

Educational Effect of Remote Lectures for Students Aiming to Become Radiologic Technologists: Questionnaire on Nuclear Medicine Technology Examinations

Koji Nakaya, Eisuke Yasuda, Hiroe Muto, Kanae Matsuura, Ryo Higashide, and Nobuyuki Arai

Department of Radiological Technology, Faculty of Health Science, Suzuka University of Medical Science, Suzuka, Japan

In the latter half of 2019, coronavirus disease 2019 (COVID-19) began spreading worldwide. To prevent COVID-19 infection, all teaching at Suzuka University of Medical Sciences from April to June 2020 took place as remote lectures, not in the face-to-face format. This study analyzed postlecture questionnaire responses regarding face-to-face and remote teaching on the subject of nuclear medicine technology examinations. We examined the educational effect of using remote lectures. **Methods:** We conducted a questionnaire survey among students by means of a 5-point evaluation scale about satisfaction, comprehension, concentration, preparation, reviewing, and the question environment for face-to-face and remote lectures. **Results:** We present the results as means and SDs. Satisfaction results for face-to-face and remote lectures were 3.30 ± 0.72 and 3.36 ± 0.88 , respectively. Comprehension results for face-to-face and remote lectures were 3.30 ± 0.71 and 3.30 ± 0.83 , respectively. Concentration results for face-to-face and remote lectures were 3.50 ± 0.69 and 3.05 ± 0.90 , respectively. The preparation results for face-to-face and remote lectures were 2.57 ± 0.88 and 2.67 ± 0.94 , respectively. The reviewing results for face-to-face and remote lectures were 2.84 ± 0.85 and 3.39 ± 0.89 , respectively. The question environment results for face-to-face and remote lectures lessons were 2.94 ± 0.90 and 3.43 ± 0.84 , respectively. There were no significant differences between face-to-face and remote lectures in terms of satisfaction, comprehension, or preparation. There were significant differences between face-to-face and remote lectures in terms of concentration, reviewing, and the questioning environment ($P < 0.001$). **Conclusion:** This comparative analysis of the postlecture questionnaire responses for face-to-face and remote formats in nuclear medicine technology examinations showed that remote lectures have a strong educational effect. We believe that, in future, remote lectures should be considered a tool in student education.

Key Words: remote lecture; face-to-face lecture; educational effect; COVID-19

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In the latter half of 2019, coronavirus disease 2019 (COVID-19) began spreading worldwide. COVID-19 is a very dangerous infectious disease (1) that may have worsening symptoms such as difficulty breathing, and death may result. The infection route of COVID-19 is believed to be respiratory droplets and physical contact (2). The incubation period of COVID-19 is reportedly long (3), and some patients remain asymptomatic (3,4). To deal with COVID-19 infection in Japan, avoiding the “3 Cs” has been promoted: closed spaces, crowded places, and close-contact settings (5).

To prevent infection, Suzuka University of Medical Sciences stopped students from attending university from late March to late June 2020. Thus, face-to-face lectures have not been held at the university since March to September. If lectures were canceled that would impede the students' study, the university held remote lectures via the Internet. Other Japanese universities have also held remote lectures, though some have continued to offer face-to-face lectures as before.

Suzuka University of Medical Sciences had no experience with holding remote lectures, and the educational effect of such lectures was unknown. One course offered at the university is Nuclear Medicine Technology Examination. It comprises 3 lecture courses run by the Department of Radiologic Technology Science: the second half of the second year covers Nuclear Medicine Technology Examination 1; the first half of the third year covers Nuclear Medicine Technology Examination 2; and the second half of the third year covers Nuclear Medicine Technology Examination 3. In 2020, third-year students took face-to-face lectures in Nuclear Medicine Technology Examination 1 and remote lectures in Nuclear Medicine Technology Examination 2. Thus, third-year students experienced both face-to-face and remote lectures in the Nuclear Medicine Technology Examination series. In this study, we evaluated the educational effect of the remote lectures among third-year students. We analyzed the results of postlecture questionnaires on face-to-face and remote teaching and evaluated the educational effect of remote lectures.

MATERIALS AND METHODS

Participants

The participants were third-year students at the Department of Radiation Technology Science of Suzuka University of Medical

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For correspondence or reprints contact: Koji Nakaya, Department of Radiological Technology, Faculty of Health Science, Suzuka University of Medical Science, 1001-1 Kishioka, Suzuka, Mie 510-0293, Japan.

