Evaluation of the online learning of veterinary anatomy education during the Covid-19 pandemic lockdown in Egypt: Students' perceptions

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ABSTRACT
The sudden shift of veterinary anatomy teaching from traditional to online mode during the coronavirus disease 2019 (Covid-19) pandemic lockdown was a major challenge used for the first time in Egyptian veterinary medical schools. This study aimed to evaluate the students' perspectives regarding the shift of veterinary anatomy teaching to online mode during the lockdown in Egypt. A total of 502 students from all veterinary medical schools in Egypt (n = 17) answered the questionnaire. The results revealed that nearly two-thirds of students felt enthusiastic about studying anatomy online during the pandemic. Moreover, approximately 63% of students were satisfied with the provided learning materials, 66% were able to understand anatomy using the online learning system during the lockdown period, 67% were comfortable with technological skills during their online study, and 47% believed that online learning of anatomy could replace face-to-face teaching. Therefore, despite the problems associated with the emergency switch to remote teaching, it appears to be a suitable alternative in teaching veterinary anatomy in Egyptian universities during this pandemic crisis in Egyptian universities. Moreover, the study provided several measurements to overcome the common problems associated with this challenging method for future application, such as providing three-dimensional virtual tools and electronic devices with either free or low-priced Internet packages, and measuring students' understanding before and after each lecture. This is the first study to solicit the early students' feedback regarding the emergency shift to online veterinary anatomy teaching which might help decision-makers in Egypt for future implementation of online learning of veterinary anatomy.

KEYWORDS
Covid-19, efficacy, Egypt, gross anatomy education, remote teaching, veterinary, veterinary education

INTRODUCTION
Coronavirus disease 2019 (Covid-19) pandemic has influenced the educational systems worldwide, where more than one and half billion students in 188 countries globally have been affected by the closure of schools, colleges, and universities as measures taken by countries to prevent its spread (UNESCO, 2020a). Thus, shifting to remote or distance learning has applied in many educational institutions worldwide (UNESCO, 2020b). Despite the efforts done by the educational institutions to offer online course materials and
encourage students to study online (Mukhtar et al., 2020). Students, lecturers, and universities globally are facing several challenges due to the rapid shift to the online learning mode (Gonçalves & Capucha, 2020; Sahu, 2020; Parkes & Barrs, 2021; Nazeefa, 2021).

Although anatomists worldwide have rapidly shifted to emergency remote learning and provided resources for students to continue their learning during the Covid-19 crisis (Bozkurt & Sharma, 2020; Evans et al., 2020; Pather et al., 2020; Choudhary, 2021; Evans & Pawlina, 2021), the sudden transition has forced traditional anatomists in developing countries to shift into virtual mode without planning or training (Patra et al., 2021a). Moreover, practical training for students was missing (Patra et al., 2021b). Therefore, it is important to evaluate this shift to explain the possible methods for recovery from this pandemic (Ferrel & Ryan, 2020).

Pather et al. (2020) classified the challenges in anatomy education during the pandemic into four categories: challenges for staff (information technology skills and the absence of previous training on effective delivery of online education), students (financial issues and Internet-related issues), resources (software availability, network failure, and technical issues), and curriculum (lack of practical experience and assessment of students). Brasset et al. (2020), Franchi (2020), and Ross et al. (2021) reviewed the impact of the Covid-19 pandemic on medical anatomy education and practice. They showed that the absence of practical teaching of medical anatomy, suspension of working on cadaveric materials, cancellation of practical examinations, and suspension of the body donation program due to lockdown may be accompanied by long-term effects on students. These effects include loss of practical experience and the influence of a deeper understanding of the complex anatomical structures and relationships (Franchi, 2020; Ross et al., 2021). Recently, Saber (2021) reviewed challenges in teaching veterinary anatomy during the Covid-19 pandemic lockdown in Egypt and possible solutions. The main challenges were on how education (lectures, as well as the practical lessons of the second semester) would continue and how the assessment (especially the practical ones) would be done (Saber, 2021).

Veterinary anatomy education in Egypt

Undergraduate students in Egyptian veterinary medical schools study their curriculum for five years to obtain a bachelor’s degree. Veterinary anatomy is one of the basic science subjects that is taught during the first two years (four semesters) of the veterinary curriculum. The anatomy curriculum is composed of general, comparative, and developmental anatomy (Hailat, 2005; Mohamed et al., 2019). The curriculum in each semester is divided into 15 weeks. In the regular classes (before Covid-19), students attend didactic lectures followed by practical sessions (cadaveric prossection) in the dissection hall (Saber et al., 2016). The veterinary anatomy course includes two hours of lecture and two hours of practical sessions per week for the first and second-year students. For lectures, PowerPoint slides and recorded anatomy videos were presented using data presentations with the aid of a whiteboard, bones, plastinated specimens (when possible), and illustrations. Practical sessions were conducted for small groups of students under the supervision of anatomy staff members and demonstrators. The anatomical samples used in these sessions included macerated bones from euthanized animals, preserved wet preserved cadaver materials, freshly euthanized chicken and fish, plastinated specimens, and colored plasticine models (Basset et al., 2014; Saber et al., 2016). Nearly the same contents of the anatomy curriculum are taught across veterinary medical schools in Egypt. But the course design differs according to each veterinary school internal bylaws. The resources available for students included the department notes prepared by staff members of the anatomy department and anatomy textbooks available in the school library. E-learning using computer-based learning programs has been introduced as a part of the practical veterinary anatomy course in some veterinary schools in Egypt as an effective learning tool in veterinary anatomy teaching (Elnady et al., 2014; El Sharaby et al., 2015; Saber et al., 2016; Elsáid et al., 2020). Student assessment is conducted according to each veterinary school internal bylaws at the end of each semester, in January and June. In general, student assessment is nearly the same across different veterinary schools. It includes written, spot practical, and oral examinations (Abdelaziz et al., 2018), in addition to laboratory and home assignments, including essay writing, group discussion, and preparation of bones and preserved specimens.

