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Online educational methods vs. traditional teaching of anatomy during the COVID-19 pandemic

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Abstract: Aim of the present study was to determine the impact of the COVID-19 outbreak on anatomy teaching to medical and dental students comparing the traditional anatomy teaching with three remote teaching modalities. A cross-sectional study was conducted among undergraduate medical and dental students of the Aristotle University of Thessaloniki. Four hundred and twenty students who attended anatomy classes during COVID-19 outbreak in Greece, were asked to fill in a questionnaire of 22 questions evaluating the formats of the different courses provided. Each student was asked to complete the questionnaire anonymously via the Google Forms® platform. A total of 200 students participated. During the lockdown, 59.5% of students attended all online anatomy lectures compared to 44.5% in the pre-pandemic year. Overall, the higher percentage of 73.5% was satisfied with the traditional anatomy teaching, instead of 56% which were satisfied with the effectiveness of online anatomy lectures. Asking whether any remote educational method can partially or completely replace the traditional anatomy teaching, the majority of students replied "no" for all the three remote modalities. The traditional anatomy teaching remains the most preferred and effective teaching modality. The students ranked online anatomy lectures and pre-recorded anatomy lectures in second place in terms of effectiveness and preference. The development of remote learning methods has increased students' active participation in anatomy lessons, but significantly negatively affected the students' performance at exams. Remote learning cannot replace the traditional anatomy teaching method, but online lectures could be incorporated into anatomy curricula as an additional tool.

Key words: Anatomy, Education, Teaching, COVID-19, Online education

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Introduction

The COVID-19 pandemic has had a huge impact on many aspects of the human life, including all levels of education, and especially medical education. The majority of medical schools around the world have shifted towards remote learning. Almost 10 months after the COVID-19 pandemic emerged, virtual learning seems to be the only sustainable option in medical education and especially in anatomy education [1, 2]. While any theoretical lecture could be effectively delivered in online classrooms, learning anatomy exclusively in this mode is challenging, because teaching anatomy requires three-dimensional (3D) perception and depends on the student's engagement with the online resources [3].

Human anatomy is one of the most important and classic parts of the curriculum of medical schools around the world. Deep knowledge of anatomy is essential for all physicians,

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regardless of their specialty. The shift of Greek Universities to remote education due to COVID-19 restrictive measures has limited the opportunities for full-time education of medical students, which inevitably led to the use of remote teaching methods. Anatomists have been playing a pivotal role in driving the innovation of digital education for several years and host to e-learning programs [4]. The resources have been used to complement traditional teaching methods in anatomy [5] and have been shown to improve student learning outcomes [6]. In the period after the introduction of COVID-19 restrictive measures, works began to appear comparing traditional methods of teaching anatomy with remote methods [7-9]. So far, very few such studies exist; hence this issue requires further research. Moreover, different perspectives from several countries and continents could be beneficial.

Aim of the present study was to determine the impact of COVID-19 outbreak on anatomy teaching to medical and dental students at the Aristotle University of Thessaloniki and compare the traditional anatomy teaching method with three methods of remote teaching: online anatomy lectures, pre-recorded anatomy lectures, and self-teaching by studying the anatomy lectures' presentation.

Materials and Methods

Study design and population

The current study took place during the summer semester of the academic year 2019 to 2020. The participants were first-year (2nd semester) and second-year (4th semester) medical and dental students attending the courses of Musculoskeletal System Anatomy and Neuroanatomy of the Department of Anatomy and Surgical Anatomy, School of Medicine, Faculty of Health Sciences, of the Aristotle University of Thessaloniki, Greece.