E-mail: nakaya@suzuka-u.ac.jp

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Sciences who took face-to-face lectures in Nuclear Medicine Technology Examination 1 and remote lectures in Nuclear Medicine Technology Examination 2 in 2020. The remote lectures were held using Zoom (Zoom Video Communications).

The Judging Committee of the Suzuka University of Medical Sciences approved this study, and all subjects gave written informed consent.

Survey Question 1 (Satisfaction)

We investigated satisfaction, comprehension, concentration, preparation, reviewing, and the question environment for Nuclear Medicine Technology Examination 1 (face-to-face lectures) and Nuclear Medicine Technology Examination 2 (remote lectures) using an evaluation scale for which each of 5 different responses was assigned a different number of points: “I was able to do it well” (5 points); “I was able to do it fairly well” (4 points); “I was able to do it neither badly nor well” (3 points); “I was able to do it, though badly” (2 points); and “I was unable to do it at all” (1 points). We present the results as means and SD. We used the Mann–Whitney *U* test for statistical analysis to compare the 2 types of lectures.

Survey Question 2 (Lectures That Could Be Taken Remotely)

The university holds 14 lectures for each course. Among the 14 face-to-face lectures, we examined which ones could be taken remotely. We asked the participants to indicate all such lectures. Table 1 presents the titles of the face-to-face lectures.

Survey Question 3 (Good Remote Lectures)

Among the remote lectures, we identified those that appeared to work well in that format. We asked the participants to indicate all such lectures. Table 2 shows the titles of the remote lectures.

TABLE 1

Titles of Face-To-Face Lectures in Nuclear Medicine Technology Examination 1

Lecture no.	Title
1 and 2	Nuclear medicine examination; what is a radioisotope?
3	About radiopharmaceuticals, single photons, in vitro examination, and positrons
4	In vivo examination system, section 1
5	In vivo examination system, section 2
6	Other nuclear medicine examination equipment
7	PET (PET/CT) equipment, section 1
8	PET (PET/CT) equipment, section 2
9	Equipment related to PET (cyclotron, synthesis of radiopharmaceuticals, automatic quality control equipment, and hot cells)
10	Imaging technology (characteristics of nuclear medicine imaging)
11	Image processing
12	SPECT image reconstruction
13	Various SPECT correction methods (scatter correction and attenuation correction)
14	Various SPECT correction methods (nonuniform absorber correction, position resolution correction, and various PET corrections)

TABLE 2

Titles of Remote Lectures in Nuclear Medicine Technology examination 2

Lecture no.	Title
1 and 2	Artifacts, dynamic function test analysis method, image display, and image output
3	Safety management laws (nuclear medicine practice and law)
4	Safety management laws (radiation protection in nuclear medicine, prevention of medical accidents)
5	Equipment performance evaluation and safety implementation maintenance inspection (γ -camera and SPECT)
6	Equipment performance evaluation and safety implementation maintenance inspection (PET)
7	Midterm examination (range, first to sixth lectures)
8	γ -camera examination (cerebral nervous system; cerebral blood flow scintigraphy)
9	γ -camera examination (cerebral nervous system; nerve receptors and cerebrospinal cavity scintigraphy)
10	γ -camera examination (cardiovascular system; myocardial perfusion scintigraphy)
11	γ -camera examination (cardiovascular system; analysis method, electrocardiogram synchronization SPECT, and quantitative gated SPECT)
12	γ -camera examination (cardiovascular system; exercise load and resting myocardial blood flow SPECT and cardiac pool scintigraphy)
13	γ -camera examination (cardiovascular system; myocardial fatty acid metabolism, myocardial sympathetic nerve, and myocardial pyrophosphate scintigraphy)
14	New examination method for neurodegenerative diseases

Survey Question 4 (Advantages and Disadvantages of Remote Lectures)

We asked the participants to indicate the advantageous aspects (Table 3) of remote lectures and the disadvantages (Table 4). Six faculty members considered the choice of advantages and disadvantages and presented them to the students.

Survey Question 5 (Evaluation of Remote Lectures)

We investigated the preference for future face-to-face or remote lectures. We used a free-description field to obtain impressions about taking remote lectures.

RESULTS

The questionnaire response rate was 99.1%. There were 115 respondents: 69 men and 46 women (age, 20.7 ± 1.2 y).