Following the announcement of Covid-19 as a pandemic, the Egyptian government closed all schools and universities across the country initially for two weeks from March 15, 2020; then, it was extended until the end of the school year (May 14, 2020) to prevent the spread of the virus. Meanwhile, approximately 25.3 million students continued their study remotely through online lectures for the first time in the Egyptian governmental institutions (Bozkurt et al., 2020; Enterprise, 2020; UNICEF, 2020). Suspension of ordinary classes and shift to remote teaching has been effective immediately with no initial national guidance for this shift (Bozkurt et al., 2020). This suspension of classes came into effect at the fifth week of the second semester while students still had ten weeks of teaching to complete. Therefore, completing the syllabus for the second semester was a major challenge (Saber, 2021). The Egyptian Ministry of Higher Education and Scientific Research instructed universities to continue the educational process through online learning. The theoretical lectures have been prepared in the form of PowerPoint presentations (Microsoft Corp., Redmond, WA), and videos and uploaded to Google Drive (Google LLC., Mountain View, CA) and university platforms, and students can download them and view on their computers or smartphones at home (Shaheen, 2020). In some universities, the lecturers’ files were either sent to students through WhatsApp groups (WhatsApp Inc., Mountain View, CA) or uploaded on Facebook (Facebook, Palo Alto, CA) or university curriculum management platform, thus students could view or download them to their smartphones or computers (Bozkurt et al., 2020; Saber, 2021). Students who encountered Internet-related problems had the opportunity to obtain a CD or a flash drive containing the lectures (Shaheen, 2020).
Examinations for the second semester have been canceled and replaced by essays or research articles on certain topics. An alternative assessment (Pass/Fail grade) system has been used for the second semester with providing a second chance for failed projects (Alaa El-Din, 2020; Bozkurt et al., 2020; Shehata et al., 2020; Saber, 2021). While practical examinations were replaced by online multiple-choice questions with a Pass/Fail grade system (Saber, 2021). However, the online assessment has several challenges, such as security, Internet connection, technical problems, reliability, difficulty to assess different skills, and plagiarism (Shehata et al., 2020; Consorti et al., 2021).

The lack of online teaching facilities and the prior experience with online teaching make the forced transition to online teaching during the pandemic particularly difficult in Egypt (Shehata et al., 2020). Subsequently, the Supreme Council of Egyptian Universities has announced the implementation of a “hybrid education” model, which merged traditional classrooms and online learning activities allowing students to attend any on them, starting from the academic year 2020–2021 to reduce the density of students inside education halls (Ahram Online, 2020). As a result of this decision, it was essential to evaluate the rapid shift to distance learning during the pandemic in Egyptian public universities, in addition to measuring the satisfaction of students, professors, and educational leaders and their recommendations for the future incorporation of this model in Egyptian universities (El Said, 2021).

Therefore, this study aimed to evaluate students’ perspectives and attitudes regarding the sudden shift of veterinary anatomy learning from face-to-face to virtual mode during the lockdown period as a new and challenging method used for the first time in Egyptian veterinary medical schools.

Materials and Methods

Study design and target population

A cross-sectional survey was conducted to evaluate the students’ satisfaction with online learning of veterinary anatomy during the Covid-19 pandemic lockdown in Egypt. The target population was students studying veterinary anatomy online during the lockdown period (March 15 to May 15, 2020), in all veterinary medical schools in Egypt (n = 17). The data were collected during the period from June 4 to July 15, 2020, using snowball sampling. The study was registered in "clinical trials.org" under the registration number: NCT04418284.

Ethical approval and questionnaire design

The study was approved by the institutional ethics committee for scientific research, Faculty of Veterinary Medicine of South Valley University, Egypt (Approval number: 3B-9-2020). An anonymous online Google Form questionnaire (Google LLC., Mountain View, CA) (Supporting Information File 1) was designed by the first author and tested by both authors. The aim and data use were stated clearly at the beginning of the questionnaire. Students studying veterinary anatomy online, in all Egyptian universities, were invited to voluntarily answer the questionnaire for research purposes. Students’ invitation to answer the questionnaire was sent through either contacting either a faculty member in the anatomy departments in some schools or students in the first/second year in the rest of the schools. Contacted persons were asked to share the questionnaire link with their students/colleagues through the Facebook class groups. Furthermore, participating students were also asked to share the questionnaire link with their colleagues to ensure a wide distribution of the questionnaire to more participants. All participants were asked whether they agree to participate in this study.

The questionnaire consisted of 20 questions categorized into four sections. The first section consisted of six questions (four closed-ended and two open-ended), comprising the participants’ consent and their demographic features, such as sex, age, university, and year of study, while the second section was designed to address students’ experience about remote veterinary anatomy teaching during the lockdown period. Students were asked to express their views using four-point Likert scale questions (Mulyanti et al., 2020). It consisted of five questions comprised of student interest in studying anatomy online during the lockdown, student satisfaction with the provided learning materials, comfortability with technological skills, degree of understanding of online learning of anatomy, and possibility of replacing face-to-face teaching with online mode. Responses to four-point Likert scale questions showed acceptable internal consistency (Cronbach's alpha = 0.77).

The third section consisted of four multi-select multiple-choice questions. Students were asked to mention the type of the provided learning materials, a device used to access the online learning materials, online sources used to study anatomy, and the most common problem encountered during the online learning of anatomy, while the fourth section consisted of five questions (four closed-ended and one open-ended). Students were asked to express their opinion regarding the need for additional learning materials (dichotomous question), average studying hours before and during the lockdown period, suitability of online learning of anatomy to either the theoretical lectures or practical lessons. Finally, students were asked to write their recommendations and suggestions to improve the e-learning of anatomy courses in the future using an open-ended free-text question.

Pilot study

A response process validity study was conducted on 30 participants at the first author’s school to test the clarity of the items and statements in the questionnaire. The necessary modifications and corrections were done to ensure that the questions were easily understandable and clear. Questionnaire reliability was measured by Cronbach's alpha test, and it was 0.75.
Data collection

Data were collected using a Microsoft Excel spreadsheet (Microsoft Corp., Redmond, WA) linked to the online designed Google Form questionnaire. A total of 561 responses were received, of which 59 responses were discarded because they did not agree to be included in this study. The collected data were anonymous.

