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ORIGINAL ARTICLE

# Learning anatomy before and during COVID-19 pandemic: Students' perceptions and exam performance



*L'étude de l'anatomie avant et pendant la pandémie de COVID 19 : perception des étudiants et performances aux examens*

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## KEYWORDS

Anatomy demonstrations;  
Face-to-face;  
Online teaching;  
COVID-19

**Summary** The objective of our study was to explore the impact of COVID-19 pandemic on learning anatomy and to compare the students' perceptions of "face-to-face" and "online" anatomy teaching, and to assess their impact on student's performance. We used a descriptive, cross-sectional, questionnaire-based study that focused on a single cohort of undergraduate medical students who attended anatomy demonstrations, at the College of Medicine and Medical Sciences, Arabian Gulf University (CMMS-AGU), both pre-pandemic (face-to-face) during 2019-2020 and the pandemic (online) during 2020-2021. Students who participated in this study responded in favor of face-to-face demonstrations for better understanding of the spatial orientation of body organs and systems, the visualization of the anatomical relations between structures, understanding the difficult anatomical structures, understanding the clinical correlations, and making them more confident about their practical exams. On the other hand, students were in favor of online demonstrations for retaining key information, confidence levels on discussing anatomy learning needs, effective utilization of demonstration time, and

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lower stress associated with the online learning. Regarding anatomy exam scores, statistically significant difference was found between mean scores of online and onsite exams in one of the two analyzed multiple choice questions tests. However, there was a statistically significant difference between the mean scores of objective structured practical examination of online and onsite exams in the two analyzed tests. Furthermore, the majority of the students who participated in the survey prefer a mixture of both face-to-face and online anatomy demonstrations during the pandemic and also in the post-COVID-19 era.

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## Introduction

Medical education all over the world, among other types and levels of education, facing a big challenge due to unprecedented scale of coronavirus disease- (COVID-19) pandemic. As of 7th July 2021, a total of 183.78 million cases have been reported globally and 3,977,060 individuals have lost their lives [1]. To cope with that challenge, most of the medical schools across the world adopted online teaching methods following physical distancing measures for disease control [2]. After confirming the first COVID-19 case in the Kingdom of Bahrain in February 2020, containment had come into force and the universities were instructed to conduct online teaching for all the disciplines including anatomy demonstrations. Since then, all the anatomy demonstrations are conducted at the College of Medicine and Medical Sciences, Arabian Gulf University (CMMS-AGU) via online videos and Zoom® platform.

Remote learning of anatomy by video demonstrations and Zoom® platform tools [3] were shown to have high levels of students' engagement [4–6]. Since the beginning of the pandemic, a number of articles have been published about teaching, learning, and assessment in medical education, and student experiences and perceptions of online education. On this note, a systematic review before the pandemic concluded that face-to-face and online teaching are equivalent in terms of outcomes of examinations [7]. Many authors have suggested that digital platforms for students will remain as an integral part of medical education even after the COVID-19 pandemic [8].

The COVID-19 pandemic has created a unique situation to evaluate the significance of anatomy online teaching platforms in medical education as anatomy teaching is one of the most important and classic parts of the curriculum of medical schools around the world [9]. While many students have acknowledged the impact of COVID-19 on their education [10,11], to date and to the best of our knowledge, no study has investigated the perceptions of medical students on online *versus* face-to-face anatomy demonstrations in problem-based learning curriculum.

Therefore, the primary aim of our study was to investigate students' perceptions of online *versus* face-to-face anatomy demonstrations at the CMMS-AGU. The secondary aim of this study was to explore the outcomes of their online examinations during the COVID-19 pandemic, and also to compare them with the outcomes of their face-to-face examinations they had prior to the pandemic.

## Materials and Methods

### Setting and study participants

This study focused on pre-clerkship undergraduate medical students at the CMMS-AGU, who attended anatomy demonstrations both pre-pandemic (face-to-face) during 2019-2020 and the pandemic (online) during 2020-2021. The targeted number of students was 184.

The MD curriculum at the CMMS-AGU is organized as Phases: Phase-I (premedical–1 year), Phase-II (pre-clerkship–3 years), and Phase-III (clerkship–2 years). The bulk of basic sciences, including anatomy, are introduced through 9 organ system-based units during Phase-I (premedical-1 year) and Phase-II (pre-clerkship–3 years) of MD program.

