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GENERAL RADIOLOGY

INVITED REVIEW

Multidisciplinary approach to diagnostic radiology education: a novel educational intervention for Turkish medical students

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ABSTRACT

Teleconferencing can facilitate a multidisciplinary approach to teaching radiology to medical students. This study aimed to determine whether an online learning approach enables students to appreciate the interrelated roles of radiology and other specialties during the management of different medical cases. Turkish medical students attended five 60–90-minute online lectures delivered by radiologists and other specialists from the United States and Canada through Zoom meetings between November 2020 and January 2021. Student ambassadors from their respective Turkish medical schools recruited their classmates with guidance from the course director. Students took a pretest and posttest to assess the knowledge imparted from each session and a final course survey to assess their confidence in radiology and the value of the course. A paired t-test was used to assess pretest and posttest score differences. A 4-point Likert-type scale was used to assess confidence rating differences before and after attending the course sessions. A total of 1,458 Turkish medical students registered for the course. An average of 437 completed both pre- and posttests when accounting for all five sessions. Posttest scores were significantly higher than pretest scores for each session ($P < 0.001$). A total of 546 medical students completed the final course survey evaluation. Students' rating of their confidence in their radiology knowledge increased after taking the course ($P < 0.001$). Students who took our course gained an appreciation for the interrelated roles of different specialties in approaching medical diagnoses and interpreting radiological findings. These students also reported an increased confidence in radiology topics and rated the course highly relevant and insightful. Overall, our findings indicated that multidisciplinary online education can be feasibly implemented for medical students by video teleconferencing.

KEYWORDS

Educational intervention, online teaching, radiology education, radiology teaching, remote learning, Turkish medical students

Online education can be effective in augmenting the educational experience of students.[1] This study uses high-impact practice principles of online higher education to conduct online education through a video teleconferencing platform. In Türkiye, as elsewhere, the coronavirus disease-2019 (COVID-19) pandemic interrupted medical students' education, as many in-person classes were canceled or moved online, and clinical clerkships were modified to accommodate social distancing measures.[2] To help address the limitations in radiology education caused by the pandemic and to provide an opportunity to learn about clinical cases from radiologists and other specialists, we created and implemented an online radiology course for a large cohort of medical students in Türkiye.

At the onset of the COVID-19 pandemic, Bao[3] published a case study regarding online education at Peking University that provided insight into five high-impact principles of online teaching: relevance, delivery, support, participation, and contingency plans. To help address the limitations in radiology education caused by the pandemic and to provide an opportunity to learn about clinical cases from radiologists and other specialists, we created and implemented an online radiology course for a large cohort of Turkish medical students. In this study, we seek to determine whether our course enabled students to appreciate the interrelated roles of radiology and other specialties in the management of medical cases. Students

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completed pretests, posttests, and a course evaluation survey to assess their knowledge of session topics, confidence about radiology, and the effectiveness of the course. Overall, the data suggests that a multispecialty integrated approach to providing radiology education via teleconferencing was well received by medical students.

Methods

Course structure and development

The course director designed an online multidisciplinary radiology lecture series comprising five sessions (liver disease, neck infections, pediatric headaches, shoulder injuries, and first-trimester pregnancy). Distinguished faculties from teaching institutions were invited to participate, and the topics were selected based on the expertise and availability of the faculty volunteers. Sessions occurred biweekly between November 2020 and January 2021 and were conducted over Zoom (Zoom Video Communications, Inc., San Jose, California). Session lecturers were radiologists and non-radiology specialists from different academic institutions throughout the United States and Canada. Each 60–90-minute session focused on the pathology of a given medical case and the role of imaging in making the diagnosis. The interplay between the presiding radiologist and other specialists demonstrated to the students how different healthcare professionals view and approach a given medical presentation.

At the onset of the COVID-19 pandemic, Bao[3] published a case study regarding online education at Peking University that provided insight into five high-impact principles of online teaching. The first principle is that the teaching material be relevant to students. This was incorporated by relating radiology topics to pertinent anatomy, physiology, and pathology for each case to increase students' understanding of the role of radiology amongst other specialties. The second principle of effective delivery of educational material and the fourth principle of audience participation were achieved via video conferencing involving question-and-answer sessions through audio and chat features. The third principle of sufficient support was achieved by having student ambassadors serve as liaisons between the course director and medical students to help coordinate feedback and share notes. The last principle of contingency planning was effectively implemented, as the course was organized amidst the COVID-19 pandemic to address limitations posed upon medical education at the time.

