Online Anatomy Education in the COVID-19 Pandemic: Challenges and Suggested Practices as Per Student and Faculty Experiences in the Saudi Arabia and United Arab Emirates

Mohammed H. Karrar Alsharif[1], Hosam Eldeen Elsadig Gasmalla[2], Juman M. Almasaad[3], Jibran Sualeh Muhammad[4], Abubaker Y. Elamin[5], Ahmad Alamro[6], Sarra Shorbagi[7], Mohamed H. Taha[8], Mohamed Ahmed Eladl[4]

[1]College of Medicine, Prince Sattam Bin Abdulaziz University, Al-Kharj, SAUDI ARABIA

[2]Department of Anatomy, Faculty of Medicine, Al-Neelain University, Khartoum, SUDAN

[3]Department of Basic Medical Sciences, College of Medicine, King Saud bin Abdulaziz University for Health Sciences, Jeddah, SAUDI ARABIA

[4]Department of Basic Medical Sciences, College of Medicine, University of Sharjah, Sharjah, UNITED ARAB EMIRATES

[5]Department of Histology and Embryology, Faculty of Medicine, Ondokuz Mayıs University, Samsun, TURKEY

[6]Department of Medical Education, College of Medicine, Qassim University, Buraydah, SAUDI ARABIA

[7]Department of Family and Community Medicine and Behavioral Sciences, College of Medicine, University of Sharjah, Sharjah, UNITED ARAB EMIRATES

[8]Medical Education Centre, College of Medicine, University of Sharjah, Sharjah, UNITED ARAB EMIRATES

ABSTRACT

Anatomy was studied through e-learning as a social distancing measure to prevent the spread of COVID-19. This study explored anatomy educators' and learners' experiences with online learning in two Middle Eastern countries in terms of instruction, engagement and assessment. The study employed a cross-sectional, mixed-methods approach using a validated questionnaire to collect data from students in 14 medical schools in Saudi Arabia and the United Arab Emirates on their experience with online teaching, engagement strategies and assessment in anatomy courses. The Delphi technique was used to explore faculty challenges and recommended solutions. Six hundred and sixty-six students completed the questionnaire. Less than half (41.74%) reported that their interaction with

the instructor was easier and more comfortable than during face-to-face lectures. In addition, less than a quarter (21.32%) believed it was better to adopt online rather than face-to-face anatomy instruction. Faculty members described challenges and provided suggestions to enhance online teaching, including faculty and staff development, technical support, appropriate software to increase student engagement and curriculum development to suit the new normal. They also suggested improving assessment design and construction as well as adopting measures to eliminate cheating, train faculty and staff and properly select software. In conclusion, the student and faculty experiences with e-learning in anatomy were generally positive. Both faculty and staff identified many challenges with an emphasis on the loss of face-to-face teaching. Accordingly, faculty development, technical support, appropriate software to enhance student engagement and reformed curricula to suit online teaching are needed in online anatomy education.

Keywords: *Anatomy education, COVID-19, e-Learning, Online education*

CORRESPONDING AUTHOR   Mohamed Ahmed Eladl, Basic Medical Sciences Department, College of Medicine, University of Sharjah, P. O. Box 27272, Sharjah, United Arab Emirates

Email: meladl@sharjah.ac.ae

BACKGROUND

Anatomy is the pillar of the medical sciences. Through studying anatomy, medicine and allied health sciences, students develop a basic foundation of knowledge for their future clinical practice (1). Medical students must develop anatomical skills as a foundation for future clinical and professional activities. Having an adequate knowledge of anatomy is an inevitable criterion for medical doctors, as they need to utilise their anatomic knowledge and related skills in providing diagnoses, conducting a physical examination and performing procedures (2). Many traditional anatomy education pedagogies rely on "hands-on" practical experience and face-to-face, small-group teaching (3–6). During the last two decades, anatomical e-learning has been developed using digital technologies and networks to support face-to-face teaching and learning interactivity (7–8) in the form of e-books, virtual dissection and simulations (9). Recently, the COVID-19 pandemic has had a varied impact on anatomy education, whereby face-to-face anatomy teaching has been replaced with online teaching (10).

This replacement resulted from the restricted movement and physical distancing of pandemic-curtailed laboratory access, cadaver dissection and model manipulation, so instructors sought alternative methods to promote student engagement. Digital learning, including video-based learning and dissection videos (4, 11), replaced face-to-face classes and practical sessions (12) to overcome restrictions (13), but challenges accompanied the transition, including time constraints and inadequate support staff. The diverse cultural backgrounds and academic levels of students added to those challenges (14–15).

Medical schools' responses to the pandemic differed by country, ranging from school closures to online/distance learning depending on the country's preventive measures (15). Some schools in Saudi Arabia (KSA) and the United Arab Emirates (UAE) reported a resilient response, shifting to online education within days. In those cases, students' learning was minimally affected, and they continued their education remotely and safely (15–18). To the best of our knowledge, no previous study has evaluated anatomy education pedagogies in the COVID-19 era from the perspective of faculty and students in the Middle East. Therefore, the aim of this study was to explore the responses of medical schools in KSA and the UAE in teaching anatomy

courses in undergraduate medical education and student assessment. In addition, the study explored the challenges faced while teaching anatomy and the recommended solutions in this new normal.

METHODS

This research used a mixed-study approach. This exploratory, cross-sectional study collected quantitative data using a self-administered student questionnaire and used the Delphi technique for qualitative data collection from faculty. The participants were students and faculty involved in anatomy instruction during the early phase of the pandemic in KSA and UAE universities. All the participants had experienced traditional on-campus instruction as well as the transition to distance learning.