Pre-COVID-19, weekly schedule of the face-to-face anatomy demonstrations were mostly done by using Structured Practical Anatomy Demonstrations (SPRAD) approach [12] and consisted of two-hour laboratory sessions, wherein, students were divided into four subgroups of 15–20 students and rotated through different stations on cadavers, prosected specimens, plastic models, Anatomage® table, and radiological and microscopic anatomy in the anatomy lab area [13]. As of March 2020, and until now, all the face-to-face laboratory sessions are replaced by recording and uploading video demonstrations in university's official digital platform followed by weekly review sessions via Zoom® platform to answer students' queries. Every faculty member is designated for recording his/her content in a studio setup at the anatomy lab. All the onsite, face-to-face anatomy demonstrations are being substituted by recorded videos on cadavers, prosected specimens, plastic models, histology slides and radiological anatomy.

### Instrument

The questionnaire was devised by the authors according to the steps of:

- review of the relevant literature and similar studies;
- developing and revising the questionnaire items by all authors, and;
- piloting on few participants.

Since the instructional language used in our MD program is English and the students enrolled have the necessary

English language proficiency, the questionnaire was written in English. It included 14 statements representing exploring the perceptions of face-to-face and online anatomy demonstrations. It employed a 5-point Likert scale (Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree). In addition, the questionnaire contained a question on the mode of learning anatomy students would prefer post-COVID-19 pandemic (face-to-face, online, or blended). The students also given the chance (in two open-ended questions) to express their viewpoints on two adaptations in anatomy demonstration sessions, which are the recording of demonstration sessions and making them available for the students and the conduction of anatomy review sessions (Appendix 1).

The suitability of the questionnaire was determined by establishing its validity and reliability. The content validity was established through revision by a group of seven subject experts in anatomy and a medical education expert (AA). The structure and content of the questionnaire and its ability to explore the perceptions of the students was established.

The survey was tested for reliability (internal consistency) through calculating Cronbach's  $\alpha$  value.

### Data collection

The questionnaire was put into an electronic format using Microsoft Forms® and distributed to the participants through official e-mails. The questionnaire was open for each student to respond only once.

### Ethical approval

This study was approved by Institutional Research and Ethics Committee (Project number: E01-PI-5/21). Participation in this study was voluntary. Before starting to fill in the questionnaire, the students were briefed about the aim of the research study and were given the option not to respond to the survey without any consequences.

### Assessment of students' performance in face-to-face and online anatomy examinations

We analyzed the student assessment results of four different units, in which the students of two batches were taught face-to-face in two units in 2019–2020 (Unit II: Respiratory System and Unit IV: Endocrine and Reproductive System) through the SPRAD approach and were taught online in two units in 2020–2021 (Unit IV: Endocrine and Reproductive System and Unit VII: Musculoskeletal System) with the video recorded demonstrations. Box 1 shows an excerpt of the MD curriculum layout illustrating the chosen units and the two batches in our study:

We compared the performance of the students in each batch in anatomy in written exams of multiple-choice questions (MCQs) and practical exams of objective structured practical examination (OSPE) of both pre-pandemic (face-to-face) and pandemic (online) teaching. Before the pandemic, all exams took place onsite (inside the campus) using "Remarks Classic OMR®" software for MCQs and OSPE stations in lab spaces. All these modalities during the pandemic are replaced with an online student assessment

#### Box 1: Excerpt of the MD curriculum layout of the CMMS-AGU illustrating the chosen units and the two batches of students in our study.

Year 2 students in 2019–2020 (face-to-face) who moved to Year 3 in 2020–2021 (online):			
Curriculum Year 2 (2019-2020)	Unit I	Unit II* (face-to-face)	Unit III
Curriculum Year 3 (2020-2021)	Unit IV* (online)	Unit V	Unit VI
Year 3 students in 2019–2020 (face-to-face) who moved to Year 4 in 2020–2021 (online):			
Curriculum Year 3 (2019-2020)	Unit IV* (face-to-face)	Unit V	Unit VI
Curriculum Year 4 (2020-2021)	Unit VII* (online)	Unit VIII	Unit IX

\* Units chosen for comparison.

platform "ExamSoft®" for MCQs and OSPE stations. Secure proctored exams were delivered using "ExamMonitor". ExamMonitor captures video and audio of the exam takers during an assessment and uses strong AI-enabled analysis to detect attempts at academic misconduct and ensure exam integrity.