Statistical analysis

The obtained data were analyzed using SPSS statistical package, version 21.0 (IBM Corp., Armonk, NY). The normality of data distribution was assessed by the Shapiro–Wilk test. Quantitative data were analyzed using descriptive statistics by means and standard deviation. For the four-point Likert scale questions, students’ answers were converted into numeric values as follows (strongly agree = 4 points; agree = 3 points; disagree = 2 points; strongly disagree = 1 point) (Mayer & Cavallaro, 2019). For questions in section C (type of provided learning materials, electronic device used, online learning tools used to access the learning materials, and the most common problems that faced students during online learning), students were able to select more than one answer. The data were represented as proportions of all answers provided. Then, the results of the first- and second-year students were then analyzed using the student’s t-test and the effect size (Cohen’s d) of the differences between the two groups was calculated. The statistical difference was indicated when $P < 0.05$. Qualitative data were analyzed by both authors using thematic analysis as described by Braun and Clarke (2006). All answers were thoroughly examined then similar answers were summarized, organized, and coded. The answers were then divided into themes and subthemes that were identified and agreed by both authors.

RESULTS

Demographic features of participants

A total of 561 participants from all veterinary medical schools in Egypt participated in this study ($n = 17$). Participants who refused to participate in the study ($n = 59$) were eliminated. Therefore, the final number of participants was 502. Participants consisted of first academic year (42.83%, $n = 215$) and second academic year (57.17%, $n = 287$), undergraduate students (Table 1). All participants confirmed that they studied anatomy online during the lockdown period. Nearly two-thirds of the participants were female students (63.35%, $n = 318$), while male students accounted for 36.65% ($n = 184$) (Table 1). The age of participants (mean $\pm$ SD) was 19.07 $\pm$ 0.56 years for the first-year students and 20.08 $\pm$ 0.65 years for the second-year students.

TABLE 1 Distribution of participants in the Egyptian veterinary medical schools

| University              | Participants n (%) | First-year students | Male n (%) | Female n (%) | Second-year students | Male n (%) | Female n (%) |
|-------------------------|--------------------|---------------------|------------|--------------|----------------------|------------|--------------|
|                         |                    |                     | Male n (%) | Female n (%) |                      | Male n (%) | Female n (%) |
| Sohag University        | 121 (24.10)        | 10 (8.26)           | 34 (28.10) |              |                      | 24 (19.83) | 53 (43.80)   |
| Cairo University        | 61 (12.15)         | 5 (8.20)            | 7 (11.48)  |              |                      | 17 (27.87) | 32 (52.46)   |
| Aswan University        | 54 (10.76)         | 10 (18.52)          | 16 (29.63) |              |                      | 10 (18.52) | 18 (33.33)   |
| Zagazig University      | 53 (10.56)         | 9 (16.98)           | 13 (24.53) |              |                      | 14 (26.41) | 17 (32.08)   |
| South Valley University | 50 (9.96)          | 14 (28)             | 18 (36)    |              |                      | 8 (16)     | 10 (20)      |
| Minia University        | 30 (5.98)          | 3 (10)              | 6 (20)     |              |                      | 9 (30)     | 12 (40)      |
| Beni-suef University    | 15 (2.99)          | 1 (6.67)            | 2 (13.33)  |              |                      | 4 (26.67)  | 8 (53.33)    |
| Damanhur University     | 14 (2.79)          | 0 (0)               | 11 (78.57) |              |                      | 0 (0)      | 3 (21.43)    |
| Kafr El-Shaik University| 13 (2.59)          | 1 (7.69)            | 7 (53.85)  |              |                      | 3 (23.08)  | 2 (15.38)    |
| Menoufia University     | 13 (2.59)          | 3 (23.08)           | 3 (23.08)  |              |                      | 1 (7.69)   | 6 (46.15)    |
| Assiut University       | 12 (2.39)          | 1 (8.33)            | 5 (41.67)  |              |                      | 1 (8.33)   | 5 (41.67)    |
| New Valley University   | 12 (2.39)          | 2 (16.67)           | 3 (25)     |              |                      | 6 (50)     | 1 (8.33)     |
| Banha University        | 11 (2.19)          | 3 (27.27)           | 3 (27.27)  |              |                      | 2 (18.18)  | 3 (27.27)    |
| Mansoura University     | 11 (2.19)          | 3 (27.27)           | 2 (18.18)  |              |                      | 4 (36.36)  | 2 (18.18)    |
| Sadat City University   | 11 (2.19)          | 1 (9.10)            | 4 (36.36)  |              |                      | 4 (36.36)  | 2 (18.18)    |
| Suez Canal University   | 11 (2.19)          | 4 (36.36)           | 4 (36.36)  |              |                      | 3 (27.27)  | 0 (0)        |
| Alexandria University   | 10 (1.99)          | 3 (30)              | 4 (40)     |              |                      | 1 (10)     | 2 (20)       |
| Total                   | 502 (100)          | 73 (14.54)          | 142 (28.29)|              | 111 (22.11)         | 176 (35.06)|

and the effect size (Cohen’s $d$) of the differences between the two groups was calculated. The statistical difference was indicated when $P < 0.05$. Qualitative data were analyzed by both authors using thematic analysis as described by Braun and Clarke (2006). All answers were thoroughly examined then similar answers were summarized, organized, and coded. The answers were then divided into themes and subthemes that were identified and agreed by both authors.
Evaluation of students’ attitude toward the online learning of anatomy during the pandemic

Students’ interest in studying anatomy online during the pandemic

The present data showed that nearly two-thirds of the participating students felt enthusiastic about studying anatomy online during the Covid-19 pandemic (68.33%, n = 343); approximately 53.49% of the first-year students (n = 115) and 79.44% of the second-year students (n = 228) were interested in studying anatomy online during the Covid-19 pandemic. Second-year students (mean ± SD = 2.97 ± 0.79) had a significantly higher interest rate in studying anatomy online than the first-year students (mean ± SD = 2.59 ± 0.93), P < 0.05 (Cohen’s d = 0.44) (Figure 1).