For the quantitative data collection, the estimated population size of the students was 4,200. The calculated sample size was 353, using the formula $n = [\text{DEFF} \star \text{Np}(1\text{-}p)] / [(d^2/Z^2_{1-\alpha/2} \star (\text{N-1}) + p \star (1\text{-}p)]$. The accuracy was checked using the OpenEpi calculator (19) based on the projected subjects. The assumption was that 50% of the population would participate, giving the study 95% power to detect distinctions of 0.05 at the α level.

The questionnaire comprised 19 questions on a Likert scale allocated to four areas: demographic data, virtual dissection sessions, assessments and overall evaluation. The questionnaire was based on two relevant studies (20–21) found through a literature search based on MeSH terms related to anatomy teaching ("anatomy teaching" or "anatomy education") and the pandemic ("COVID-19" or "Corona Virus" or "SARS-CoV-2"). The search was conducted in PubMed and Scopus (20–21) from April to May 2020 and included all articles in English published in 2020. To ensure the questionnaire's validity and reliability, we piloted it in a group of five faculty members who were experts in the field of medical education (with at least 10 years' teaching experience) to ensure the wording's clarity and simplicity. The items were then tested in a pilot study – content validity – with 69 students that achieved a Cronbach's alpha of 0.931. The students in the pilot study were excluded from the main study. The SPSS was used for data analysis. The results were summarised and presented as averages, the Chi-square was calculated, and the significance level was set at the 95% confidence interval.

For the qualitative data collection from faculty, the Delphi technique explored the challenges and recommendations for online anatomy teaching and assessment. The questionnaire comprised four questions:

a. What are the challenges facing teaching anatomy courses using e-learning approaches in the COVID-19 era?

b. What are the recommended solutions for teaching anatomy courses using e-learning approaches during and after the COVID-19 era?

c. What are the challenges facing the assessment of students in anatomy courses using e-learning approaches during and after the COVID-19 era?

d. What are the recommended solutions for e-assessment in anatomy education during and after the COVID-19 era?

In all the questions, the participants were invited to elaborate. The subjects in the Delphi study were recruited through non-probability purposive sampling comprised teachers with at least 10 years' experience (eight from the KSA and six from the UAE) (Figure 1). The results did not affect these individuals, and there was no conflict of interest and no participant bias. The recommended number of participants to ensure reliability ranges from six to 12 (22), with some authors citing seven participants as a minimum (23); this study had 14 participants.
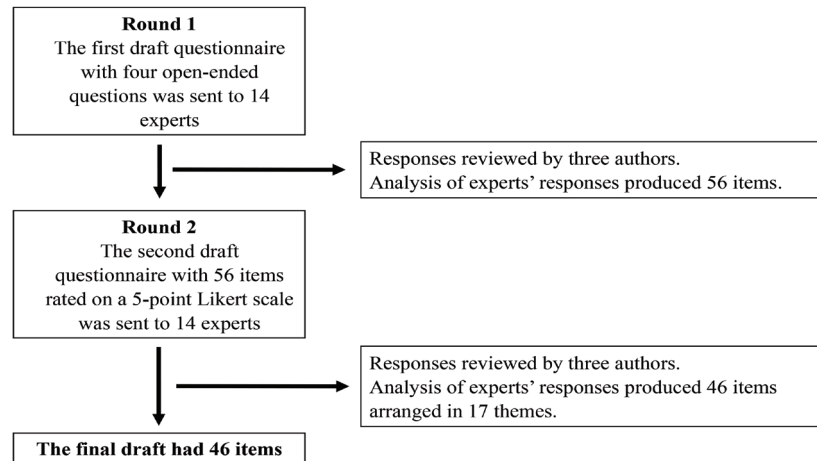
Figure 1: Summary of participants "faculty" responses in Delphi technique and how a consensus was reached by all of the panelists on all 46 items.

Before the Delphi rounds, the researchers agreed that the cut-off point for continuation was an 80% consensus. That is, if a statement gained an 80% consensus, it was considered accepted. To accommodate the participants' schedules, a consensus was assumed if a statement scored an average of over 3 on a 5-point Likert scale. If the score was less than 3, the statement was discarded.

Round One comprised four open-ended questions. From these responses, the authors produced 56 statements that were posed for ranking on a 5-point Likert scale (strongly agree, agree, I am not sure, disagree, strongly disagree) and used in successive rounds.

Following the first round, the input was reviewed by the first three authors, and topics were arranged and modified after discussion. In the second round, newly introduced topics, modified topics and topics that did not achieve a consensus were presented, along with their statistics.

Each statement was ranked in the next round, the scores were tabulated, and the means were obtained and presented to the subjects. The consensus rules were applied to determine the number of statements achieving a consensus.

RESULTS

Quantitative: Perceptions of Students

Six hundred and sixty-six students answered the questionnaire. Among them, 62.76% ($n = 418$) were from the KSA, and 37.24% ($n = 248$) were from UAE schools. Moreover, 270 were males (40.54%), and there were 396 females (59.46%), most in their second-year ($n = 306$; 45.95%). The rest were in their first- or third-year. Four hundred and two students (60.54%) reported using computers as their primary device for online learning, while tablets, mobile phones or other devices were used by a minority (Table 1, Figure 2).

Table 1: Demographic data

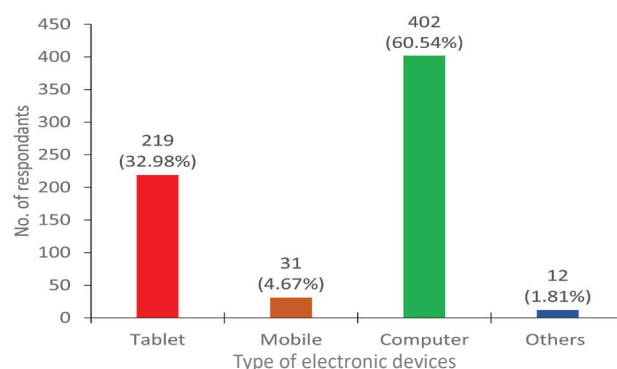| Demographic data		Frequency (%)
Gender	Male	270 (40.54)
	Female	396 (59.46)
Level of study	First-year	155 (23.27)
	Second-year	306 (45.95)
	Third-year	152 (22.82)
	Fourth-year	53 (7.96)
Country	KSA	418 (62.76)
	UAE	248 (37.24)

Figure 2: Electronic devices used by the students for online anatomy education.

