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Educational effect of remote lectures for students aiming to become radiological technologists: Questionnaire on nuclear medicine examinations

Short Title: Educational effect of remote lectures

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Educational effect of remote lectures

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Abstract

In the latter half of 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 analyzes post-lecture questionnaire responses regarding face-to-face and remote teaching in the subject of Nuclear Medicine Examination Technology. We examine the educational effect of using remote lectures. **Methods:** We conducted a questionnaire survey among students by means of a five-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 standard deviations. 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, and 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 post-lecture questionnaire responses for face-to-face and remote formats in Nuclear Medicine Examination Technology showed that remote lectures have a strong educational effect. We believe that, in future, remote lectures should be considered as a tool in student education.

Key words: remote lecture, face-to-face lecture, educational effect, COVID-19

Introduction

In the latter half of 2019, COVID-19 began spreading worldwide. Patients infected with COVID-19 may suffer worsening symptoms: they can have difficulty breathing, and death may result. COVID-19 is a very dangerous infectious disease (*1*). The infection route of COVID-19 is believed to be droplet and contact infection (*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 "three Cs" has been promoted: eschewing closed spaces, crowded places, and close-contact settings (*5*).

To prevent infection, Suzuka University of Medical Sciences stopped students attending university from late March to late June 2020. Thus, face-to-face lectures have not been held at the university since April. If lectures were canceled that would impede the students' study, so the university has 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 of holding remote lectures, and their educational effect was unknown. One course offered at the university is Nuclear Medicine Examination Technology. It comprises three lecture courses run by the Department of Radiological Technology Science: the second half of the 2nd year covers Nuclear Medicine Examination

Technology I; the first half of the 3rd year covers Nuclear Medicine Examination Technology II; and the second half of the 3rd year covers Nuclear Medicine Examination Technology III. In 2020, 3rd-year students took face-to-face lectures in Nuclear Medicine Examination Technology I and remote lectures in Nuclear Medicine Examination Technology II. Thus, 3rd-year students experienced both face-to-face and remote lectures in Nuclear Medicine Examination Technology. In this study, we evaluated the educational effect of remote lectures in Nuclear Medicine Examination Technology among 3rd-year students. We analyzed the results of post-lecture questionnaires with face-to-face and remote teaching in Nuclear Medicine Examination Technology and evaluated the educational effect of remote lectures.

Materials and Methods

Participants

The participants were 3rd-year students at the Department of Radiation Technology Science of Suzuka University of Medical Sciences who took face-to-face lectures in Nuclear Medicine Examination Technology I and remote lectures in Nuclear Medicine Examination Technology II in 2020. The remote lectures were held using Zoom (Zoom Video Communications, San Jose, USA).

Judging Committee of Suzuka University of Medical Sciences (IRB or equivalent) approved this study and all subjects signed a written informed consent.

Questionnaire Survey 1 (Satisfaction)

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

Questionnaire Survey 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.

Questionnaire Survey 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.

Questionnaire Survey 4 (Advantages and Disadvantages of Remote Lectures)

We examined the advantages of remote lectures (Table 3). We asked the participants to indicate the advantageous aspects of remote lectures. We did the same for disadvantages (Table 4). We asked the participants to indicate the disadvantages of remote lectures. Six faculty members of the Department of Radiation Technology Science assessed the advantages and disadvantages of remote lectures.

Questionnaire Survey 5 (Evaluation of Remote Lectures)

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

Results

The questionnaire response rate was 99.1%. There were 115 respondents: 69 males, 46 females (age, 20.7 ± 1.2 years).

Questionnaire Survey 1 (Satisfaction)

Figure 1 shows the results of the five-point evaluation scale of satisfaction, comprehension, concentration, preparation, reviewing, and the question environment for face-to-face and remote lectures. Satisfaction scores for face-to-face 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, and preparation. There were significant differences between face-to-face and remote lectures in terms of concentration, reviewing, and the question environment ($P < 0.001$).