Provided learning materials: Type, sufficiency, and the need for additional materials

Students reported that the learning materials provided by their lecturers were either PowerPoint slides (Microsoft Corp., Redmond, WA) with narration (59.93%) or Portable Document Format (pdf) (40.07%) that were available through the university platform. Data showed that 59.53% of the first-year students and 64.81% of second-year students were satisfied with the learning materials provided by their lecturers (Figure 1). Second-year students (mean ± SD = 2.74 ± 0.74) had higher satisfaction rate with the provided learning materials than first-year students (mean ± SD = 2.62 ± 0.75), P =0.07 (Cohen’s d = 0.16). Although 62.55% of students (n = 314) were satisfied with the learning materials provided by their lecturers, 85.86% of students (n = 431) showed their need for additional learning materials.

Online sources used by students to study anatomy

Students reported that they used different online sources to obtain anatomy information to help them understand anatomy during the Covid-19 lockdown. The most commonly stated sources by students were anatomy e-books (31.71%) and YouTube videos (YouTube, LLC., San Bruno, CA) (22.94%). Other sources included educational websites (9.85%), anatomy telegram channels (a tool for broadcasting of public messages only by admins to an unlimited number of audiences) (9.49%), anatomy Facebook pages (Facebook, Palo Alto, CA) (9.21%), educational applications (6.78%), research papers (6.32%), and anatomy WhatsApp groups (WhatsApp Inc., Mountain View, CA) (3.70%) (Figure 2).

Students’ understanding and comfortability with studying anatomy online

Approximately 66% of the participating students (n = 331) reported that they can understand anatomy using the online learning system during the Covid-19 pandemic (Figure 1). Second-year students (mean ± SD = 2.70 ± 0.76) had a significantly higher understanding rate than first-year students (mean ± SD = 2.50 ± 0.84), P < 0.05 (Cohen’s d = 0.56). To access the learning materials, students used various electronic devices. The most commonly used electronic device was smartphones (63.94%), followed by laptops (15.14%), personal computers (2.78%), and tablets (1.59%), while approximately 13.45% of surveyed students used both smartphones and laptops.
Approximately 63.93% of surveyed students \((n = 336)\) were comfortable with technological skills during the online study of anatomy during the pandemic (e.g., using computer, surfing the Internet, downloading files, etc.) (Figure 1). Second-year students (mean \(\pm SD = 2.90 \pm 0.77\)) had a significantly higher comfortability rate with technological skills than first-year students (mean \(\pm SD = 2.56 \pm 0.83\)), \(P < 0.05\) (Cohen's \(d = 0.41\)).

The current data showed that 44.42% of the participating students believed that online learning of anatomy during Covid-19 lockdown was suitable for theoretical lectures only while 12.95% of students believed that it was suitable for practical lessons (using cadavers) only, and 27.69% of students believed that it was suitable for both theoretical lectures and practical lessons. In contrast, 14.94% of surveyed students believed that online learning of anatomy was suitable for neither theoretical lectures nor practical lessons (Figure 3). Moreover, approximately 47.01% of surveyed students believed that online learning of anatomy could replace face-to-face teaching (both the lectures and practical sessions) (Figure 1).

**Average time spent studying anatomy before and during the lockdown**

The average time spent studying anatomy varied from the period before and during the lockdown. The average number of hours/week spent by the first-year students to study anatomy before and during the pandemic was 4.35 \(\pm 2.22\) and 3.61 \(\pm 2.41\) \((P < 0.05)\), respectively. While the average number of hours/week spent by the second-year students before and during the pandemic was 4.14 \(\pm 2.19\) and 3.46 \(\pm 2.47\) \((P < 0.05)\), respectively (Figure 4).

**Most common problems associated with the online learning of anatomy**

The most common problems reported by students during online learning of anatomy during lockdown were as follows (Figure 5):
Students compared to class teaching (as reported by 27.64% and 36.11% of first- and second-year students, respectively). There are problems on reliable and high-speed Internet connection (as reported by 24.55% and 23.85% of first- and second-year students, respectively). Lecturers require training in e-learning communication skills (as reported by 16.02% and 14.66% of first- and second-year students, respectively). Online learning requires more time to understand compared to class teaching (as reported by 15.76% and 13.57% of first- and second-year students, respectively). It takes longer to obtain feedback and comments back from their lecturers (as reported by 16.02% and 11.82% of first- and second-year students, respectively).

Students’ recommendations to improve the online learning of anatomy

Of 502 students, only 72 (14.34%) students provided recommendations to improve the online learning of anatomy. These recommendations were summarized in the following four main themes: Improvement of the learning materials, enhancement of teaching methods, provision of electronic devices to students, and enhancement of Internet services. The four themes and subthemes with quotations from students’ comments were listed as follows.

Theme 1: Improvement of the learning materials

It is essential to improve the learning materials provided to students to help them in their self-learning. The learning materials should be innovative, easily understandable, and interactive and meet the curriculum learning outcomes. According to the students’ perspectives, this can be achieved through the integration of several tools.

Theoretical parts should be delivered as live streaming through video conferencing software instead of providing either pdf or PowerPoint files. The use of interactive video-streaming in the real-time mimics, to some extent, traditional face-to-face teaching. It allows teachers to share their screen and switch between different teaching methods and allows students to interact, and respond to students’ inquiries. In contrast, pdf and PowerPoint files provide little or no interaction with the absence of response to students’ inquiries.

“Lectures should be given in the form of live videos at least, but not as PDF and PowerPoint files”, “students need to see the teacher explaining the anatomical information as if in face-to-face lectures”, “anatomy needs an imagination which can’t be done with pdf learning materials”.