As illustrated in Table 2, 435 students (65.32%) agreed that the lecture content was easily covered and that the intended learning objectives were easily achieved in interactive, focused sessions. However, 41.44% of the respondents indicated a lack of comfort in their interactions with the instructor. Only about one-third of the students agreed that the images used in online teaching were as informative and descriptive as real specimens. The same proportion agreed that the demonstration of anatomical relations was clear in online teaching (item 6: 37.54%; item 7: 38.29%).

Some also recognised that online teaching was not enough to minimise their fear of cadaveric dissections and plastinated human specimens (40.39% and 52.25%, respectively). Almost half of the students agreed that online teaching prepared them well for the final exam (49.4%), with the rest divided between neutral and disagreement. The assessment was perceived as linked to online teaching by 62.01% of the students. Overall, almost all students agreed that e-learning is a good protective measure against COVID-19 infection, and the ability to access lecture recordings was an added benefit (Table 2).

Table 2: Perception of the students about the virtual classroom, virtual dissection sessions and assessment

Virtual classroom	Disagree (%)	Neutral (%)	Agree (%)
The content of the lecture/seminar was covered easily with the allotted/allocated duration of the session.	86 (12.91)	145 (21.77)	435 (65.32)
Interaction between the instructor and the students was easier and comfortable than the face-to-face lecture.	276 (41.44)	112 (16.82)	278 (41.74)
The sessions were interactive, and I was fully focused through all the duration of the session.	222 (33.33)	156 (23.42)	288 (43.24)
I have achieved the intended learning outcomes/objectives from online lecture/seminar.	141 (21.17)	163 (24.47)	362 (54.35)
Virtual dissection sessions	**Disagree (%)**	**Neutral (%)**	**Agree (%)**
Online teaching helped in minimising my fears or concerns from cadavers and plastinated specimens.	348 (52.25)	184 (27.63)	134 (20.12)
The used images during online teaching were as informative and descriptive as the real specimens.	269 (40.39)	147 (22.07)	250 (37.54)
Demonstration of anatomical relations was clear through online teaching.	213 (31.98)	198 (29.73)	255 (38.29)

(continued on next page)

Table 2: *(continued)*

Assessment	Disagree (%)	Neutral (%)	Agree (%)
The online teaching of anatomy during COVID-19 has prepared me for the final exam.	175 (26.28)	162 (24.32)	329 (49.4)
During COVID-19, the assessment that has been used in anatomy was linked to online teaching.	74 (11.11)	179 (26.88)	413 (62.01)

Overall evaluation	Disagree (%)	Neutral (%)	Agree (%)
e-Learning is a good protective measure against COVID-19 infection.	27 (4.05)	39 (5.86)	600 (90.09)
In the online teaching of anatomy, it is better for me to access recorded learning materials rather than to attend live sessions.	176 (26.43)	136 (20.42)	354 (53.15)
The instructor used e-learning appropriately.	53 (7.96)	104 (15.62)	509 (76.43)
The instructor was encouraging the students to participate.	46 (6.91)	100 (15.02)	520 (78.08)
Online teaching experience made anatomy easier to me.	280 (42.04)	176 (26.43)	210 (31.53)
It is better to adopt online teaching than face-to-face learning in anatomy.	431 (64.71)	93 (13.96)	142 (21.32)

Last, we compared the students' academic levels to their perceptions of online anatomy teaching and learning methods. The students were in their first through fourth years at the College of Medicine. Only third-year students agreed that online anatomy lectures were interactive and focused (53.29%), while the agreement from other academic levels was less (34.19% of the first-year, 43.14% of the second-year and 41.51% of the fourth-year). All four academic years agreed that online instruction was adequate to prepare them for the final exam, a statistic that ascended according to the year (first-year: 36.77%, second-year: 49.02%, third-year: 56.58%, fourth-year: 67.92%). Students from all academic years agreed that the instructors used e-learning tools appropriately and that they always encouraged student participation (Table 3).

Table 3: The relation between students' academic levels and perception

Virtual classroom					
Description	Level of study	Disagree (%)	Neutral (%)	Agree (%)	Sig
The content of the lecture/ seminar was covered easily with the allotted/allocated duration of the session.	First-year	15 (9.68)	31 (20.00)	109 (70.32)	0.193
	Second-year	42 (13.73)	72 (23.53)	192 (62.75)	
	Third-year	18 (11.84)	28 (18.42)	106 (69.74)	
	Fourth-year	11 (20.75)	14 (26.42)	28 (52.83)	