The pre-COVID era weekly schedule of the musculoskeletal system anatomy course in first-year students consisted of two-hour laboratory lectures and one-hour practical laboratory, including anatomical structures' demonstration on dried cadaveric bones from our laboratory collection, for 15 weeks (a total of 45 hours per semester). As for the second-year students, the neuroanatomy course in the pre-COVID era included one-hour theoretical lectures and two-hour laboratory education for 15 weeks (a total of 45 hours per semester). The two-hour laboratory education consisted of one hour theoretical and another one practical part with demonstration of anatomical structures (such as brain sections, nuclei and cranial nerves origin, etc.) on SOMSO® hand-made plastic anatomical models of organs of the human central nervous system (such as cerebral hemispheres, brain stem, etc.). A group of students of the same course underwent a two-hour education every Monday to be able to perform the demonstration to their classmates. The second-year (4th semester) students had already been taught neuroanatomy during cadavers' dissections in the anatomy courses of the 3rd semester.

In February 2020, before the emergency measures introduction, traditional face-to-face teaching was performed according to the previously described format for 2 weeks. After the enforcement of emergency measures and the transition of the Aristotle University of Thessaloniki to remote work, musculoskeletal anatomy and neuroanatomy courses also changed. The musculoskeletal system anatomy course was then weekly and consisted of one-hour online or pre-recorded theoretical lectures and one-hour online or pre-recorded laboratory lectures. The online lectures were presented live as a teleconference using the "share-screen" function on the Skype for Business® (Microsoft, Redmond, WA, USA) program to present the PowerPoint slides to the students for 8 weeks. The official platform of the Aristotle University of Thessaloniki for e-learning (elearning.auth.gr®; Meducator, Thessaloniki, Greece) was used to provide students the link to join the teleconference for the online lectures. Another 5 weeks, pre-recorded lectures were performed. In this format, the professor recorded their voice in the PowerPoint file presenting the lesson without an audience and then shared with the students the created video file on the e-learning platform, including the slides and the Professor's voice. The absence of demonstrations on dried cadaveric bones was substituted with photographs of every aspect of the dried bones from our laboratory collection indicating the anatomical structures. As for the Neuroanatomy course, it was weekly, and consisted of one-hour online or pre-recorded theoretical lectures and one-hour online or pre-recorded laboratory lectures. The absence of anatomical structures demonstrations on plastic models was substituted with photographs of all aspects of those models and photographs of cadaveric brain specimens indicating each anatomical structure. At the beginning of each online lesson, a PowerPoint file of the current lesson (without voice guidance) was sent to the Skype for Business general chat. Thus, students who followed the online lesson were able any time to perform a self-study by

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using the lecture's material.

A total of 420 students were asked to fill in a questionnaire, giving their opinion about the format of anatomy teaching during the COVID-19 outbreak and compare it with the traditional face to face teaching.

The questionnaire consisted of two parts: one general and one specific. The general part included questions, such as demographics data, university, and academic year as well as each participant's level of internet use for educational and entertainment purposes. The specific part enclosed questions regarding the comparison and evaluation of the four different teaching methods: "traditional anatomy lecture", "online anatomy lecture", "pre-recorded anatomy lecture", and "self-teaching by studying the anatomy lectures' presentation". The "anatomy lectures" material included information from classic anatomical atlases, photos of anatomical models and cadaveric images with the goal to become the teaching material as interactive as possible. A translated sample of all questions is presented in Table 1.

The students' June exam period grades of the pre-pandemic year (2018–2019 academic year) were compared to those of the pandemic year (2019–2020 academic year), in order to determine how the transition of the traditional teaching into remote teaching methods affected the students' learning outcomes.