Main points

- Multidisciplinary online education can be feasibly implemented for medical students by video teleconferencing.
- Educational limitations from measures such as social distancing can be addressed through the implementation of effective online teaching.
- Medical students appreciate the role of radiology integrated alongside other medical specialties.

Participants

Student ambassadors from 10 medical schools in Türkiye were recruited by the course director through social media to help recruit participants and coordinate communication with participants during and after the sessions. Each ambassador recruited participants by sending a message to their schools' group chats and personal emails asking all medical students whether they were interested in participating. The ambassadors sent out the registration form using Google Forms.

Because initial registrants exceeded the participant limit of the available Zoom plan (500 participants), ambassadors helped to divide the students randomly into two groups. Each group attended sessions held on a fixed day of the week; half of the students attended sessions on Saturdays and the other half attended sessions on Sundays. The Saturday sessions were live and recorded and then replayed during the Sunday session. Students from the pre-recorded session could have their questions answered by lecturers, with email coordination from student ambassadors. Student ambassadors shared the course information with the students. In addition to helping recruit participants and transmit announcements from the course director to the participants, ambassadors helped prepare pretests and posttests with the session speakers. They also created session handouts that summarized the main points from each session and emailed these handouts to all participants.

Session structure

At the beginning of each live session, students received a link to the pretest, a Qualtrics survey (Qualtrics, Provo, UT), in the Zoom chat. Students were given 10 minutes to complete the pretest. Next, the lecturers -usually a radiologist and an accompanying specialist- were introduced to the students. The lecturers discussed the case presentation and possible diagnoses. The radiologist explained the imaging modality of choice and interpreted the relevant radiologic findings. Relevant imaging studies in the form of both static images and videos from different modalities were presented. The clinical interpretation of the case was discussed by the specialists and presented alongside the pertinent normal anatomy and imaging findings.

After the lecture, students were given 10 minutes to complete the posttest. The posttest was a Qualtrics survey that was identical to the pretest and provided via a link in the Zoom chat. Following the completion of the posttest, students from the live sessions participated in a question-and-answer session with the speakers. Students from the pre-recorded sessions could email questions and coordinate a discussion through the student ambassadors. Participants submitted their questions using the question-and-answer feature of Zoom. The lecturers were thus able to interact with the medical students in the live audience and provide valuable insights by directly answering their questions.

Course evaluation

The course evaluation consisted of questions asking students about the effectiveness of course sessions and the multidisciplinary approach. Students were also asked to self-identify their gender and year of study in medical school. Students rated each session and provided feedback on the course meeting their expectations and on the educational value of the session topics. In addition, students rated their confidence in the practice of radiology before and after attending the sessions. This was carried out using a scale of four points: not confident, somewhat confident, moderately confident, and very confident. Students answered questions on the best use of radiology practices, interpreting radiographs, safety in radiology, identifying gross abnormalities on imaging, use of imaging as a diagnostic tool, and choosing between different diagnostic tools.

Statistical analysis

A paired t-test was used to compare students' pretest and posttest scores, which were paired using the IP address as the unique identifier. Only data from students who completed both the pretest and

posttest were used in this analysis; students who completed only one test or whose pretests and posttests could not be paired were excluded. This analysis was conducted using Excel (Microsoft, Redmond, Washington). A *P* value of <0.05 was considered significant.

In the course evaluation survey, students were asked to assess their confidence regarding basic radiology skills before and after completion of the course. A 4-point Likert-type scale that ranged from "not confident at all" to "very confident" was used. The difference in the confidence ratings before and after the course completion was evaluated from the course evaluation survey using the Wilcoxon signed-rank test with a one-tailed hypothesis and an alpha value of 0.05. This analysis was performed using R software (R Core Team, Vienna, Austria). Students were also asked on the course evaluation survey to rate each session, rate the program meeting their expectations, and rate the clinical importance of presented topics.

Results

Participants

The course had 1,438 registrants across 29 Turkish medical schools. Registrants attended sessions voluntarily with an upper limit of 500 for each session. Of those, 1,256 students (86.1%) attended state universities and 202 (13.9%) attended private universities (Table 1). Students who attended the sessions were asked to self-identify their gender and year of study in school. A total of 343 (62.82%) identified as female, 196 (35.90%) identified as male, and 7 (1.29%) identified as other or preferred not to answer (Table 1). A total of 85 (15.57%) were in their first year, 116 (21.25%) were in their second year, 93 (17.03%) were in their third year, 113 (20.70%) were in their fourth year, 85 (15.57%) were in their fifth year, 52 (9.52%) were in their sixth year, and 2 (0.37%) were in their preparatory year or were alumni (Table 1).