Survey Question 1 (Satisfaction)

Figure 1 shows the results of the 5-point evaluation scale for satisfaction, comprehension, concentration, preparation, reviewing, and the question environment for face-to-face and remote lectures. Satisfaction scores for face-to-face

TABLE 3
Advantages of Remote Lectures

Advantage no.	Description
1	I do not have to travel to university
2	I can take lectures while relaxing
3	I am able to cover all lecture content
4	I can study at my own pace
5	Online environment makes it easy to look up unknown terms
6	It is easy to concentrate on lecture content because of absence of other students
7	A high learning effect can be achieved
8	It is easier to study with remote lectures than from books
9	Lectures are like watching YouTube, which makes studying easy
10	None

and remote lectures were 3.30 ± 0.72 and 3.36 ± 0.88 , respectively. Comprehension scores for face-to-face and remote lectures were 3.30 ± 0.71 and 3.30 ± 0.83 , respectively. Concentration scores for face-to-face and remote lectures were 3.50 ± 0.69 and 3.05 ± 0.90 , respectively. Preparation scores for face-to-face and remote lectures were 2.57 ± 0.88 and 2.67 ± 0.94 , respectively. Reviewing scores for face-to-face and remote lectures were 2.84 ± 0.85 and 3.39 ± 0.89 , respectively. Question environment scores for face-to-face and remote lectures were 2.94 ± 0.90 and 3.43 ± 0.84 , respectively. There were no significant differences between face-to-face and remote lectures in terms of satisfaction, comprehension, or preparation. There were significant differences between face-to-face and remote lectures in terms of concentration, reviewing, and the question environment ($P < 0.001$).

Survey Question 2 (Lectures That Could Be Taken Remotely)

Figure 2 presents the results for face-to-face lectures that could be replaced by remote ones. The numbers of participants

TABLE 4
Disadvantages of Remote Lectures

Disadvantage no.	Description
1	It is difficult to follow lectures if communication environment is poor
2	I cannot study with my friends
3	Logging in can be a problem
4	It is hard to hear what is being said
5	I am not motivated by remote lectures
6	It is easy to not try to understand if there is something you do not understand
7	Learning effect is low
8	They are harder to understand than face-to-face lectures
9	I am unable to ask questions
10	Screen is difficult to see properly
11	None

who believed that face-to-face lectures could be replaced by remote ones were as follows: 93 for the first and second lectures; 67 for the third; 65 for the fourth; 65 for the fifth; 60 for the sixth; 65 for the seventh; 66 for the eighth; 61 for the ninth; 59 for the 10th; 57 for the 11th; 56 for the 12th; 56 for the 13th; and 59 for the 14th.

Survey Question 3 (Good Remote Lectures)

Figure 3 shows the results for participants who believed remote lectures to be effective. The numbers of participants who believed remote lectures to be good were as follows: 79 for the first and second lectures; 62 for the third; 62 for the fourth; 54 for the fifth; 53 for the sixth; 56 for the seventh; 57 for the eighth; 57 for the ninth; 56 for the 10th; 50 for the 11th; 53 for the 12th; 53 for the 13th; and 54 for the 14th.

Survey Question 4 (Advantages and Disadvantages of Remote Lectures)

Figure 4 presents the results relating to the advantages of remote lectures. The numbers of participants who believed such lectures to be advantageous were as follows: 109 for the first lecture; 79 for the second; 74 for the third; 57 for the fourth; 50 for the fifth; 42 for the sixth; 23 for the seventh; 19 for the eighth; 17 for the ninth; and 0 for the 10th. The above numbers are defined in Table 3. Figure 5 shows the results relating to the disadvantages of remote lectures. The number of participants who considered such lectures to be disadvantageous were as follows: 57 for the first lecture; 47 for the second; 38 for the third; 32 for the fourth; 31 for the fifth; 19 for the sixth; 17 for the seventh; 15 for the eighth; 12 for the ninth; 12 for the 10th; and 7 for the 11th. The above numbers are defined in Table 4.

Survey Question 5 (Evaluation of Remote Lectures)

Figure 6 shows the results relating to the preference for future face-to-face or remote lectures. In all, 31 participants stated they would choose face-to-face lectures; 84 responded that they would choose remote lectures. Positive comments about taking remote lectures were as follows: “Questions are asked using chat, so you can ask questions without worrying about the people around you”; “You can review the lesson if you are not going to school”; “I could concentrate on the lecture because I was able to get more sleep time by not going to school”; “I could use my time effectively”; and “I could watch the videos easily on the computer.” Negative comments about taking remote lectures were as follows: “It is easy to skip lectures”; “The lecturer cannot see the students’ facial expressions, so it is hard for the lecturer to tell whether the student is properly understanding the content.”