Data collection

Data were obtained by an online questionnaire available in Google Forms® (Alphabet Inc., Mountain View, CA, USA; https://google.com/forms/about). Google Forms is an online tool that allows collecting information from users through a personalized survey or quiz. The information is then collected and automatically linked to a spreadsheet. At first, the questionnaire was sent to two of the co-authors (MT, TT) to obtain feedback regarding the clarity of the questions. Then, it was sent to all participants via chat during an online lecture on the Skype for Business® platform. Afterwards, the answers were collected automatically upon the questionnaire

Table 1. Translated sample of questions asked in the questionnaire

General part
1. What is your age in years?
2. What is your sex?
3. What year of study are you in?
4. In which department do you study at?
5. At what age did you start using the internet?
6. How much time (in hours) per day do you spend on average on internet browsing for educational purposes?
7. How much time (in hours) per day do you spend on average on internet browsing for entertainment purposes?
8. Rate how much do you agree with the following phrase: "During the COVID-19 pandemic, I used the internet for my education".
Specific part
1. How often did you attend "traditional anatomy lectures" in the pre-pandemic years?
2. How often do you attend "online anatomy lectures" during lockdown?
3. How would you rate your satisfaction with the effectiveness of the "traditional anatomy lectures" teaching method (based on your experience, from the time before the pandemic)?
4. How would you rate your satisfaction with the effectiveness of the "online anatomy lectures" teaching method?
5. How would you rate your satisfaction with the effectiveness of the "pre-recorded anatomy lectures" teaching method?
6. How would you rate your satisfaction with the effectiveness of the "self-teaching by studying the anatomy lectures' presentation" teaching method?
7. Your opinion on the educational value of the "online anatomy lectures", taking traditional anatomy lectures as a standard.
8. Your opinion on the educational value of the "pre-recorded anatomy lectures", taking traditional anatomy lectures as a standard.
9. Your opinion on the educational value of the "self-teaching by studying the anatomy lectures' presentation", taking traditional anatomy lectures as a standard.
10. My stand on the claim "After the COVID-19 pandemic, the traditional way of teaching by attending "traditional anatomy lectures" may be completely replaced by "online anatomy lectures"?".
11. My stand on the claim "After the COVID-19 pandemic, the traditional way of teaching by attending "traditional anatomy lectures" may be completely replaced by "pre-recorded anatomy lectures"?".
12. My stand on the claim "After the COVID-19 pandemic, the traditional way of teaching by attending "traditional anatomy lectures" may be partially replaced by "online anatomy lectures"?".
13. My stand on the claim "After the COVID-19 pandemic, the traditional way of teaching by attending "traditional anatomy lectures" may be partially replaced by "pre-recorded anatomy lectures"?".
14. Sort in order (1st most preferred […] 4th least preferred) the preferred way of teaching (a. traditional anatomy lectures, b. self-teaching by studying the lectures' presentation, c. online anatomy lectures, d. pre-recorded anatomy lectures).
Comments:

completion by each participant. The students' feedback was obtained during the last two lessons, after 13 weeks of remote anatomy education. Responses from all questionnaires were registered in a database using 2020 Microsoft Excel for Macintosh.

Statistical analysis

Statistical analysis was performed using the IBM SPSS software ver. 26 (IBM Corp., Armonk, NY, USA). The students' demographic characteristics (sex, academic year, age group, and School) were tabulated. The survey data were analyzed using descriptive statistics to determine the frequency distribution (%) of the responses. The chi-square test was applied to examine the significance in the differences between students' exam grades before and after the pandemic. The significance level was set at $P<0.05$. Normality of the distributions was also controlled.

Ethics statement

The questionnaire was submitted to the Ethical Committee of the Medical School, where ethical permission was granted (approval number: 4290). The questionnaire completion was voluntary. Participants could refuse to participate with no problems or considerations. In the first page of the online questionnaire (https://forms.gle/tMPfKydYv8CebHuU9), study participants were informed that their answers were highly confidential and anonymous. Subsequently, they were asked to give their consent for participating before being guided to the questionnaire. Only participants that gave their informed written consent were able to continue.