### Statistical analysis

Data were analyzed using SPSS v.25. Descriptive statistics were used, and data are presented in the form of means and standard deviations. Comparisons of responses were made by paired-samples *t*-test. Students' performance scores were compared using independent-samples *t*-test. The level of significance was set at  $P < 0.05$ . Three of our researchers independently analyzed the frequency of open-ended responses, with subsequent consensus on qualitative analysis of these comments.

## Results

### Survey results

Of 184 students who appeared for both face-to-face and online anatomy demonstrations, 101 students (54.9%) have responded and filled in the questionnaire. The reliability of the responses to different items of the questionnaire was assessed by Cronbach's  $\alpha$  test and was found to be 0.96, which indicated excellent consistency of the questionnaire.

### Student perceptions of the face-to-face versus online anatomy demonstrations

Table 1 summarizes the results of students' responses on the items listed in the distributed questionnaire. In general, the perception of students on all items of the questionnaire regarding both ways of learning was positive and the mean score was above 3.

**Table 1** Comparison of students' perception of face-to-face versus online anatomy demonstrations.

No.	Statement	Face-to-Face (Mean $\pm$ SD)	Online (Mean $\pm$ SD)	Mean Difference
1.	Demo sessions were useful in understanding the spatial orientation (i.e., position or direction) of body organs and systems	4.06 $\pm$ 1.03	3.62 $\pm$ 1.17*	0.44
2.	Demo sessions helped me visualize the anatomical relations between structures	3.97 $\pm$ 1.14	3.59 $\pm$ 1.13*	0.38
3.	Demo sessions helped me understand the difficult anatomical structures	3.98 $\pm$ 1.08	3.63 $\pm$ 1.23	0.35
4.	Learning anatomy in demo sessions helped me understand the clinical correlations	3.88 $\pm$ 1.02	3.72 $\pm$ 1.14	0.16
5.	Demo sessions were stimulating and engaging	3.75 $\pm$ 1.18	3.28 $\pm$ 1.25*	0.47
6.	Demo sessions helped me remember key information in anatomy	3.66 $\pm$ 1.19	3.74 $\pm$ 1.19	-0.08
7.	Demo sessions helped me understand the learning needs (objectives) of anatomy in the weekly PBL problem	3.76 $\pm$ 0.99	3.80 $\pm$ 1.12	-0.04
8.	Demo sessions made me confident in discussing anatomy topics	3.52 $\pm$ 1.11	3.66 $\pm$ 1.13	-0.14
9.	Demo sessions made me confident about the practical exams	3.63 $\pm$ 1.13	3.45 $\pm$ 1.25	0.18
10.	There was more efficient utilization of sessions' time	3.16 $\pm$ 1.16	3.86 $\pm$ 1.03*	-0.70
11.	I could concentrate better in demo sessions	3.30 $\pm$ 1.32	3.70 $\pm$ 1.39	-0.40
12.	Quality of the content delivery in demo sessions was satisfactory	3.62 $\pm$ 1.09	3.91 $\pm$ 1.17	-0.29
13.	Demo sessions decreased the stress associated with learning	3.16 $\pm$ 1.20	3.54 $\pm$ 1.20*	-0.38
14.	Overall, I could learn anatomy effectively from demo sessions	3.71 $\pm$ 1.13	3.80 $\pm$ 1.08	-0.09

SD: Standard Deviation.

\*  $P < 0.05$  when compared to face-to-face group.

Three items showed a significant difference in favor of the face-to-face demonstration when compared to online demonstration. The highest score (4.06  $\pm$  1.03) being given to item 1, which is understanding of the spatial orientation of body organs and systems. Also, the mean scores of item 2 related to visualization of the anatomical relations between structures (3.97  $\pm$  1.14), and item 5 related to stimulating and engaging demonstrations (3.75  $\pm$  1.18) were significantly higher for face-to-face when compared to the online demonstrations.

Although they are non-significant, the results of some other items indicate that face-to-face demonstration help the students to understand the difficult anatomical structures better (item 3) and the clinical correlations related to anatomy (item 4) when compared to online demonstration and make the students more confident about the practical exams (item 9).

On the other hand, two items showed a significant difference in favor of the online demonstration when compared to face-to-face. These are the efficient utilization of sessions' time (item 10) with a mean of 3.86  $\pm$  1.03, and the decrease in stress associated with learning (item 13) with a mean of 3.54  $\pm$  1.1.20. Also, some other items (6–8, 11, 12 and 14) showed a non-significant higher score in favor of the online demonstration.