Questionnaire Survey 2 (Lectures That Could Be Taken Remotely)

Figure 2 presents the results for face-to-face lectures that can be replaced by remote ones. The numbers of participants who believed that face-to-face lectures could be replaced by remote ones were as follows: 93 for the 1st and 2nd lectures; 67 for the 3rd lecture; 65 for the 4th; 65 for the 5th; 60 for the 6th; 65 for the 7th; 66 for the 8th; 61 for the 9th; 59 for the 10th; 57 for the 11th; 56 for the 12th; 56 for the 13th; and 59 for the 14th.

Questionnaire Survey 3 (Good Remote Lectures)

Figure 3 shows the results for participants who believed remote lectures to be effective. The numbers of participants who believe remote lectures to be good were as follows: 79 for the 1st and 2nd lectures; 62 for the 3rd lecture; 62 for the 4th; 54 for the 5th; 53 for the 6th; 56 for the 7th; 57 for the 8th; 57 for the 9th; 56 for the 10th; 50 for the 11th; 53 for the 12th; 53 for the 13th; and 54 for the 14th.

Questionnaire Survey 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 No. 1; 79 for

No. 2; 74 for No. 3; 57 for No. 4; 50 for No. 5; 42 for No. 6; 23 for No. 7; 19 for No. 8; 17 for No. 9; and 0 for No. 10. 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 No. 1; 47 for No. 2; 38 for No. 3; 32 for No. 4; 31 for No. 5; 19 for No. 6; 17 for No. 7; 15 for No. 8; 12 for No. 9; 12 for No. 10; and 7 for No. 11. The above numbers are defined in Table 4.

Questionnaire Survey 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 aren’t 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’s easy to skip lectures”; “The lecturer can’t see the students’ facial expressions, so it’s hard for the lecturer to tell whether the student is properly

understanding the content.”

Discussion

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

In the satisfaction survey, we observed no difference (non-significant) between face-to-face and remote lectures 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 owing to the absence of other students and lecturers in the remote format, there

was 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. We did this due to 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 increase tension and improve concentration.

Regarding preparation, we observed no difference (non-significant) 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, that was because the time gained by not traveling to university could be used for reviewing. For some students, that time can amount to 3–4 hours 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. That was mainly attributable to the chat function, which is executed remotely. The Department of Radiation Technology has over 100 students in 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 was stated as a positive factor and a considerable advantage of remote lectures.

With the face-to-face lectures for Nuclear Medicine Examination Technology I, 93 participants stated that the 1st and 2nd lectures should be conducted remotely. For the remote lectures of Nuclear Medicine Examination Technology II, 79 students responded that the 1st and 2nd lectures should be held remotely. To prepare for studying nuclear medicine examinations, those 1st and 2nd 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 that face-to-face lectures were preferable. Thus, the Nuclear Medicine Examination Technology 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 Examination Technology, 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: “Don’t have to travel to university”; “I can take lectures while relaxing;” “I’m 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 university.

The only disadvantage of remote lectures indicated by over half the participants was “It’s 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 by students with a poor communication environment watching the recordings of the lectures at a later date. In the free description, there was also a negative comment about the instructor 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 with 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. Owing to 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 studying Nuclear Medicine Examination Technology. 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 owing to the threat of COVID-19, remote lectures can be used to provide high-quality education and train radiological 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 university. Studying at university allows students to talk with their peers and develop communication skills. Attending college can result in a fun life. Students can undertake club activities at 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 considered 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. While remote lectures are continuing, we think it is necessary for students to hold zoom study sessions or meetups by themselves in order to improve their communication skills, etc.

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 in Nuclear Medicine Examination Technology. Thus, remote lectures can offer educational effectiveness and are not inferior to face-to-face learning. However, lectures should prioritize face-to-face lectures over remote lectures. The additional benefits of attending college lead to the development of relationships and improved communication skills through

participation in Various activity opportunities such as engaging in non-academic clubs / societies or other enriching activities. We believe that remote lectures should be considered as an educational tool for students.

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Disclosure

The authors have no conflicts of interest to declare.