Results

A total of 200 students out of the 420 (47.6%), with a mean age of 20.66±4.25 years (range, 18–50 years) completed the questionnaire. One hundred and twenty-four participants were female (62.0%) and 76 were male (38.0%). The respondents were 1st year/2nd semester (61.5%, n=123) and 2nd year/4th semester (38.5%, n=77) students. They attended either medical (75.5%, n=151) or dental school (24.5%, n=49) (Table 2). In terms of internet use, participants stated that the average age of starting computer use was 12.31±3.74 years (range, 4–44 years). Also, after the COVID-19 outbreak, 94.0% (n=188) of participants declared that they began to use the internet more often than before. Students spent similar time on the Internet for educational and entertainment purposes (Table 3). Before the pandemic, only 44.5% (n=89) of participants stated that they constantly attended "anatomy lectures", whereas during the lockdown, the number of students attending each lecture increased by 15.0% and reached 59.5% (n=119) (Table 4). When assessing student satisfaction in terms of the effectiveness of each teaching method, 73.5% (n=147) of students were satisfied with the effectiveness of traditional anatomy lectures, 56.0% (n=112) with the online anatomy lectures, 52.5% (n=105) with the pre-recorded anatomy lectures, and only 21.5% (n=43) with the self-teaching by studying the anatomy lectures' presentation (Table 5). Examining the value of each remote modality of anatomy teaching, taking traditional anatomy lectures as a standard, the following results were acquired: 69.0% (n=138), 63.0% (n=126) and 31.0% (n=62) of students considered online anatomy lectures, pre-recorded anatomy lectures and self-teaching by studying the anatomy lectures' presentation,

Table 2. Baseline characteristics of the students (n=200)

Characteristic	Value
Age (yr)	20.66±4.25
Sex	
Male	76 (38.0)
Female	124 (62.0)
Academic year	
1st	123 (61.5)
2nd	77 (38.5)
School	
Medical	151 (75.5)
Dental	49 (24.5)

Values are presented as mean±SD or number (%).

Table 3. How much time do students spend on the internet?

Item	For educational purposes	For entertainment purposes
Less than an hour	11 (5.5)	20 (10.0)
1–2 hours	63 (31.5)	57 (28.5)
2–4 hours	80 (40.0)	79 (39.5)
4–6 hours	37 (18.5)	38 (19.0)
More than 6 hours	9 (4.5)	6 (3.0)

Values are presented as number (%).

Table 4. Student participation in lectures before COVID-19 pandemic and during lockdown

Item	Before the COVID-19 pandemic	During lockdown
100% lectures	89 (44.5)	119 (59.5)
≥75% lectures	43 (21.5)	48 (24.0)
=50% lectures	30 (15.0)	23 (11.5)
≤25% lectures	37 (18.5)	10 (5.0)
0% lectures	1 (0.5)	0 (0)

Values are presented as number (%).

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Table 5. Student satisfaction with the effectiveness of each method of teaching anatomy

Item	Traditional anatomy lecture	Online anatomy lecture	Pre-recorded anatomy lecture	Self-teaching by studying the anatomy lectures' presentation
Satisfied	147 (73.5)	112 (56.0)	105 (52.5)	43 (21.5)
Dissatisfied	53 (26.5)	88 (44.0)	94 (47.0)	151 (75.5)
Unknown	0 (0)	0 (0)	1 (0.5)	6 (3.0)

Values are presented as number (%).

Table 6. The value of each remote way of teaching anatomy, taking traditional anatomy lectures as a standard

Item	Online anatomy lecture	Pre-recorded anatomy lecture	Self-teaching by studying the anatomy lectures' presentation
Valuable	138 (69.0)	126 (63.0)	62 (31.0)
Invaluable	18 (9.0)	29 (14.5)	81 (40.5)
Unknown	44 (22.0)	45 (22.5)	57 (28.5)

Values are presented as number (%).