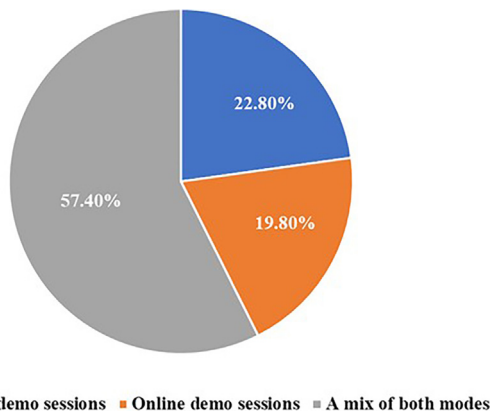
### Open-ended responses

Students were invited to justify their responses on effective learning from demonstrations, subsequent review sessions

conducted and how they improved their learning. Sixty-five out of the 101 students provided written comments on these open-ended questions. Fifty-eight of the 101 students provided written comments justifying their effective learning from anatomy demonstration. The analysis of their comments revealed that about 40% of the students prefer online video demonstrations for their easy access to the resource materials, better time management, and for their increased confidence levels in their learning. About 20% of the students prefer face-to-face demonstrations for their better visualization of the models and cadavers and also to interact with instructors for solving their queries. About one third of the students explained that a mix of both teaching methods would be a good practice in order not to lose social interaction with instructors and other students as in online learning.

Forty-nine of the 101 students have given their positive comments on video recording of demonstrations and making them available for the students. Most of the students (91.8%) responded that the recorded sessions are beneficial and greatly improved their learning ability in revising them as and when necessary. Only a small percentage (8.2%) of the students reported that the recorded sessions are good but cannot replace the elements of face-to-face demonstrations.

Students were also asked to provide their written comments on how the conduction of online review sessions improved their learning of anatomy. Forty-two of the 101 students have given their written comments. The majority of them (88.1%) responded that the review sessions benefited their learning and clarified the important information,



**Figure 1** Showing the mode of anatomy demonstrations students prefer post-COVID-19.

which was not well-understood over the recorded sessions of demonstrations. A small percentage of the students (11.9%) responded that these sessions have not benefited them in their learning process.

The majority of the students who participated in the survey preferred a mix of both face-to-face and online anatomy demonstrations (57.4%) in post-COVID-19 practical sessions as shown in Fig. 1.

### Students' performance in face-to-face and online examinations

Performance in anatomy exams, including written (MCQs) and practical (OSPE) of the 2019–2020 and 2020–2021 classes were compared (Table 2). There was no statistically significant difference between students' scores of MCQs in Unit II (Face-to-Face) and Unit IV (Online). However, there was a statistically significant difference in the students' scores of MCQs in Unit VII (Online) when compared to Unit IV (Face-to-Face) ( $P=0.003$ ).

In the OSPE exams, there was a statistically significant decrease in the students' scores in Unit IV (Online) when compared to Unit II (Face-to-Face) ( $P=0.000$ ). Also, there was a statistically significant increase in the students' scores

in Unit VII (Online) when compared to Unit IV (Face-to-Face) ( $P=0.000$ ).

### Discussion

The purpose of our study was to assess students' perception of anatomy online demonstrations and its impact on their assessment during the COVID-19 pandemic. Anatomy demonstrations in PBL curriculum of our MD program are quite unique and heavily depending on the SPRAD approach. SPRAD is a weekly program of regularly scheduled anatomy demonstrations for students in years 2, 3, and 4. Students in each year are divided into two groups (A and B), and each group is allocated for a 2-hour session per week, conducted in the anatomy pathology learning resource center (APLRC) and the adjoining histology lab [12]. This approach is changed to online video demonstrations from March 2020 due to the COVID-19 pandemic. To explore the difference in student performance in face-to-face and online learning, we compared the student assessment results in two units for each batch. For Year 2 students, we compared their performance in Unit II (taught face-to-face in 2019–2020) and Unit IV (taught online in 2020–2021), and for Year 4 students, we compared their performance in Unit IV (taught face-to-face in 2019–2020) and Unit VII (taught online in 2020–2021). The rationale was that those units are either taught completely face-to-face or completely online—none of them was taught partly face-to-face and partly online as was the case with other units. Moreover, we chose to compare performance within each batch as we felt that it would be more accurate if we study the performance of the same students in different units, especially that anatomy load is similar among such units.