Table 3: *(continued)*

Virtual classroom					
Description	**Level of study**	**Disagree (%)**	**Neutral (%)**	**Agree (%)**	**Sig**
Interaction between the instructor and the students was easier and comfortable than the face-to-face lecture.	First-year	54 (34.84)	29 (18.71)	72 (46.45)	0.330
	Second-year	131 (42.81)	50 (16.34)	125 (40.85)	
	Third-year	62 (40.79)	26 (17.11)	64 (42.11)	
	Fourth-year	29 (54.72)	7 (13.21)	17 (32.08)	
The sessions were interactive, and I was fully focused through all the duration of the session.	First-year	46 (29.68)	56 (36.13)	53 (34.19)	0.000*
	Second-year	108 (35.29)	66 (21.57)	132 (43.14)	
	Third-year	45 (29.61)	26 (17.11)	81 (53.29)	
	Fourth-year	23 (43.40)	8 (15.09)	22 (41.51)	
I have achieved the intended learning outcomes/objectives from online lecture/seminar.	First-year	38 (24.52)	42 (27.10)	75 (48.39)	0.527
	Second-year	62 (20.26)	78 (25.49)	166 (54.25)	
	Third-year	30 (19.74)	30 (19.74)	92 (60.53)	
	Fourth-year	11 (20.75)	13 (24.53)	29 (54.72)	
Virtual dissection sessions					
Online teaching helped in minimising my fears or concerns from cadavers and plastinated specimens.	First-year	84 (54.19)	42 (27.10)	29 (18.71)	0.283
	Second-year	170 (55.56)	73 (23.86)	63 (20.59)	
	Third-year	68 (44.74)	51 (33.55)	33 (21.71)	
	Fourth-year	26 (49.06)	18 (33.96)	9 (16.98)	
The used images during online teaching were as informative and descriptive as the real specimens.	First-year	63 (40.65)	40 (25.81)	52 (33.55)	0.660
	Second-year	125 (40.85)	68 (22.22)	113 (36.93)	
	Third-year	60 (39.47)	27 (17.76)	65 (42.76)	
	Fourth-year	21 (39.62)	12 (22.64)	20 (37.74)	
Demonstration of anatomical relations was clear through online teaching.	First-year	50 (32.26)	53 (34.19)	52 (33.55)	0.601
	Second-year	103 (33.66)	88 (28.76)	115 (37.58)	
	Third-year	46 (30.26)	41 (26.97)	65 (42.76)	
	Fourth-year	14 (26.42)	16 (30.19)	23 (43.4)	
Assessment					
The online teaching of anatomy during COVID-19 has prepared me for the final exam.	First-year	52 (33.55)	46 (29.68)	57 (36.77)	0.000*
	Second-year	88 (28.76)	68 (22.22)	150 (49.02)	
	Third-year	27 (17.76)	39 (25.66)	86 (56.58)	
	Fourth-year	8 (15.09)	9 (16.98)	36 (67.92)	
During COVID-19, the assessment that has been used in anatomy was linked to online teaching.	First-year	12 (7.74)	52 (33.55)	91 (58.71)	0.074
	Second-year	41 (13.4)	80 (26.14)	185 (60.46)	
	Third-year	17 (11.18)	39 (25.66)	96 (63.16)	
	Fourth-year	4 (7.55)	8 (15.09)	41 (77.36)	

Table 3: *(continued)*

		Overall evaluation			
Description	Level of study	Disagree (%)	Neutral (%)	Agree (%)	Sig
e-Learning is a good protective measure against COVID-19 infection.	First-year	5 (3.23)	8 (5.16)	142 (91.61)	0.709
	Second-year	17 (5.56)	18 (5.88)	271 (88.56)	
	Third-year	4 (2.63)	10 (6.58)	138 (90.79)	
	Fourth-year	1 (1.89)	3 (5.66)	49 (92.45)	
In the online teaching of anatomy, it is better for me to access recorded learning materials rather than to attend live sessions.	First-year	34 (21.94)	36 (23.23)	85 (54.84)	0.182
	Second-year	92 (30.07)	62 (20.26)	152 (49.67)	
	Third-year	41 (26.97)	30 (19.74)	81 (53.29)	
	Fourth-year	9 (16.98)	8 (15.09)	36 (67.92)	
The instructor used e-learning appropriately.	First-year	9 (5.81)	15 (9.68)	131 (84.52)	0.007*
	Second-year	30 (9.80)	52 (16.99)	224 (73.2)	
	Third-year	6 (3.95)	25 (16.45)	121 (79.61)	
	Fourth-year	8 (15.09)	12 (22.64)	33 (62.26)	
The instructor was encouraging the students to participate.	First-year	4 (2.58)	23 (14.84)	128 (82.58)	0.000*
	Second-year	26 (8.50)	38 (12.42)	242 (79.08)	
	Third-year	7 (4.61)	24 (15.79)	121 (79.61)	
	Fourth-year	9 (16.98)	15 (28.30)	29 (54.72)	
Online teaching experience made anatomy easier to me.	First-year	74 (47.74)	39 (25.16)	42 (27.1)	0.210
	Second-year	134 (43.79)	75 (24.51)	97 (31.7)	
	Third-year	52 (34.21)	44 (28.95)	56 (36.84)	
	Fourth-year	20 (37.74)	18 (33.96)	15 (28.30)	
It is better to adopt online teaching than the face-to-face learning in anatomy.	First-year	102 (65.81)	26 (16.77)	27 (17.42)	0.037*
	Second-year	198 (64.71)	50 (16.34)	58 (18.95)	
	Third-year	98 (64.47)	11 (7.24)	43 (28.29)	
	Fourth-year	33 (62.26)	6 (11.32)	14 (26.42)	

Note: *The Chi-square statistic is significant less than 0.05 level.

Qualitative: Perceptions of Faculty

Fourteen experts participated in the first Delphi round and 13 in the second round (92.85% of those in the first round). All the Delphi panellists were senior faculty members, with the minimum ranking of senior lecturers. The first round generated 56 items, of which 46 (94.6%) were included in the second round. Following the second round, a consensus was reached by all the panellists on all 46 items (Table 4).