Table 7. Opinion of students on the prospect of complete or partial replacement of the traditional method of teaching anatomy with remote methods

Item	Online anatomy lecture	Pre-recorded anatomy lecture
Completely		
Yes	29 (14.5)	28 (14.0)
No	133 (66.5)	137 (68.5)
Unknown	38 (19.0)	35 (17.5)
Partially		
Yes	69 (34.5)	59 (29.5)
No	72 (36.0)	96 (48.0)
Unknown	59 (29.5)	45 (22.5)

Values are presented as number (%).

respectively, to be equivalent to traditional anatomy lectures as a teaching tool (Table 6). When analyzing students' view on whether any remote educational method can partially or completely replace traditional anatomy teaching the majority of students replied "no" for all three remote methods. However, 69 students (34.5%) and another 59 students (29.5%) declared that online anatomy lectures and pre-recorded anatomy lectures, respectively, could partially replace the traditional teaching (Table 7). As for the preferable teaching method, 49.0% (n=98) of students indicated traditional anatomy lectures as the most preferred teaching modality. Self-teaching by studying the anatomy lectures' presentation was indicated as the least preferable teaching modality (n=25, 12.5%) (Table 8). We also compared the students' exam grades in musculoskeletal system anatomy and neuroanatomy between the pre-pandemic (2018–2019) and the pandemic (2019–2020) academic year. In musculoskeletal anatomy, the mean exam score for students in the pre-pandemic year was 6.88±2.12 (range, 0–10), while in the pandemic year was 6.59±1.67 (range, 0–9). In neuroanatomy, the mean exam score was 6.10±2.23 (range, 0–10) in the pre-pandemic academic year and 5.70±1.61 (range, 0–10) in the pandemic academic year. Both differences in exam grades were statistically significant, (chi-square test, for both $P<0.001$) (Table 9).

Discussion

The COVID-19 pandemic has led to the transition from traditional to online education in medical schools. The use of modern technologies in the current situation helps educational institutions and students to continue the learning process and acquire new skills. However, holding onto the students' attention during online lectures is a rather serious problem [10]. Furthermore, it is important to evaluate the effectiveness and impact of the transition to online education.

The most important findings of the present study are that the traditional anatomy teaching method through face-to-face lectures remains the most preferred and effective teaching modality according to students. Second in terms of effectiveness and students' preference occur both the online anatomy lectures and the pre-recorded anatomy lectures, with similar results. The self-teaching by studying the anatomy lectures' presentation is considered the least effective and preferred method. An interesting finding is that the remote teaching methods' development has increased the active participation of students in the anatomy lessons. The majority of students do not believe that remote teaching can completely replace the traditional anatomy teaching method. However, one third of the students consider that the online lectures or the pre-recorded lectures could be implemented in the anatomy curricula. Furthermore, the transition from the traditional teaching method into remote methods seems

Table 8. Students' preferences for the anatomy teaching methods

Item	Traditional anatomy lecture	Online anatomy lecture	Pre-recorded anatomy lecture	Self-teaching by studying the anatomy lectures' presentation
1st place	98 (49.0)	46 (23.0)	44 (22.0)	25 (12.5)

Values are presented as number (%).

Table 9. Comparison of students' exam grades following remote anatomy teaching during the pandemic year (2019–2020 academic year) with the grades following the pre-pandemic traditional anatomy teaching (2018–2019 academic year)

Anatomy course	Academic year	No. of students	Exam grade	*P*-value
Musculoskeletal system anatomy	2018–2019	252	6.88±2.12 (0–10)	<0.001*
(2nd semester of the 1st year students)	2019–2020	272	6.59±1.67 (0–9)	
Neuroanatomy	2018–2019	211	6.10±2.23 (0–10)	<0.001*
(4th semester of the 2nd year students)	2019–2020	295	5.70±1.61 (0–10)	

Values are presented as mean±SD (range). *Statistically significant value (chi-squared test).

to affect the students' performance at exams.

