	Max
Pre-test 1	37	3.2	1.3	1	7	Pre-test 3	40	3.4	1.7	2	7
Post-test 1	37	5.3	1.9	1	8.5	Post-test 3	40	7.0	1.8	5	10
Pre-test 2	37	5.2	1.7	1	8.5	Pre-test 4	40	4	1.5	1	8.5
Post-test 2	37	6.7	1.09	4.5	8.5	Post-test 4	40	7.5	1.09	5	9

Table 4
Number of students scoring higher in post-test compared to pre-test in the practical sessions (Wilcoxon Signed-Rank test) (CH119 cohort).

	Lecturer-led						e-Learning-led				
	N	Percent of total	Mean + ve Rank	Z-statistics	P-value		n	Percent of total	Mean + ve Rank	Z-statistics	P-value
Post-test1- Pre-test 1	30	81%	17.40	−4.833	0.000[a]	Post-test- Pre-test 3	38	95%	20.50	−5.465	0.000[a]
Post-test2 Pre-test2	35	70%	16.15	−4.391	0.000[a]	Post-test- Pre-test 4	38	95%	19.50	−5.396	0.000[a]

[a] Indicates significant differences (*P* < *0.05*).

Table 5
Pearson correlation between scores of pre-test and post-test in the practical sessions (CH218 cohort).

Lecturer-led e-Learning led									
	n	Coefficient	R^2	P value		n	Coefficient	R^2	P value
Pre-Test1 Post-test1	53	0.681	0.463	0.000[a]	Pre-test3Post-test3	48	0.338	0.114	0.019[b]
Pre-test2 Post-test2	50	0.947	0.898	0.000[a]	Pre-test4Post-test4	48	0.198	0.039	0.176

[a] Indicates significant differences (*P* < *0.01*).
[b] Indicates significant differences (*P* < *0.05*).

Table 6
Pearson correlation between scores of pre-test and post-test in the practical sessions (CH119 cohort).

Lecturer-led e-Learning led									
	n	Coefficient	R^2	P value		n	Coefficient	R^2	P value
Pre-Test1 Post-test1	37	0.617	0.381	0.000[a]	Pre-test3Post-test3	40	0.318	0.101	0.045[b]
Pre-test2 Post-test2	37	0.526	0.277	0.001[a]	Pre-test4Post-test4	40	0.566	0.32	0.000[a]

[a] Indicates significant differences (*P* < *0.01*).
[b] Indicates significant differences (*P* < *0.05*).

engagement of the chiropractic students with the gross anatomy videos prepared with the recorded voice of tutor and 3D anatomic visualizations found that the videos could not produce a significant impact on the students' gross anatomy performance. However, the level of engagement among the students was improved [17]. A previous quasi-experimental study in the chiropractic students, which compared the blended method of learning about tuberculosis with the conventional lecture-based method of learning the same topic, found that the post-test score increased compared to the pre-test score in both methods [18].

Table 7
Students' responses to the questionnaire regarding the use of the e-learning tool in 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

	CH2/2018 Cohort n = 48			CH1/2019 Cohort n = 40		
	Mean Response	Median	Std Deviation	Mean Response	Median	Std Deviation
Like to use e-learning tool in the phone to identify structures	3.17	3.0	1.1	3.05	3.0	1.1
Like to use e-learning tool as I can identify structures myself	3.68	4.0	0.9	3.62	3.0	1.0
Like to use e-learning tool as I can revise content anytime	3.69	4.0	1.08	3.72	3.5	1.06
Like to use e-learning tool as I can revise identification at my own time	3.68	4.0	1.01	3.8	4.0	0.9
Narration of structures in e-learning tool was adequate	3.65	4.0	0.8	3.57	3.0	0.9
Arrows used to identify structures was at correct places	3.57	3.0	0.8	3.62	4.0	0.4

4.2. Pre-test post-test design

Pre-test and post-test design are often used when an intervention is applied in a well-defined time-point. This design applies to the experimental and quasi-experimental studies with the effect of interventions being observed compared with a control group [19,20]. To detect any significant change, the average-based change approach was applied to evaluate the difference between the mean score of the pre-test and post-test group [21]. In the present study, in consecutive two cohorts of semester 2 chiropractic students, a higher percentage of students scored more in the post-test compared to pre-test in the laboratory sessions using e-learning tools compared to the sessions led by the teachers. It may be argued that a pre-test might have a motivational effect on the students' learning process. However, such an effect can be excluded as the pre-test was held for the same cohort of students both for the laboratory sessions using e-learning tool for identification and the laboratory sessions using teacher-led identification. A previous study concluded that the pre-test had no significant effect on the students' learning process and did not result in a measurable increase in learning [22].