DISCUSSION

In this study, we analyzed postlecture questionnaires relating to face-to-face and remote formats in Nuclear Medicine Technology Examination courses. We examined the educational effect of teaching using remote lectures.

In the satisfaction survey, we observed no difference (nonsignificant) between face-to-face and remote lectures

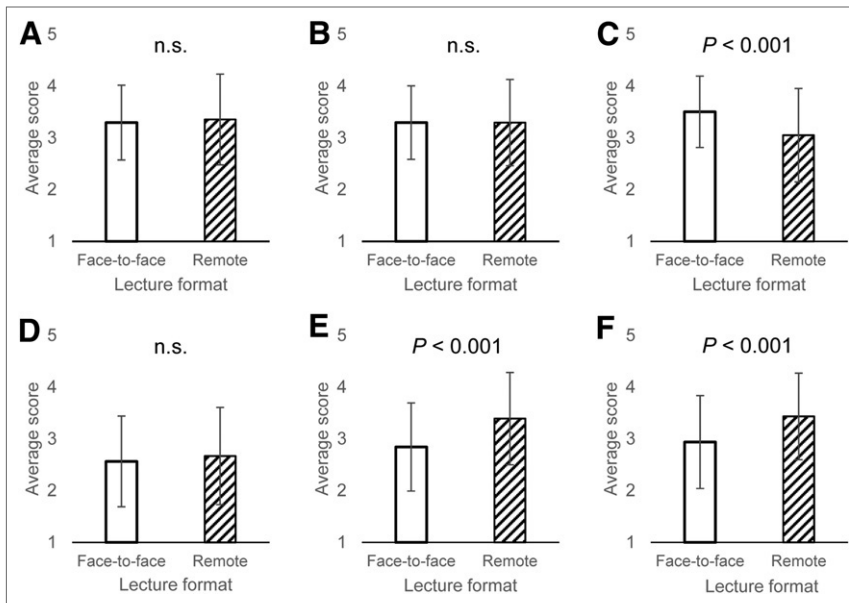


FIGURE 1. Results of evaluation of satisfaction (A), comprehension (B), concentration (C), preparation (D), reviewing (E), and question environment (F) on 5-point scale for face-to-face and remote lectures. We used Mann–Whitney *U* test for statistical analysis to compare lecture formats. n.s. = not significant.

in terms of satisfaction and comprehension. For the participants, the learning effect of remote lectures was comparable to that of face-to-face lectures. However, educational strategies used for face-to-face lectures cannot be applied to remote ones (6). For example, with face-to-face lectures, it is possible to ask students questions on an individual basis or conduct small tests. To improve the quality of remote education in the present study, we devised ways to give more tasks than with face-to-face lectures, and we encouraged students to ask questions using the chat function. In that way, the remote lectures could provide participants with the same level of satisfaction and understanding as in a face-to-face format.

With regard to concentration, however, remote lectures were inferior to face-to-face ones. We believe that because of the absence of other students and lecturers in the remote

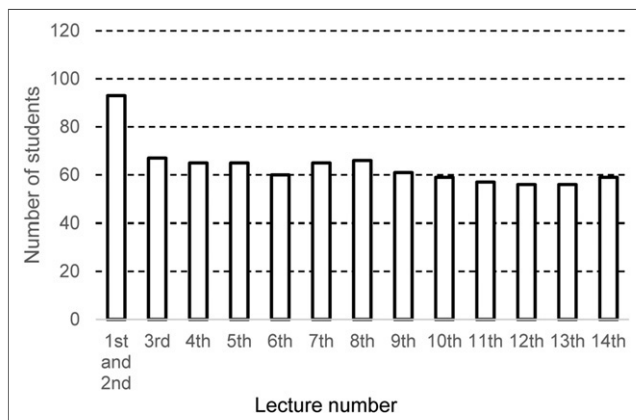


FIGURE 2. Survey results relating to face-to-face lectures being replaced by remote lectures.

format, there was less tension: students at home were able to relax. With the remote lectures, the participants were asked to take part without displaying their own image on the computer screen. The school did this because of possible invasion of privacy in terms of the students' home environment appearing on other people's screens. To enhance concentration in future remote lectures, it may be necessary for the students to be visually involved. Further, increasing the number of questions asked of students by teachers during the lecture should help decrease tension and improve concentration.