Practical lessons should be studied in the university after lockdown or recorded from real laboratories. Students miss the practical and...
hands-on experience that cannot be substituted during online learning. Therefore, students recommend postponing the practical lessons after returning back to school. However, the length of the lockdown period cannot be predicted. Therefore, recorded dissection videos that were recorded from dissection rooms using real cadavers might help students to imagine and understand the practical lessons.

“The practical lessons should be studied in university after lockdown”, “e-learning isn't enough to study anatomy as it is essential to see samples directly not only through screens”, “the practical lessons should be recorded inside the university labs with teachers’ voice and handwork”.

Three-dimensional (3D) virtual tools and animations should be provided to mimic the practical teaching using cadavers. This approach will improve anatomy teaching and in turn increase students' understanding of the complex anatomical features rather than using two-dimensional images.

“The practical lessons need 3D animations for better understanding as in real situation”, “Please add apps to make practical anatomy easy”.

More images and videos should be added to help in understanding the anatomical features. Integration of dissection videos and different types of images, such as radiographic, computed tomography, and magnetic resonance images will increase students' comprehension of anatomical relationships.

“More pictures and videos are required for well understanding of the anatomical features”, “professors may include some YouTube videos to help students to understand the lectures well”.

Theme 2: Enhancement of teaching methods

Adopting different innovative strategies to enhance the teaching methods to be suitable for the online mode of delivery. Several subthemes were obtained from students’ comments regarding the enhancement of teaching methods including training on e-learning and communication skills, using innovative methods for simple delivery of information, increasing the interaction between students and teachers, and measuring students' understanding.

Training of lecturers on e-learning and communication skills. Online teaching differs from traditional teaching as the former requires effective communication skills and skills in using modern technologies. Thus, it is essential for institutions to provide training for their teachers to facilitate their mission.

“Lecturers should be trained how to use this modern technology”, “Lecturers require training on effective communication skills”, “University staff should be better prepared to handle e-learning”, “Teachers should be trained for online education, many of them just read the content without illustration”.

Lecturers should use a clear and simple method to deliver concise information. Lecturers should practice effective communication during online teaching through delivering simple, clear, concise, and easily understandable information. Moreover, the scientific contents should be selected carefully, and lengthy explanations should be avoided. This approach will attract students' interest.

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Increasing interaction between students and lecturers. Student-teacher interaction encourages the students to be active in discussion and increases their understanding. It also decreases the distraction of students.

“E-learning requires more interaction between students and their lecturers”, “It is difficult to understand anatomy without interaction”, “giving the student the opportunity to ask questions and receive answers”.

Measuring students’ understanding through applying several assignments before and after each lecture. Assessment of the students’ background knowledge helps the teachers to adapt their teaching plan, while assessment after teaching helps to measure the students’ understanding.

“Online education can be improved by making assignment every lesson to know the level of students’ understanding”, “it is important to provide different tasks and assignments to students”, “providing frequent quizzes continuously”.

Theme 3: Provision of electronic devices to students

Universities should provide students with electronic devices, such as tablets to help their access to the learning materials. Not all students have electronic devices to access the online resources and continue their online learning, which increases the digital divide between students.

“Unfortunately, not all students have the privilege to access the internet for online learning”, “providing students internet facilities like laptop and devices and having biometric verification attendance”.

Theme 4: Enhancement of Internet services

Internet access is a critical factor in the success of distance learning in emergency situations like the Covid-19 pandemic. Therefore, students should have constant access to an Internet connection for a smooth shift to emergency remote learning during the Covid-19 era.

Internet companies should provide free or even cheaper data packages to students during the lockdown to help them participate in their online learning. Not all students can afford the cost of Internet connection for online learning due to the economic divide.

“Internet should be provided for free for students during the pandemic”, “The government should provide free internet packages to students weekly or monthly”.

A stable Internet connection that covers both urban and rural areas should be provided. Fast and reliable broadband connection for all students living in different geographical areas is crucial for equal and effective online learning.

“Reliable internet access should be provided to students”, “improvement of internet network and make it available to all students”, “a stable internet connection for all students is of a great requirement to be able to have a good online education”.

DISCUSSION

This is the first study to analyze the students’ perspectives and attitudes regarding the sudden shift of veterinary anatomy teaching mode during the Covid-19 pandemic lockdown as a new and challenging method used for the first time in Egyptian veterinary medical schools. Recent studies discuss the effect of the Covid-19 pandemic on the current anatomy education in several veterinary and medical schools in several countries (Brassett et al., 2020; Longhurst et al., 2020; Shehata et al., 2020; Cheng et al., 2021; Choudhary, 2021; Chandragirish et al., 2021; Saber, 2021; Shahrvini et al., 2021). Although several plans have been described by the Egyptian educational leaders, the schools were not prepared for this sudden change, resulting in confusion and chaos (Shehata et al., 2020). Therefore, it is essential to evaluate the rapid shift to the online mode of veterinary anatomy teaching during the Covid-19 pandemic in Egyptian institutions.

The present data showed that nearly two-thirds of students were interested in studying anatomy online. The present result agrees with previous results reporting that approximately 63% of medical students at the University of Malta were satisfied with the online teaching of anatomy during the pandemic (Cuschieri & Calleja Agius, 2020). Moreover, about 62% of MBBS first-year medical students believed that online classes of anatomy during the Covid era are effective (Chandragirish et al., 2021). Students believe that online classes are a good use of time during the pandemic (Verma et al., 2020). Online learning allows students to improve their time management skills and offers an opportunity for self-study (Mahdy, 2020; Theoret & Ming, 2020; Parkes & Barrs, 2021; Yoo et al., 2021). In contrast to the present findings, Shahrvini et al. (2021) showed that medical students were not satisfied with the online learning of anatomy during the pandemic because it was passive and could not replace traditional teaching with anatomical specimens. The present results showed that second-year students had a significantly higher interest rate in studying anatomy online than first-year students. Moreover, second-year students had a higher satisfaction rate with the provided learning materials than first-year students. The possible explanations for these findings are that senior students are more familiar with anatomical and medical terminologies than first-year students. In addition to the prior exposure of second-year students
to on campus anatomy and cadavers has allowed them to gain a
baseline understanding that first-year students have not gained yet.
Moreover, second-year students are more sympathetic than first-
year students, as they are more comfortable with university learn-
ing, know the staff, and have each other as an established support
network. It is worth to mention that second-year students had a
significantly higher comfortability rate with technological skills than
first-year students. Therefore, second-year students can better un-
derstand anatomical topics compared to first-year students (Dutta
et al., 2021). Suspension of ordinary class teaching in Egyptian uni-
versities was associated with shifting to emergency remote teaching
via university platforms for the first time (Enterprise, 2020, El Said,
2021). However, most Egyptian public universities had no previous
experience and did not use the learning management system before.
Therefore, difficulties and chaos were obvious (Shehata et al., 2020).
This might explain why the emergency remote learning of anatomy
during the pandemic time was not attractive to approximately one-
third of the participants.