Table 4: Perception of the faculty about the teaching and assessment of anatomy courses during COVID-19 and their recommended solutions

Challenges facing teaching anatomy courses using e-learning approaches during COVID-19		Average score out of 5
Theme	**Item**	
Technical issues	There are issues related to the internet connection.	3.9
	Technical issues related to the software: voice is not clear.	3.2
	Lack of technological skills of the staff.	3.0
Interaction and engagement	There is a lack of face-to-face interaction.	4.6
	There are difficulties in the process of attendance control.	4.1
	There is a feeling of isolation during the online session.	3.8
	There are distractors in the surrounding environment during the online session.	3.5
Miscellaneous	Practical sessions cannot be covered online.	3.6
	There are time management difficulties.	3.4
	There are financial issues related to the students.	3.2
The recommended solutions for teaching anatomy courses using e-learning approaches during and post-COVID-19		**Average score out of 5**
Theme	**Item**	
Faculty and staff development	Training of the staff.	4.5
Technical issues and software selection	Careful selection of suitable software.	4.4
	Using the 3D/virtual dissection applications during the practical sessions.	4.3
	Providing a fully equipped studio for transmission of practical sessions in HD.	4.0
Students engagement	Providing recorded sessions after the session.	4.2
	Using reflections from the students about virtual learning sites.	4.2
	Providing recorded sessions for the students in advance.	3.9
	Reduction of the duration of the session while increasing the number of sessions per topic.	3.8
	Provide extra-online sessions during office hours.	3.7
	Minimising the number of students per session.	3.2
Curriculum design and management	Using both on-campus and online sessions.	4.5
	Modify the curriculum according to the current situation.	3.7
Others	Dealing with students' stress.	4.5
The challenges facing the assessment of students in anatomy courses using e-learning approaches during and post-COVID-19		**Average score out of 5**
Theme	**Item**	
Logistics	The duration of each question in the exam may facilitate cheating if not managed properly.	4.7
	Internet connectivity issues.	4.4
	There are time management challenges for students.	3.9

(continued on next page)

Table 4: *(continued)*

The challenges facing the assessment of students in anatomy courses using e-learning approaches during and post-COVID-19		Average score out of 5
Theme	**Item**	
Faculty and staff development	There is a lack of experience among students in online assessment.	3.7
	There is a lack of experience among related administrative staff in an online assessment.	3.5
	There is a lack of experience among academic staff in online assessment.	3.4
Limited accessibility to the dissection room	Assessment of psychomotor skills (practical skills) is not possible.	3.9
Students stress	Dealing with student stress.	4.5
The recommended solutions for e-assessment in anatomy education during and post-COVID-19		**Average score out of 5**
Theme	**Item**	
Improving the assessment design and construction	Align assessment tools with learning outcomes (assess the students the way you taught them, i.e., practical assessment for practical contents of the course).	4.2
	Adopt formative assessment: Short and frequent quizzes and provide feedback to the student to track learning.	4.2
	Enhance the engagement of students through sudden quizzes.	4.2
	Assess the students through personal interview using online video conference.	3.9
Measures to eliminate cheating	Using different versions of the same exam.	4.3
	Using questions addressing higher cognitive functions to decrease the chance of cheating.	4.2
	Limit the time for answering each question.	3.9
	Using the video camera during MCQs and quizzes as a monitoring tool.	3.8
Faculty and staff development	Software training for staff.	4.6
	Software training for students.	4.4
Proper software selection	Check for internet access.	4.6
	Enhance technical support.	4.5
On-campus learning with health precautions	Using both on-campus and online assessment sessions.	4.2
	Conduct the examinations as usual (on-campus) with precautions.	3.8

Concerning teaching anatomy using e-learning, the challenges with the highest average scores related to interaction and engagement, with a lack of face-to-face interaction and difficulties in controlling attendance, obtained mean scores of over 4. The recommended solutions include faculty and staff development, the careful selection of software and using 3D/virtual dissection applications in practical sessions.

Regarding the assessment of students using e-learning approaches, the challenges with the highest average scores were related first to the duration of each exam question (which could facilitate cheating if not managed properly), second to internet connectivity and third to dealing with student stress. The highly rated recommended solutions included software training for staff, checking for internet access, enhancing technical support and using both on-campus and online assessments. Other highly rated recommendations were aligning assessment tools with learning outcomes (assessing students as they were taught, i.e., practical assessments for practical content), adopting formative assessments (such as short, frequent quizzes) and providing feedback to students to track learning and enhance their engagement.

DISCUSSION

This study explored the perceptions of students and faculty on implementing e-learning in anatomy courses during COVID-19 in terms of instruction, engagement and assessment from both the students' and faculty's perspectives.

In the current study, one-third of the students reported that interactions with instructors were easier and more comfortable than in face-to-face lectures; the same proportion agreed that the sessions were interactive. They further reported being fully focused throughout the sessions. Face-to-face teaching in anatomy education is of utmost importance, providing effective student learning in a small group setting and connecting students with values related to ethics and humanism (24). Previous studies conducted in Australia, New Zealand, Singapore and China similarly reported that lost interaction was perceived as a challenge by both students and faculty, especially concerning teaching in dissection rooms (24–26). Furthermore, students' performance and 3D visualisation abilities

were noted as below the expected level, and anatomists were concerned that this was attributed to the lack of interaction (27–28). In Germany, the issue of a lack of interaction prompted the Teaching Commission of the Anatomical Society to issue a recommendation for anatomical educators to carefully balance the two modes of teaching, that is, online and face-to-face (27). It was reported that, even though students have enjoyed online anatomy lectures and virtual practical sessions, they assert that it could not replace a traditional dissection course (29–30). Again, the problem is less interaction, which was not confined only to the interaction with the teachers but also extended to peers (31–32). By contrast, a study in one university in the KSA reported that most students felt satisfied with their interactions in online sessions and believed that e-learning could compensate for a lack of face-to-face teaching (33).

In this study, only about one-third of the students agreed that the images used in online teaching were as informative and descriptive as real specimens. The same proportion agreed that the demonstration of anatomical relations was clear. These findings concur with earlier studies reporting that an inability to visualise and comprehend 3D anatomical relations was perceived as a challenge by both students and faculty (24–26). Cadaveric dissection, practical sessions and observing cadavers and specimens in dissection rooms have been considered the standard of anatomy education for over four centuries (4, 34). This traditional approach has helped learners understand 3D relationships among anatomical structures in a way that classical textbooks cannot and enhanced deep learning, active participation and professionalism (4, 34). Anatomists have adopted various approaches to teaching creatively, such as synchronous and asynchronous lectures, virtual learning, 3D images and videos, virtual simulations and augmented reality, as well as social media application-integrated instruction (35–41).