4.3. Pre-test post-test correlation

A higher pre-post correlation signifies a lower variance of the differences between pre-test and post-test score [20]. A lower Pearson coefficient value in the correlation analysis of the pre-test and post-test scores in the e-learning tool-led laboratory sessions in CH2/2018 and CH1/2019 cohorts indicated higher variance of differences between the pre-test and post-test score. The e-learning tool used in the study was compatible with the hand-held devices and could be used anywhere. The perception analysis showed that compared to the convenience of using the tool in their phones, students liked the tool as they could revise the identification of anatomical structures in their own time. This study indicated the need of the chiropractic students for additional tools which could help them in the revision of anatomical structures outside the time-tabled laboratory sessions.

It may be summarized that the e-learning tool used in this study helped the chiropractic students to identify the anatomical structures on their own. Increased skills in identifying anatomical structures would improve the understanding and appreciation of the anatomy content which has been mentioned as essential for practising chiropractors [23]. The face-to-face demonstration of anatomical structures improves the teacher-student engagement and initiates motivation among the students to learn. To improve the skills in the identification of anatomical structures, there is a need for change in the approach of anatomy teachers towards the use of TEL during the laboratory sessions along with the face-to-face interaction.

4.4. Limitations

Our study has some limitations. Due to ethical reasons, we could not divide the cohort into two groups (teacher-led identification and e-learning tool-lead identification) in each laboratory session. The data of performance score was collected from the first two laboratory sessions conducted with teacher-led identification and next two laboratory sessions with e-learning tool-led identification. Although the topics of the laboratory sessions 1, 2, 3 and 4 were different, the post-test and pre-test were conducted in each laboratory session. The difference between the post-test and pre-test score and any improvement in the score was presumed due to the tool employed in that laboratory session. The students used the narration and annotation of the structures embedded in the e-learning tool to identify the structures during the laboratory sessions using e-learning tools and even during the period immediately following the session. For laboratory sessions using the teacher-led identification, such arrangements could not be made. For this study, we did not include any possible determinants like the personal study by any student seeking additional help from any other resources during the interval between post-test and pre-test. The interaction between the tutor and the students was minimal in the laboratory sessions using e-learning tool-led identification. The possible changes in the summative practical performance due to the use of e-learning tool-led identification in two laboratory sessions could not be included in the study due to the long time interval between the experiment and the summative end-of-semester assessment.

5. Conclusion

An e-learning tool which was user-friendly and could help the students to identify the anatomical structures during the laboratory session was able to improve the anatomy skills among the chiropractic students and improved the performance score. Despite the limitations of the study, the study could highlight the importance of the use of e-learning tool in self-identification of anatomical structures during the anatomy laboratory sessions.

Ethics approval

Ethical approval was granted by International Medical University Joint Committee on Research and Ethics vide no. IMU 437/2019.

Funding sources

The research was funded by Institute for Research, Development, and Innovation (IRDI) of International Medical University. Fund No. 437/2019.

CRediT authorship contribution statement

Nilesh Kumar Mitra: Conceptualization, Design, Methodology, and experimentation, Analysis/Interpretation, Writing. **Htar Htar Aung:** Methodology, and experimentation, Analysis/Interpretation. **Mangala Kumari:** Data collection. **Joachim Perera:** Design, Critical Review. **Anupa Sivakumar:** Data collection. **Anudeep Singh:** Methodology, and experimentation. **Vishna Devi Nadarajah:** Critical Review.

Declaration of competing interest

No conflict of interest was reported for this study.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tria.2020.100100.

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