Online teaching worldwide involves two methods: synchronous
teaching with live teaching at a specific time using a virtual classroom
(Google classroom, Microsoft Teams, and Zoom) and asynchronous
teaching using recorded lectures (Rashid et al., 2020; Fabriz et al.,
2021). The synchronous mode of teaching provides more interac-
tion between students and lecturers (Mohmmed et al., 2020), but it
requires a high-speed and stable Internet connection (Cardall et al.,
2008). In contrast, the asynchronous mode is more preferable than
attending live lectures because of its flexibility. Students can access
the learning materials at their convenient time, review the recorded
lectures at any time of the day, repeat the lecture several times to
watch the missed parts, stop the lecture to take notes, or look up for
an information, manage their time, and use them in revision (Cardall
et al., 2008; Dhawan, 2020; Parke & Barrs, 2021; Shahrvinii et al.,
2021; Yoo et al., 2021). Additionally, they are convenient in case of
Internet-related issues, such as availability, connectivity, and speed
(Rashid et al., 2020). Frequent access to asynchronous learning
materials enhances veterinary students’ performance (Schoenfeld-
Tacher & Dorman, 2021). The current study showed that the vet-
ery school followed the asynchronous mode of teaching and the
learning materials provided to students through the university
platform were either PowerPoint slides with recorded voice or pdf
format. Recorded voice-over PowerPoint slides produces a small
file size that requires minimal Internet requirements (Mohmmed
et al., 2020), which seem to be more beneficial to students than
providing only text materials alone, such as PowerPoint slides and
pdf format (Patra et al., 2021b). However, it is difficult to incorporate
several forms of media into the PowerPoint presentation. Moreover,
vetenary students reported that narrated PowerPoint lectures de-
creased interaction between students on the one hand and between
students and teachers on the other hand (Schoenfeld-Tacher &
Dorman, 2021). Using visual and auditory aids in teaching increases
the level of understanding and enhances information processing
and memory recall (Shabiralyani et al., 2015). It is worth mentioning
that the rapid transition from traditional teaching to online learning,
due to the Covid-19 crisis in developing countries, occurred without
planning or training and did not allow teachers to develop new re-
sources (Parkes & Barrs, 2021; Patra et al., 2021a). Therefore, it is
recommended to apply a hybrid model in teaching the anatomy cur-
riculum in which traditional laboratory dissection is combined with
remote learning (Shahrvinii et al., 2021).

In agreement with the present findings, medical students in
Libya reported high levels of proficiency in using computers and
information technology (Alsoufi et al., 2020). The present find-
ings showed that the most commonly reported online sources by
students were anatomy e-books and YouTube videos, while other
sources included educational websites, anatomy telegram channels,
anatomy Facebook pages, educational applications, research papers,
and anatomy WhatsApp groups. The current results agree with that
of Barry et al. (2016) and Saadeh et al. (2021), who showed that most
students use web-based platforms, such as Internet search engines,
social media platforms, and anatomy e-books, to find anatomical and
physiological information, respectively. It has been reported that
undergraduate students prefer the integration of social media ap-
plication platforms, such as YouTube and WhatsApp in their medical
education (Banerjee et al., 2019). Social media, especially YouTube is
considered a valuable educational tool that helps medical students
study anatomy due to its popularity and availability (Jaffar, 2012;
Barry et al., 2016; Mustafa et al., 2020). Therefore, anatomy edu-
cators are recommended to create anatomy YouTube channels in
which effective educational videos of superior educational quality
and accuracy together with instructional dissection videos can be
uploaded and the link can be shared with their students (Langfield
et al., 2018; Hennessy et al., 2020; Mustafa et al., 2020). Moreover,
other social media platforms, such as educational Facebook pages,
Twitter (Twitter Inc., San Francisco, CA), and Instagram (Instagram
Inc., San Francisco, CA), operated by anatomy educators allow stu-
dents to interact, ask questions, and consult with specialists (Barry
et al., 2016; Pickering & Bickerdike, 2017; Hennessy et al., 2020).

The current data showed that nearly half of students supported
the concept that online learning of anatomy could replace face-to
face teaching. In this regard, about one-third of medical students at
Saudi Arabian University are against the concept that online learn-
ing of anatomy can substitute traditional anatomy teaching (Mehdar,
2020). Furthermore, approximately 50% of medical students at the
University of Malta believe that online learning of anatomy is com-
parable to face-to-face teaching (Cuschieri & Calleja Agius, 2020),
while approximately 40% of medical students in the United Kingdom
(UK) preferred virtual simulation to learn anatomy (Zargaran et al.,
2020). Medical students in India reported that neither theoretical
nor practical parts of anatomy could be effectively learned online
(Eluru et al., 2021). Despite the popularity of online learning, the
majority of students prefer traditional classes because they can
deliberate, concentrate, ask, interact, and discuss with their friends
and class teachers (Radha et al., 2020; Yoo et al., 2021). College stu-
dents who prefer traditional learning struggled with adapting to the
emergency online learning (Aguilera-Hermida, 2020; Shahrvinii et al.,
2021) and faced some difficulties to understand online anatomy
materials (Mehdar, 2020). Previous studies revealed the possibility for medical students to learn anatomy using online modalities instead of using cadaver dissection (McLachlan et al., 2004; Patel et al., 2015; McMenamin et al., 2018). Although online sources, including e-books, simulations, 3D models, and digital media, play an important role in anatomy education, virtual tools cannot replace the traditional anatomy education based on the dissection of real cadavers (Byrnes et al., 2021; Patra et al., 2021a; Ross et al., 2021).