Both the online anatomy lectures and pre-recorded lectures left 56.0% and 52.5% of students satisfied. These findings, are similar to the 53.5% reported in Sharma et al. [11] study and close to the 63.4% in Cuschieri and Agius [12] cohort. However, in the relevant literature there are studies mentioning more than 87% satisfaction [7, 13], contrariwise to others reporting lower than 14% satisfaction [8, 14] with the online educational methods in health sciences (medicine, dentistry, pharmacy etc.). In an older study, Pourghaznein et al. [15] reported that student satisfaction with the online learning was significantly lower compared to traditional lectures.

Half of the students declared traditional anatomy lectures as the most preferred teaching modality. This preference rate is much higher than the corresponding rate found for any online educational method. Similar results can be found in other studies, as Zhang et al. [16] mentioned the preference of the 54.17% of the students for the traditional anatomy lectures compared to online lectures. Singh et al. [17] found that 50.9% of students rated traditional anatomy lectures as the preferred teaching method and 22.1% preferred online anatomy lectures being in accordance with the 23% found in the current study.

The greater satisfaction to the traditional anatomy education could be attributed to the fact that students are more familiar with traditional lectures and may feel more isolated in a virtual learning environment without eye contact with the teacher. The speed and adequacy of the internet connection, the availability of technical assistance, and the quality of the online program of the lectures may also negatively affect the student's satisfaction with e-learning [18, 19]. Other studies have shown that students' satisfaction with the remote education methods increased when they were equipped with the latest technology. Lack of training and technical knowledge prevented users from taking full advantage of remote teaching education systems, thereby reducing student satisfaction [20].

In line with the findings in terms of student satisfaction and preference, only a minority (14.5%) of students suggested, that online educational modalities can completely replace traditional methods. However, 34.5% of the students would like some of the lectures to become remotely. In studies coming from Nepalese, Pakistani and Kuwait students, it was highlighted that 89.8%, 77% and 51.2% of these students respectively, prefer to continue the online lectures [11, 21, 22]. This inconsistency may reflect different perspectives between Nations and disparities in the traditional and /or the online learning modalities. Moreover, students' skills play an important role in their online learning satisfaction. Students who are proficient in appropriate educational technologies can continue their studies with remote teaching methods without problems [23].

The students noted that they attended online lectures more frequently than traditional ones. This is supported by Liaw et al. [24] as well, who reported that remote educational modalities have higher attendance compared to the traditional lectures. This observation is another reason to implement some online courses in the traditional anatomy education curricula.

Online medical teaching is a challenge since students during medical education need to learn and work directly with patients. Anatomy education based on the laboratory specimens' demonstration is characterized by the necessity for the

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student to understand the 3D topography and anatomical structures relations [25]. The e-learning modality results in a loss of "hands-on" experience affecting workload, traditional roles, pedagogy, and personal educational philosophy of anatomy teachers (the so-called anatomists) [26]. However, anatomy educators should continue to participate in remote learning even after the pandemic restrictions will be lifted. Advancement of the quality of remote teaching modalities during this period could be utilized in the future by them as an additional tool in their arsenal.

The current study should be interpreted in the context of the following limitations. The quality of each participant's local internet connection was out of the department's control and thus, many problems in attending efficiently the online anatomy lectures could have been reflected to less satisfaction with the online modalities. The subjects of the study were from only one university, which limits the external validity of the current findings. However, this is another reason for the necessity of the present study and more similar studies reflecting perspectives on this topic from different regions around the world.

In conclusion, the COVID-19 pandemic has affected all aspects of the human life, and medical students were not an exception. Comparing several remote education methods to the traditional face to face anatomy teaching, the present study revealed that the traditional anatomy teaching method remains the most preferred and effective teaching modality for students. The students ranked online anatomy lectures and pre-recorded anatomy lectures in the second place in terms of effectiveness and preference. Self-teaching by studying the anatomy lectures' presentation was considered the least preferred by the students. However, the development of remote learning methods has increased the active participation of students in anatomy lessons. The current research also clarifies that remote learning cannot replace the traditional anatomy teaching method. Online lectures could be incorporated into anatomy curricula as an additional educational tool.

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Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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