Regarding preparation, we observed no difference (nonsignificant) between face-to-face and remote lectures. With respect to reviewing, remote lectures were considered superior to face-to-face ones ($P < 0.001$). As some participants noted in the free description, the remote lectures were considered

superior because the time gained by not traveling to the university could be used for reviewing. For some students, that time can amount to 3–4 h a day. We believe that increasing study time by offering remote lectures offers considerable advantages for students.

With respect to the question environment, we found that remote lectures were superior to face-to-face ones, mainly because of the chat function, which is executed remotely. The Department of Radiation Technology has over 100 students each year, and they all take the same lectures. With face-to-face lectures, shy students cannot easily ask questions. But since the remote lectures use chat, it is possible to ask questions away from the gaze of other students. In the free description, this feature was stated as a positive factor and a considerable advantage of remote lectures.

With the face-to-face lectures for Nuclear Medicine Technology Examination 1, 93 participants stated that the first and second lectures should be conducted remotely. For the remote lectures of Nuclear Medicine Technology Examination 2, 79 students responded that the first and second lectures should be held remotely. To prepare for studying nuclear medicine examinations, those first and second lectures cover orientation and the basics of radiation. Thus, we believe that remote lectures are suitable there. With other lectures, about half the participants found the remote format superior. However, about half the students considered face-to-face lectures to be preferable. Thus, the Nuclear Medicine Technology Examination lectures may be held in either format. We expected that there would be a difference in the results between lectures related to technical explanations of nuclear medicine and those about clinical examinations. But regardless of the lecture content in Nuclear Medicine Technology Examination

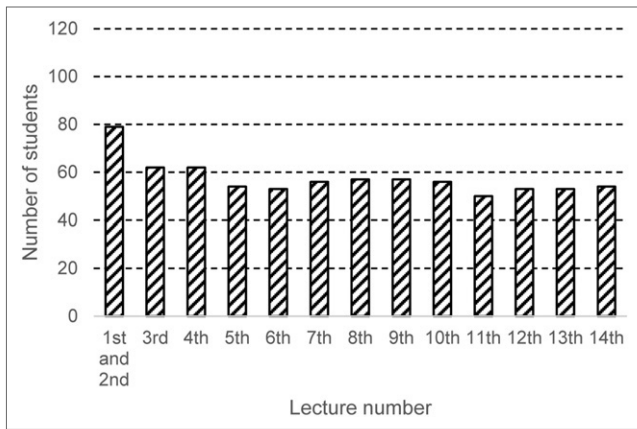


FIGURE 3. Survey results relating to effectiveness of remote lectures.

courses, the same educational effect could be achieved with both face-to-face and remote lectures.

Regarding the advantages of remote lectures, the following items were indicated by over half the participants: “Do not have to travel to university”; “I can take lectures while relaxing;” “I am able to cover all the lecture content”; and “I can study at my own pace.” Remote lectures do offer many advantages in not having to travel to the university.

The only disadvantage of remote lectures indicated by over half the participants was “It is difficult to follow lectures if the communication environment is poor.” If the Wi-Fi connection is bad, it may not be possible to communicate: students may be unable to see the video or hear their own voice. Previous research has found that computer and network malfunctions may discourage both instructors and students from remote learning (7). Network problems are the chief issue with remote lectures. However, the Zoom software used in the present study has a recording function. We believe it can be possible to overcome this problem if students with a poor communication environment watch the recordings of the lectures at a later date. In the free description, there was also a negative comment about the instructor

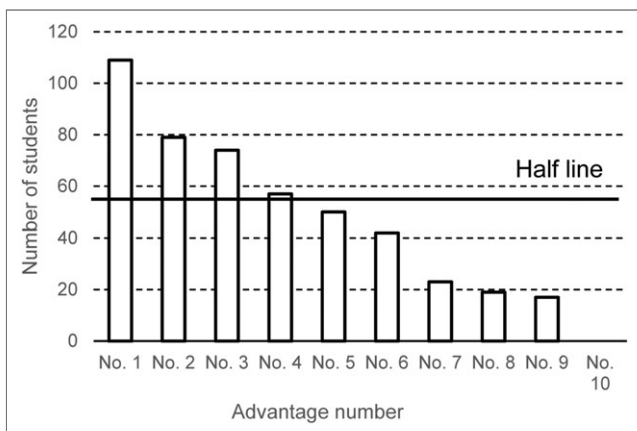


FIGURE 4. Advantages of remote lectures; half-line indicates half total number of participants.