Virtual dissection was always considered a complement, not a substitute for traditional dissection room sessions (26). It was seen as less effective in encouraging self-reflection and building teamwork skills and professional identity compared to traditional cadaveric dissection (42). Correspondingly, anatomy educators have created several guidelines to secure the supply and process of body donation, embalming and cadaveric dissection activities during the pandemic (43–45).

In Australia and New Zealand, the transition was challenging in terms of the time to prepare online lessons and a lack of training and technical skills (24). In our study, the transition was not as challenging in terms of time to prepare lessons, as most medical schools in the KSA and UAE had adopted online teaching before the pandemic. Still, technical challenges, internet connectivity problems and a lack of proper training were issues shared by our and similar studies (24).

Financial constraints were reported by students in earlier studies; with the lockdown, students feared for their income (24). This was noted to a lesser extent in our study, as most students in KSA and UAE are well supported financially. The students pursuing online learning were at home, with various qualities of internet access, some having a good connection, others having none. The internet connection was a challenge in our study and others (24). It was reported that students who were facing these technical challenges (internet connection, the availability of proper electronic devices) were disadvantaged during online instruction, and their learning environment was less than optimal. This resulted in deeper anxiety and lack of self-confidence (46–47).

In this study, the challenges perceived by the faculty fell into two main categories: problems related to technical issues and the lack of interaction and engagement. Other issues included the difficulty of covering practical sessions online and time management issues. Reports from similar studies indicated an increased workload during the preparation of online learning materials (29). Additionally, the medical teachers were concerned about the copyright issues of online materials and approaches to disseminating the learning resources (29). Furthermore, some anatomy teachers believed their teaching materials were less than optimal for online teaching (26). Studies reported heterogeneous responses regarding the perceptions of faculty regarding the effectiveness of online learning. It is safe to say that they were neutral, neither approving nor displeased with their ability to teach through online platforms (48). The faculty provided suggestions in four categories: faculty and staff development, technical issues and software selection, student engagement, and curriculum design and management.

Regarding students' assessment, several challenges were reported by both faculty and students, including challenges related to logistics and faculty and staff development. There was an emphasis on potential cheating. Similar conclusions were drawn in other studies; the pandemic made constructive alignment difficult (24). Online assessment tools take more time; since internet connection problems were anticipated, students spent a longer time in typing their answers. Thus, students preferred to have face-to-face practical examinations over online assessments (49–50). The faculty provided suggestions in four categories: improving assessment design and construction, adopting anti-cheating measures, training faculty and staff, and proper software selection. Notably, four of 14 recommendations (28.5%) addressed the elimination of cheating during exams.

STRENGTHS AND LIMITATIONS

A strength of this study is its inclusion of many students in 14 schools in two countries. The study's chief contribution

lies in providing suggested solutions derived from a consensus of anatomy teachers, which can help improve online anatomy education. This multicentred study adds to the ongoing debate about whether anatomists should continue with dissection room lessons or move the teaching of anatomy fully online, considering the perceptions of the students involved in the study. Finally, this study explored the response of medical schools in the KSA and UAE during the COVID-19 pandemic.

Some limitations were observed. Although students from 14 schools participated, the sample may not represent all Arab Gulf countries. Furthermore, the results of the Delphi study (as with any qualitative method) are difficult to generalise. Finally, the study's implications can be applied only to countries with similar cultures and infrastructures, namely, Arab Gulf countries.

CONCLUSION

The exploration of the faculty's and students' perceptions reveals that the challenges of online anatomical education relate to the loss of interaction and engagement and the inability to visualise and comprehend 3D anatomical relationships. Virtual dissection is considered complementary, not a substitute for traditional dissection.

Regarding assessment, the study found challenges related to logistics and faculty and staff development, as well as an emphasis on cheating. The faculty members' exploration provided suggestions for online teaching and assessment in these categories: faculty and staff development, technical issues and software selection, student engagement, curriculum design and management, improving assessment design and construction and adopting anti-cheating measures.

ETHICAL APPROVAL

The Research Ethics Committee (REC) pertaining to the Office of Vice Chancellor for Research and Graduate Studies, University of Sharjah has approved conducting this study with the reference number REC-20-5-21-02. All methods were carried out in accordance with relevant guidelines and regulations. An informed consent was also obtained from all participants and the research ethics committee has approved this process of consent.

REFERENCES

1. Turney BW. Anatomy in a modern medical curriculum. Ann R Coll Surg Engl. 2007;89(2):104–7. https://doi.org/10.1308/003588407X168244

2. Dangerfield P, Bradley P, Gibbs T. Learning gross anatomy in a clinical skills course. Clin Anat. 2000;13(6):444–7. https://doi.org/10.1002/1098-2353(2000)13:6<444::AID-CA9>3.0.CO;2-W

3. Jarrett-Thelwell FD, Burke JR, Poirier J-N, Petrocco-Napuli K. A comparison of student performance and satisfaction between a traditional and integrative approach to teaching an introductory radiology course on the extremities. J Chiropr Educ. 2019;33(1):21–9. https://doi.org/10.7899/JCE-17-26

4. Iwanaga J, Loukas M, Dumont AS, Tubbs RS. A review of anatomy education during and after the COVID-19 pandemic: revisiting traditional and modern methods to achieve future innovation. Clin Anat. 2021;34(1):108–14. https://doi.org/10.1002/ca.23655