Session pretest and posttest scores

The numbers of participants who completed the pre- and posttest for each session are given in Table 2. In all five sessions, students' posttest scores were significantly higher than their pretest scores ($P < 0.001$). All scores for the live and pre-recorded sessions, along with combined results, show significant improvement in posttest scores compared with pretest scores.

Course evaluation

Of the 546 participants who completed the course evaluation survey, approximately 96% strongly or somewhat agreed that the program increased their knowledge of imaging as a diagnostic tool (Table 3). Approximately 48% of students strongly agreed, and 40% somewhat agreed, that the program increased their interest in radiology. In addition, approximately 71% of the participants strongly agreed and approximately 27% somewhat agreed that the program was a worthwhile experience. More than 93% of students strongly or somewhat agreed that the presence of a surgeon, internist, or other non-radiology specialist during the sessions improved the program. Students reported increased confidence ratings after attending the sessions that were statistically significant for all six survey items outlined in the methods section (Table 4).

Table 1. Participant characteristics

Student registrants by medical school type	
State	1,256 (86.10)
Private	202 (13.90)
Gender of attendees, self-identified	
Female	343 (62.82)
Male	196 (35.90)
Other	2 (0.37)
Prefer not to say	5 (0.92)
Number of attendees by year of study	
First year	85 (15.57)
Second year	116 (21.25)
Third year	93 (17.03)
Fourth year	113 (20.70)
Fifth year	85 (15.57)
Sixth year	52 (9.52
Other	2 (0.37)
Values are n, (%)	

Table 2. Pretest and posttest scores by session topic and group

Topic and session date	Students who did both tests, n	Live-session group		Taped-session group		All students	
		Pretest score, mean (SD)	Posttest score, mean (SD)	Pretest score, mean (SD)	Posttest score, mean (SD)	Pretest score, mean (SD)	Posttest score, mean (SD)
Imaging of liver disease (11/7/20–11/8/20)	629	4.58 (1.74)	7.68 (1.70)	4.92 (1.80)	8.19 (1.56)	4.76 (1.78)	7.95 (1.65)
Imaging of neck infections (11/21/20–11/22/20)	419	3.05 (1.45)	3.96 (1.86)	2.98 (1.39)	4.54 (1.66)	3.02 (1.42)	4.25 (1.79)
Imaging of pediatric headaches (12/05/20–12/6/20)	399	3.19 (1.89)	5.95 (2.79)	3.10 (1.79)	6.76 (2.73)	3.15 (1.84)	6.36 (2.78)
Imaging of shoulder injuries (12/19/20–12/20/20)	382	3.71 (1.69)	5.88 (2.44)	4.06 (1.60)	6.61 (2.43)	3.90 (1.65)	6.27 (2.46)
Ultra-sonography of first-trimester pregnancy (01/02/21–01/03/21)	360	3.80 (1.49)	5.70 (2.33)	4.01 (1.66)	6.49 (2.35)	3.91 (1.58)	6.12 (2.37)

All $P < 0.001$. SD, standard deviation.

Table 3. Participant responses in course evaluation survey

Survey item	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
This program increased your knowledge of using imaging as a diagnostic tool	60.26	36.63	2.93	0.00	0.18
This program has increased your interest in radiology	48.72	40.11	9.52	1.47	0.18
The material presented in this program was relevant to your medical education	40.66	43.22	12.45	2.75	0.92
The presence of a surgeon, internist, or other non-radiology specialist during education sessions added to the program	62.09	31.14	6.78	0.00	0.00
The program was a worthwhile experience	71.06	26.74	2.20	0.00	0.00

All values are percentages

Table 4. Participant confidence rating before and after the course

Survey item	Mean rating (before course)	Mean rating (after course)	Test statistic (Wilcoxon signed-rank test)
I am familiar with best-use radiology practices	1.85	3.01	1,573
I feel comfortable interpreting radiographs	1.68	2.82	1,004.5
I understand safety in radiology	2.25	3.34	1,723
I am able to identify gross abnormalities on imaging	1.99	3.04	1,584
I am familiar with how imaging is used as a diagnostic tool	2.18	3.25	1,581.5
I am familiar with the different imaging modalities and when to use them	2.01	3.12	1,871

All $P < 0.001$.