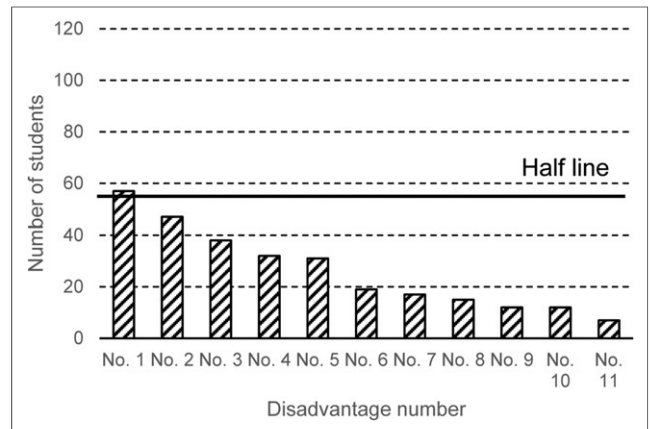


FIGURE 5. Disadvantages of remote lectures; half-line indicates half total number of participants.

being unable to see the students’ facial expressions and so having difficulty in gauging whether students were properly understanding. To address this issue, as noted above, it may be necessary for students taking lectures to visually participate while taking privacy into consideration. Seven students stated that there were no disadvantages to remote lectures.

Compared with participants citing the advantages of remote lectures, the number that found disadvantages was relatively small. Given a choice between face-to-face and remote lectures in the future, 84 students would choose the latter. Because of all the advantages, the students found remote learning to be highly effective.

From the above results, remote lectures evidently had a strong educational effect among the participants taking the Nuclear Medicine Technology Examination courses. Such lectures are necessary to reduce physical contact among students and prevent the spread of COVID-19 (8). Other research has found that distance learning will expand in the future (9). We agree with that conclusion. Remote learning is necessary to prevent the spread of COVID-19. The present study has demonstrated that because of the threat of COVID-19, remote lectures can be used to provide high-quality education and train radiologic technologists in the same way as conventional face-to-face lectures.

It is necessary, however, to regard face-to-face lectures, rather than remote ones, as the primary option. The reason is that if all lectures were conducted remotely, students would not have the opportunity to physically go to the

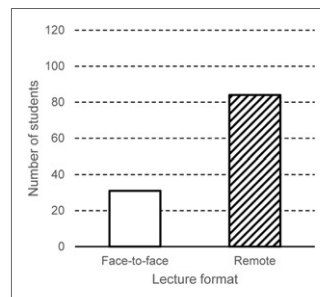


FIGURE 6. Preference for future face-to-face or remote lectures.

university. Studying at a university allows students to talk with their peers and develop communication skills. Attending college can be fun. Students can undertake club activities at the university and hone various skills toward becoming full members of society. Faculty members desire that their students should become quality members of society. Thus, even if COVID-19 soon comes to an end, not all lectures should be conducted remotely: both face-to-face and remote lectures should be used. We believe that in the future, distance learning will become increasingly legitimized as an educational tool. Through this paper, we hope that instructors involved in nuclear medicine examinations and those involved in other areas of education will appreciate the advantages of remote lectures and consider their use. Although remote lectures are continuing, we think it is necessary for students to hold Zoom study sessions or meetups by themselves to improve their communication skills.

This study dealt with technology related to nuclear medicine examinations; in the future, we aim to assess the educational effect of remote lectures in other subject areas. In one investigation, medical students conducted hands-on training for ultrasonic examinations remotely (10). In our department, we are planning to use remote learning for hands-on training for nuclear medicine examinations; thus, we intend to continue investigating the usefulness of such learning.

CONCLUSION

We observed no difference among the participants regarding satisfaction and comprehension between face-to-face and remote lectures for Nuclear Medicine Technology Examination courses. Thus, remote lectures can offer educational effectiveness and are not inferior to face-to-face learning. However, face-to-face lectures should be prioritized

over remote lectures. The additional benefits of attending college lead to the development of relationships and improved communication skills through participation in various opportunities such as nonacademic clubs or societies. We believe that remote lectures should be considered an educational tool for students.

DISCLOSURE

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

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