5. Aborajooh E, Al-Taher R, Tarboush NA, Al-Ani A, Qasem N, Ababneh S, et al. A cross-sectional study of basic education influence on the clinical training: attitudes and perception among Jordanian medical students. Ann Med Surg (Lond). 2020;60:456–61. https://doi.org/10.1016/j.amsu.2020.11.022

6. Bergman EM. Teaching and learning anatomy in a PBL curriculum. In: Chan LK, Pawlina W, editors. Teaching anatomy. Denmark: Springer; 2020. p. 143–52. https://doi.org/10.1007/978-3-030-43283-6_16

7. Trelease RB. Essential e-learning and m-learning methods for teaching anatomy. In: Chan LK, Pawlina W, editors. Teaching anatomy: Denmark: Springer; 2015. p. 313–24. https://doi.org/10.1007/978-3-319-08930-0_28

8. Lochner L, Wieser H, Waldboth S, Mischo-Kelling M. Combining traditional anatomy lectures with e-learning activities: how do students perceive their learning experience? Int J Med Educ. 2016;7:69. https://doi.org/10.5116/ijme.56b5.0369

9. Ortiz PA. Teaching in the time of COVID-19. Biochem Mol Biol Educ. 2020;48(3):201. https://doi.org/10.1002/bmb.21348

10. Muda T, Murniwati TF, Rushaidhi M, Woon CK, Dhamodharan J, Ghafar NA, et al. Anatomy teaching and learning in Malaysia during the COVID-19 pandemic. Education in Medicine Journal. 2021;13(2):71–81. https://doi.org/10.21315/eimj2021.13.2.6

11. Franchi T. The impact of the COVID-19 pandemic on current anatomy education and future careers: a student's perspective. Anat Sci Educ. 2020;13(3):312–5. https://doi.org/10.1002/ase.1966

12. Goh PS, Sandars J. A vision of the use of technology in medical education after the COVID-19 pandemic. MedEdPublish. 2020;9:49. https://doi.org/10.15694/mep.2020.000049.1

13. Xiberta P, Boada I, Thió-Henestrosa S, Ortuño P, Pedraza S. Introducing online continuing education in radiology for general practitioners. J Med Syst. 2020;44(3):55. https://doi.org/10.1007/s10916-019-1499-7

14. Saverino D. Teaching anatomy at the time of COVID-19. Clin Anat. 2021;34(8):1128. https://doi.org/10.1002/ca.23616

15. Ahmed H, Allaf M, Elghazaly H. COVID-19 and medical education. Lancet Infect Dis. 2020;7:1–9. https://doi.org/10.1016/S1473-3099(20)30226-7

16. Al-Masaud K, Gawad A. Impediments of activating e-learning in higher education institutions in Saudi Arabia. Int J Adv Comput Sci Appl. 2014;5(4):12–8. https://doi.org/10.14569/IJACSA.2014.050403

17. Lalmuanawma S, Hussain J, Chhakchhuak L. Applications of machine learning and artificial intelligence for COVID-19 (SARS-CoV-2) pandemic: a review. Chaos Solitons Fractals. 2020;139:110059. https://doi.org/10.1016/j.chaos.2020.110059

18. Khalil R, Mansour AE, Fadda WA, Almisnid K, Aldamegh M, Al-Nafeesah A, et al. The sudden transition to synchronized online learning during the COVID-19 pandemic in Saudi Arabia: a qualitative study exploring medical students' perspectives. BMC Med Educ. 2020;20(1):1–10. https://doi.org/10.1186/s12909-020-02208-z

19. Scheaffer RL, Mendenhall III W, Ott RL, Gerow KG. Elementary survey sampling. US: Cengage Learning; 2011.

20. Haig A, Dozier M. BEME Guide No 3: systematic searching for evidence in medical education – Part 1: sources of information. Med Teach. 2003;25(4):352–63.

21. Bramer WM, Rethlefsen ML, Kleijnen J, Franco OH. Optimal database combinations for literature searches in systematic reviews: a prospective exploratory study. Syst Rev. 2017;6(1):245. https://doi.org/10.1186/s13643-017-0644-y

22. Rana J, Sullivan A, Brett M, Weinstein AR, Atkins KM, Group SDW. Defining curricular priorities for student-as-teacher programs: a national Delphi study. Med Teach. 2018;40(3):259–66. https://doi.org/10.1080/0142159X.2017.1401216

23. Thangaratinam S, Redman CW. The Delphi technique. Obstet Gynaecol. 2005;7(2):120–5. https://doi.org/10.1576/toag.7.2.120.27071

24. Pather N, Blyth P, Chapman JA, Dayal MR, Flack N, Fogg QA, et al. Forced disruption of anatomy education in Australia and New Zealand: an acute response to the COVID-19 pandemic. Anat Sci Educ. 2020;13(3):284–300. https://doi.org/10.1002/ase.1968

25. Srinivasan DK. Medical students' perceptions and an anatomy teacher's personal experience using an e-learning platform for tutorials during the COVID-19 crisis. Anat Sci Educ. 2020;13(3):318–9. https://doi.org/10.1002/ase.1970

26. Cheng X, Chan LK, Pan SQ, Hongmei C, Li YQ, Yang X. Gross anatomy education in China during the COVID-19 pandemic: a national survey. Anat Sci Educ. 2021;14(1):8–18. https://doi.org/10.1002/ase.2036

27. Böckers A, Claassen H, Haastert-Talini K, Westermann J. Teaching anatomy under COVID-19 conditions at German universities: recommendations of the teaching commission of the anatomical society. Ann Anat. 2021;234:151669. https://doi.org/10.1016/j.aanat.2020.151669

28. Tucker RP, Anderson H. Dissection experience and performance on a human gross anatomy written examination: lessons learned during the COVID-19 pandemic. Anat Sci Educ. 2021;14(2):169–70. https://doi.org/10.1002/ase.2044

29. Wolniczak E, Roskoden T, Rothkötter H-J, Storsberg SD. Course of macroscopic anatomy in Magdeburg under pandemic conditions. GMS J Med Educ. 2020;37(7):Doc65.