Discussion

A multidisciplinary approach to radiology education can be feasibly implemented via video teleconference for medical students. Our course for Turkish medical students was well received and served to increase student confidence in their radiology knowledge, as evidenced by the course evaluation survey results. The findings confirm that our approach enabled students to appreciate the interrelated roles of radiology and other specialties while managing different medical cases. Course evaluation survey results affirmed that students found our multidisciplinary approach worthwhile and gained valuable insight into how radiologists and accompanying specialists approach medical cases and interpret radiological findings. At the onset of the COVID-19 pandemic, Bao[3] published a case study regarding online education at Peking University that provided insight into five high-impact principles of online teaching (2020). As outlined in the methods section, these principles were implemented in the course for effective online teaching.

Many studies have discussed different approaches to addressing the educational challenges during the COVID-19 pandemic.[3] For example, readout sessions could be performed remotely using teleconferencing software with screen-sharing capabilities.[3] Such a platform was used to discuss a "case of the day" for every specialty, host didactic conferences, and virtually present cases to overcome the pandemic-related challenges of medical education.[3] Elsayes et al.[4] showed that an online multidisciplinary approach involving several specialists helped students gain a more accurate understanding of the role of radiology. This approach teaches students basic and clinical science concepts and realistically prepares them for future practice in which interdisciplinary collaboration is common and important. There is a paucity of data assessing the efficiency of a multidisciplinary approach to medical education.

Our course, and similar ones, provided a solution to the challenges students faced because of COVID-19 distancing measures; we brought together physicians from US and Canadian universities to teach Turkish medical students via Zoom. The high-impact principles from Bao and the multidisciplinary teaching structure enabled us to design an effective multidisciplinary radiology course.[3] Students' educational experience was augmented with pretests and posttests, session handouts, and a question-and-answer session. Other studies have indicated that an interdisciplinary course involving radiology and other disciplines increases students' comprehension of radiology and anatomy and their overall motivation to learn.[5-7] In our experience, medical students seemed to appreciate the integration of clinically relevant content with the radiology and anatomy material. A recent meta-analysis of 62 studies assessing health science students' perception of online learning demonstrated positive results, and this method of teaching was preferred to the traditional teaching methods.[8]

In our course, leadership from student ambassadors was crucial for successful implementation. Student ambassadors relayed course information and initial registration opportunities, recruited participants from their medical schools, and prepared session handouts, pretests, and posttests with physician instructors. The ambassadors served as contact points for medical students regarding questions about the course or material. They triaged questions and sought input from physician instructors when needed. Therefore, we encourage implementing a liaison role, as fulfilled by student ambassadors in our course, to serve as a bridge between students and instructors when multiple different academic institutions are involved.

Our study was conducted during the COVID-19 pandemic and has its strengths and limitations. The ability to use online video conferencing for education helped break down geographical barriers and fostered global connections as physicians from the United States and Canada were able to augment the educational experience of Turkish medical students. Technical problems with internet connectivity were rare and statistically insignificant but did disrupt the flow of sessions at times. The limit on live attendance on video conferences impeded the ability of live participation for some students. These factors could be overcome in a setting

where online learning is used more broadly, the lectures recorded, and the limits on live participation removed. A bias may have been introduced in the selection process as those students with a pre-existing interest or proficiency in radiology may be more apt to participate. Additionally, there was no control group to compare the results of the online course with those of traditional teaching methods. The study involved only Turkish medical students, and its applicability to other regions without validation is a limitation.

The COVID-19 pandemic has subsided, and many institutions have returned to conducting in-person didactic lectures. As devastating as the COVID-19 pandemic was, according to a White House document,[9] future pandemics could be far worse. The document concludes, "the next pandemic will likely be substantially different than COVID-19. We must be prepared to deal with any viral threat".[9] It is important that we learn from the COVID-19 pandemic and have effective educational systems in place for future crises.

In conclusion, follow-up studies have been planned by the authors to assess the retention of knowledge and skills gained from the course over time. Future studies could also be performed to apply this educational model in different cultural and educational settings to enhance and evaluate the study's broader applicability.

Footnotes

Conflict of interest disclosure

The authors declared no conflicts of interest.

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