Our study results revealed that the majority of the students prefers face-to-face demonstrations for understanding the spatial orientation of the body organs-systems and to visualize the complex anatomical relations between the structures for gaining anatomy knowledge in clinical context. Similar results can be seen in other studies, wherein, students have preferred face-to-face anatomy teaching compared to the online methods [14–17]. However, we observed a statistically significant differences on students'

**Table 2** Students' performance grades during the face-to-face teaching (during 2019–2020) compared with online anatomy teaching (during 2020–2021).

Anatomy Units	Academic Year	Mean $\pm$ SD	<i>P</i> -value
Performance in MCQs (theory component)			
Unit II: Respiratory System (Face-to-Face)	2019–2020	72.2 $\pm$ 15.8	0.149
Unit IV: Endocrine & Reproductive System (Online)	2020–2021	74.6 $\pm$ 15.9	
Unit IV: Endocrine & Reproductive System (Face-to-Face)	2019–2020	65.6 $\pm$ 19.5	0.003*
Unit VII: Musculoskeletal & Integumentary System (Online)	2020–2021	71.5 $\pm$ 17.9	
Performance in OSPE (practical component)			
Unit II: Respiratory System (Face-to-Face)	2019–2020	70.4 $\pm$ 19.0	0.000*
Unit IV: Endocrine & Reproductive System (Online)	2020–2021	61.8 $\pm$ 19.7	
Unit IV: Endocrine & Reproductive System (Face-to-Face)	2019–2020	63.1 $\pm$ 14.9	0.000*
Unit VII: Musculoskeletal & Integumentary System (Online)	2020–2021	74.4 $\pm$ 17.0	

MCQs: Multiple-Choice Questions; OSPE: Objective Structured Practical Examination.

\* Statistically Significant.

satisfaction about quality of the content being delivered in online demonstrations unlike few previous studies, which have reported that the students were dissatisfied with online learning compared to face-to-face instruction [18,19].

Our study results suggested that the online demonstrations made it possible for students to remember the key information with effective utilization of the time and easy access to the content at their own pace with flexibility. This has helped them to concentrate better on the subject, which decreased their stress associated with learning process despite stressful working conditions of the pandemic itself. Our observations are in line with few studies conducted on Nepalese, Pakistani and Saudi students, highlighted that (89.8%, 77% and 51.2%, respectively) of these students prefer to continue the online lectures [20–22] despite their different curricular setup.

Despite the overall positive outcomes of online anatomy demonstrations, the survey results helped us to identify few challenges through open-ended responses from the students. Many students provided their open-ended responses about decreased student-student and student-instructor interactions. Few previous studies are in agreement with our results and reported that the student-instructor interactions decreased in online anatomy sessions [23,24]. We did overcome this shortfall by conducting (post-demonstration question and answer review sessions) on weekly basis, 2h/session, to clarify students' queries through the Zoom platform. This review had been compensated "decreased student-teacher and student-student interactions" and provided constructive and timely feedback on students' performance, which is essential to enhance their satisfaction with online learning.

In the detailed analysis of the examination scores, we noticed that the mean examination scores of MCQs in online class were relatively higher than the face-to-face class. It is known that correctly solving MCQs requires better understanding of the contents, and this has been acquainted through online teaching methods [25,26]. Our findings are consistent with a previous study, which reported that the online learning revealed higher outcomes than the conventional face-to-face methods [27]. With regards to OSPE, we noticed that the online teaching of Unit IV did not yield higher scores compared to the face-to-face method in Unit II. In the contrary, in Unit VII, higher scores were noticed in online teaching compared to face-to-face method in Unit IV. This could be attributed to the nature of the contents and details of the anatomical structures in each unit.

## Conclusion

Our results indicate that the blended learning in pedagogical practice is the need of the hour, and it is advisable to use it in the post-COVID-19 era. As the field of medical education is experiencing a huge digital transition, exposure to online anatomy demonstrations is mandatory as a supplement to face-to-face anatomy demonstrations.

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## Author contributions

Conceptualization: PBK. Data acquisition: PBK, HA, WANE. Data analysis and interpretation: PBK, HA, WANE, MAO, AF, NALS. Drafting of the manuscript: PBK, HA, WANE. Critical revision of the manuscript: PBK, HA, WANE, AD, RARF.

## Disclosure of interest

The authors declare that they have no competing interest.

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## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.morpho.2021.07.003>.

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