Animal cadaver dissection is still the basic method to deliver anatomical knowledge to students in veterinary medical schools and has a positive impact on students' understanding and performance (Mohamed et al., 2019). Additionally, it provides an invaluable opportunity to develop students' skills (Krähenbühl et al., 2017). Herr and Nelson (2021) showed that using cadaveric images with labels instead of cadaver dissection did not help dental students to acquire knowledge compared to the active laboratory. Furthermore, the adaptation of both students and teachers to the online learning mode is a challenging task (Franchi, 2020). The shift to emergency remote learning requires adaptation of the learning materials and teaching methods to be suitable for the online setting (Evans et al., 2020; Smith & Pawlina, 2021). Therefore, institutions and anatomists should increase efforts to modify the anatomy curriculum and integrate virtual dissection (Alisharif et al., 2020; Nazeefa, 2021; Bond & Franchi, 2021) and artificial intelligence in teaching anatomy (Remtulla, 2020; Das & Al Mushaiqri, 2021). In contrast, students prefer blended learning in studying anatomy, in which both face-to-face teaching and online lectures are included (Ocak & Topal, 2015; Singh & Min, 2017; Nazeefa, 2021). This system improves students' cognitive gain and attitude for e-learning (Bhat et al., 2022) as it allows the maximal use of both traditional and virtual learning (Jones, 2021).

The present result showed that approximately 80% of respondents used smartphones either alone or in combination with other Internet-ready electronic devices in their online learning during the pandemic lockdown. This result passes in line with that of Saad (2019), who reported that the majority of the Egyptian university students are heavy smartphone users. About 93% and 50% of the total population in Egypt have mobile connections and a mobile Internet connection, respectively (Kibuacha, 2021). In addition, laptops and smartphones have been reported as the most used devices to access online resources by veterinary students in an international survey (Gledhill et al., 2017). The present findings showed that minority of students (16.5%) used more than one Internet-ready device to access the online materials. In contrast, all students from seven veterinary schools in the UK own at least two Internet-ready electronic devices with about one-third owns three or more devices (Saadeh et al., 2021).

This may be due to the difference in the economic levels between UK and Egypt. Identifying which devices students use in their online learning helps education content developers to ensure the accessibility of their resources by many students (Saadeh et al., 2021). Since the smartphone is the most used electronic device in e-learning, it is crucial to develop smartphone applications to help accessing the online learning materials and optimizing tools that allow interactive sessions through smartphone (Alsoufi et al., 2020). Conversely, most students (approximately 64%) had a good level of technological skills. This result confirms the suggestion of implementing e-learning programs for veterinary medical students. It is worth mentioning that second-year students had a significantly higher comfortability rate with technological skills than first-year students. This result passes in line with that of Saadeh et al. (2021) who reported that second-year students are more apparent to use the Internet to research physiological information than first-year students. The authors referred that this difference to the concept that more complex topics are explained for students at a higher level of their study.

The main problems reported by students during online learning of anatomy during lockdown were lack of interaction, Internet-related issues, need for developing e-learning communication skills of lecturers, need for a long time to understand, and long waiting time to obtain feedback. Previous studies showed that the problems related to the rapid switch to distance learning during the lockdown period could be categorized into problems related to staff, students, resources, and curriculum. The problems related to staff include lack of online teaching skills, poor transmission of body language, and lack of technological skills. While the problems related to students include psychological stress, anxiety, depression, and lack of self-motivation, unfavorable study environment at home, difficulty in time management, and lack of interaction (Jawad, 2020; Kapasia et al., 2020; Mahdy, 2020; Singh et al., 2020; Parkes & Barrs, 2021; Chandragirish et al., 2021; Singal et al., 2021; Bhat et al., 2022). The problems related to resources include the Internet connection quality, the availability of electronic devices, lack of technical support, time "lag" between participants, data protection and confidentiality issues, and financial challenges of universities (Kapasia et al., 2020; Mahdy, 2020; El Said, 2021; Eluru et al., 2021; Muntaz et al., 2021; Zalat et al., 2021; Bhat et al., 2022). The problems related to the curriculum include a lack of suitable learning materials, and a lack of practical experience (Mahdy, 2020; Consorti et al., 2021; Eluru et al., 2021). Successful online teaching depends on the teacher's preparedness and will to use information technology (Shehata et al., 2020; Consorti et al., 2021). It has been reported that receiving feedback significantly improves student performance (Wang & Wu, 2008). It is worth mentioning that direct contact between Egyptian students and their anatomy teachers was maintained through WhatsApp, e-mail, and cellphone to inquire about lectures and receive feedback (Saber, 2021). Moreover, the Internet-related issues in developing countries, such as availability, connectivity, speed, infrastructure, and cost, negatively affect students' online learning (Alsoufi et al., 2020; Mukhtar et al., 2020; El Said, 2021; Muntaz et al., 2021). Most of the village students in Egypt depend mostly on Internet packages and not on "WiFi" which makes it difficult to attend online classes (Shahin, 2021). Poor connectivity in remote and rural areas leads to a loss of educational opportunities for students living in those areas (Mohmmed et al., 2020). Furthermore, faculty participation and dedication are influenced by the virtual classrooms.
by technology experienced both directly and indirectly (Shehata et al., 2020). Shifting to online learning requires the effective incorporation of e-learning platforms, digital resources, pedagogies, and technologies (Evans et al., 2020; Srinivasan, 2020; Consorti et al., 2021). Due to the above-mentioned problems, 52.98% of students believed that face-to-face teaching is more effective than online learning of anatomy. It is worth mentioning that the Egyptian Knowledge Bank, the world’s largest digital library, played a crucial role in the shift to online learning by granting unlimited resources of knowledge, cultural, and scientific content exclusively for Egyptians (Shehata et al., 2020).