30. Ortadeveci A, Ermez MN, Oz S, Ozden H. A survey study on distance anatomy education: challenges unique to anatomy. Surg Radiol Anat. 2022;44(1):41–7. https://doi.org/10.1007/s00276-021-02772-z

31. Wish-Baratz S, Crofton AR, Gutierrez J, Henninger E, Griswold MA. Assessment of mixed-reality technology use in remote online anatomy education. JAMA Network Open. 2020;3(9):e2016271-e. https://doi.org/10.1001/jamanetworkopen.2020.16271

32. Şenol D, Şeyma T, Canbolat M, Pektaş M. Evaluation of online anatomy education given in medicine and dentistry faculties of universities during COVID-19 pandemic with student feedback. Konuralp Medical Journal. 2021;13(1):30–5. https://doi.org/10.18521/ktd.757819

33. Elzainy A, El Sadik A, Al Abdulmonem W. Experience of e-learning and online assessment during the COVID-19 pandemic at the College of Medicine, Qassim University. J Taibah Univ Med Sci. 2020;15(6):456–62. https://doi.org/10.1016/j.jtumed.2020.09.005

34. Alsharif MHK, Gasmalla HEE, Elamin AY, Almasaad JM, Elhag AE. In light of COVID-19 crisis: proposed guidelines for the "new norm" of anatomy teaching. Medical Science. 2020;24(105):3281–90.

35. Vasquez S. Developing an online learning environment for community college students enrolled in human anatomy & physiology and microbiology courses amid the COVID-19 pandemic. Electronic Journal for Research in Science & Mathematics Education. 2020;24(3):53–9.

36. Chiuta SL, Argyriou A, Ahari D, Sara X, Clayton B, Cabaleiro C. Creating an anatomy webinar series to cover missed teaching sessions. BMJ. 2020;370:m2892. https://doi.org/10.1136/bmj.m2892

37. Patra A, Ravi KS, Chaudhary P. COVID-19 reflection/experience on teaching–learning and assessment: story of anatomy teachers in India. Anat Sci Int. 2021;96(1):174–5. https://doi.org/10.1007/s12565-020-00576-6

38. Yoo H, Kim D, Lee Y-M. Adaptations in anatomy education during COVID-19. J Korean Med Sci. 2021;36(1):e13. https://doi.org/10.3346/jkms.2021.36.e13

39. Iwanaga J, Loukas M, Dumont AS, Tubbs RS. A review of anatomy education during and after the COVID-19 pandemic: revisiting traditional and modern methods to achieve future innovation. Clin Anat. 2021;34(1):108–14. https://doi.org/10.1002/ca.23655

40. Naidoo N, Akhras A, Banerjee Y. Confronting the challenges of anatomy education in a competency-based medical curriculum during normal and unprecedented times (COVID-19 pandemic): pedagogical framework development and implementation. JMIR Med Educ. 2020;6(2):e21701. https://doi.org/10.2196/21701

41. Flynn W, Kumar N, Donovan R, Jones M, Vickerton P. Delivering online alternatives to the anatomy laboratory: early experience during the COVID-19 pandemic. Clin Anat. 2021;34(5):757–65. https://doi.org/10.1002/ca.23722

42. Parker E, Randall V. Learning beyond the basics of cadaveric dissection: a qualitative analysis of non-academic learning in anatomy education. Med Sci Educ. 2020;31(1):147–53. https://doi.org/ 10.1007/s40670-020-01147-0

43. Lemos GA, Araújo DN, de Lima FJC, Bispo RFM. Human anatomy education and management of anatomic specimens during and after COVID-19 pandemic: ethical, legal and biosafety aspects. Ann Anat. 2021;233:151608. https://doi.org/10.1016/j.aanat.2020.151608

44. Rajasekhar S, Kumar VD. The cadaver conundrum: sourcing and anatomical embalming of human dead bodies by medical schools during and after COVID-19 pandemic: review and recommendations. SN Compr Clin Med. 2021;3(4): 924–36. https://doi.org/10.1007/s42399-021-00778-7

45. Brassett C, Cosker T, Davies DC, Dockery P, Gillingwater TH, Lee TC, et al. COVID-19 and anatomy: stimulus and initial response. J Anat. 2020;237(3):393–403. https://doi.org/10.1111/joa.13274

46. Singal A, Bansal A, Chaudhary P, Singh H, Patra A. Anatomy education of medical and dental students during COVID-19 pandemic: a reality check. Surg Radiol Anat. 2021;43(4):515–21. https://doi.org/10.1007/s00276-020-02615-3

47. Cuschieri S, Calleja Agius J. Spotlight on the shift to remote anatomical teaching during COVID-19 pandemic: perspectives and experiences from the University of Malta. Anat Sci Educ. 2020;13(6):671–9. https://doi.org/10.1002/ase.2020

48. Yan Y, Cheng X, Zhou C, Yang X, Li Y-Q. The perceptions of anatomy teachers for different majors during the COVID-19 pandemic: a national Chinese survey. Medical Education Online. 2021;26(1):1897267. https://doi.org/10.1080/10872981.2021.1897267

49. Sadeesh T, Prabavathy G, Ganapathy A. Evaluation of undergraduate medical students' preference to human anatomy practical assessment methodology: a comparison between online and traditional methods. Surg Radiol Anat. 2021;43(4):531–5. https://doi.org/10.1007/s00276-020-02637-x

50. Harmon DJ, Attardi SM, Barremkala M, Bentley DC, Brown KM, Dennis JF, et al. An analysis of anatomy education before and during COVID-19: May–August 2020. Anat Sci Educ. 2021;14(2):132–47. https://doi.org/10.1002/ase.2051