Several recommendations had been raised by students to improve the online teaching of anatomy. These recommendations included the improvement of learning materials by providing 3D virtual tools, more images, and videos to help understand the anatomical features. The 3D virtual reality models have been reported as an effective learning tool of human anatomy compared to traditional models (Alharbi et al., 2020). The authors recommend using these models as a complementary learning tool along with traditional cadaver models. It is essential to integrate technology to enhance teaching methods in medical and veterinary education to create interactive online learning materials (Alsharif et al., 2020; Evans et al., 2020; Goh & Sandars, 2020; Srinivasan, 2020; Parkes & Barrs, 2021; El Said, 2021). In this regard, few computer programs have been developed by anatomists in some Egyptian veterinary medical schools to enhance veterinary anatomy self-learning. These programs include the electronic atlas of veterinary comparative anatomy (Elnady, 2002), Equine Anatomedia (El Sharaby et al., 2015), and the e-learning modules of the surface anatomy of equine limbs (Elnady et al., 2014) and nasal cavity (Elsaid et al., 2020). Institutions should be ready for future lockdown situations by storing their own recorded practical session in their departmental repositories (Das & Al Mushaigri, 2021). Moreover, the delivery of video tutorials for dissection or anatomical models has been reported to improve students’ learning (Barry et al., 2016; Gupta & Pandey, 2020). The videos on each dissection topic should be easy and short and have a small size; therefore, students can easily access and share them using widely available and accessible smartphones (Gupta & Pandey, 2020). These videos should be followed by interactive discussions between students themselves and their teachers (Gupta & Pandey, 2020).

Students recommended that teachers should enhance their teaching methods through training on e-learning and communication skills, enhancement of interaction between students and lecturers, live streaming of theoretical parts instead of providing pdf of PowerPoint files, and measurement of students’ understanding before and after each lecture. The development of staff skills by training is an essential requirement for successful remote teaching (Shehata et al., 2020; Mumtaz et al., 2021). Staff training is essential to develop their teaching skills and help them cope with extraordinary and unpredicted problems (Shehata et al., 2020; Pienaar & Mostert, 2021). It is also recommended to enhance teacher-to-student interaction in several ways including using pre-class questions that promote critical thinking, teaching both teachers and students to use technology, providing immediate feedback for students’ inquiries, and using a synchronous mode of teaching via virtual classrooms (Flottemesch, 2000; Mohmmed et al., 2020). In addition to providing short videos that focus on one or two ideas, mini-quiz, online polls, breakout rooms, activity task, or case study (Evans et al., 2020; Parkes & Barrs, 2021) and problem-based learning (Harmon et al., 2021) should be incorporated. Furthermore, digital and economic distress is an important challenge that students face. Many students have neither electronic device to access distance learning nor Internet access, which affects their academic progress (UNESCO, 2020c).

Therefore, it is recommended to lend students electronic devices, such as tablets and laptops to help them access the learning materials. In addition to providing reliable Internet connection with either free or discount packages for students during the pandemic, easy to access and downloadable learning materials, and easy-to-use e-learning platforms (Alsoufi et al., 2020), it is worth mentioning that the Ministry of Communications and Information Technology has provided free navigation across all educational platforms for easier and less-expensive transition for all students (Kibuacha, 2021; Gaye et al., 2021).

Limitations of the study

The current study has some limitations. The questionnaire was constructed by the authors instead of using a previously validated questionnaire. The study focused on students’ perceptions, which are affected by other stressors during the lockdown, with no direct measures of the impact on the students’ outcome as the assessment methods were replaced by essays with a Pass/Fail grade system. The study was conducted on a single course at Egyptian veterinary medical schools and students’ perception was dependent on the setting during the pandemic time; therefore, results cannot be generalized. Further studies in different countries with different settings are required. In addition, the questionnaire link was distributed online. Therefore, not all target students were reached especially students who have limited access to the Internet which could be a selection bias. Moreover, some universities were represented by a few participants. Therefore, more detailed research should be done separately in each university. Another limitation, the study did not involve professors’ perspectives.

CONCLUSIONS

This is the first study conducted to analyze the students’ perspectives and attitudes regarding the sudden shift of veterinary anatomy teaching mode during the Covid-19 pandemic lockdown as a new and challenging method used for the first time in Egyptian veterinary medical schools. Although several problems were associated with the rapid switch to the distance learning mode during the lockdown,
Online learning appeared to be acceptable in teaching veterinary anatomy during this pandemic crisis in Egyptian universities. The online learning of veterinary anatomy could be applied together with traditional education not to substitute it. To overcome the problems associated with online learning, several measurements should be conducted, including a redesign of the anatomy curriculum and learning materials by providing 3D virtual tools, more images, and videos to help understand the anatomical features. Theoretical parts should be conducted as live streaming while practical lessons should be studied in the university after lockdown or through interactive virtual laboratories. Students should be provided with electronic devices with either free or cheaper Internet packages. Additionally, students' understanding should be measured by applying several assignments before and after each lecture. This study represented a method to solicit early feedback from veterinary medical students shortly after the emergency shift to the online learning mode, which might help decision-makers in Egypt for the future strategic development and implementation of online learning of veterinary anatomy as a positive step toward evolution and change. Due to the different infrastructures and resources among Egyptian universities, future studies are recommended to evaluate the online learning of veterinary anatomy in individual universities.

ACKNOWLEDGMENTS

The author would like to acknowledge all students who participated in this study for their time, effort, and contributions. All data including statistics are available from the corresponding author and will be provided upon reasonable request.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher’s website.

How to cite this article: Mahdy MAA, Sayed RKA. 2022. Evaluation of the online learning of veterinary anatomy education during the Covid-19 pandemic lockdown in Egypt: Students’ perceptions. Anat Sci Educ 15:73–82. https://doi.org/10.1002/ase.2149