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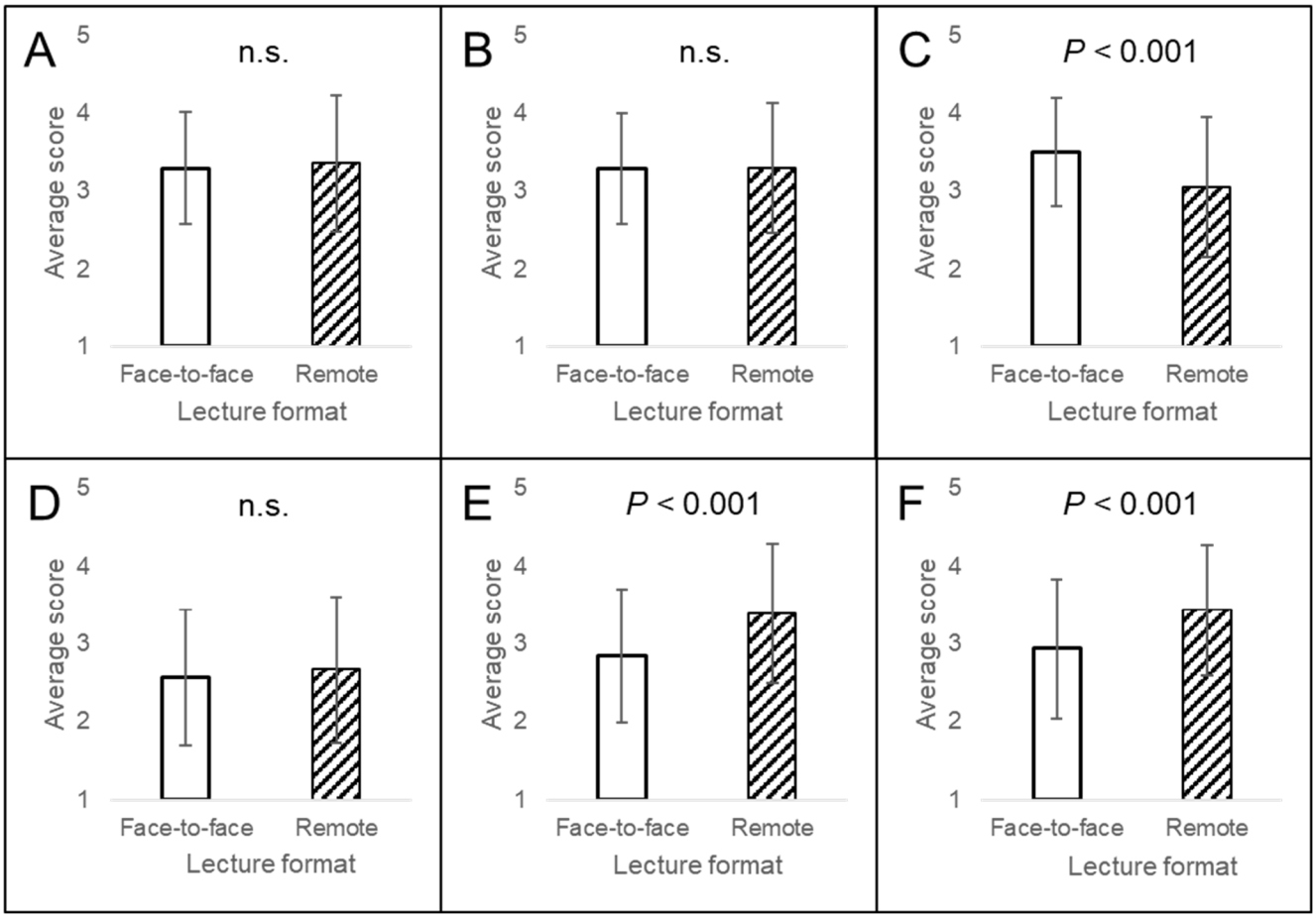

FIGURE 1. Results of evaluation of satisfaction, comprehension, concentration, preparation, reviewing, and the question environment on a five-point evaluation scale for face-to-face and remote lectures. We used the Mann-Whitney *U* test for statistical analysis to compare the lecture formats. (A) satisfaction;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

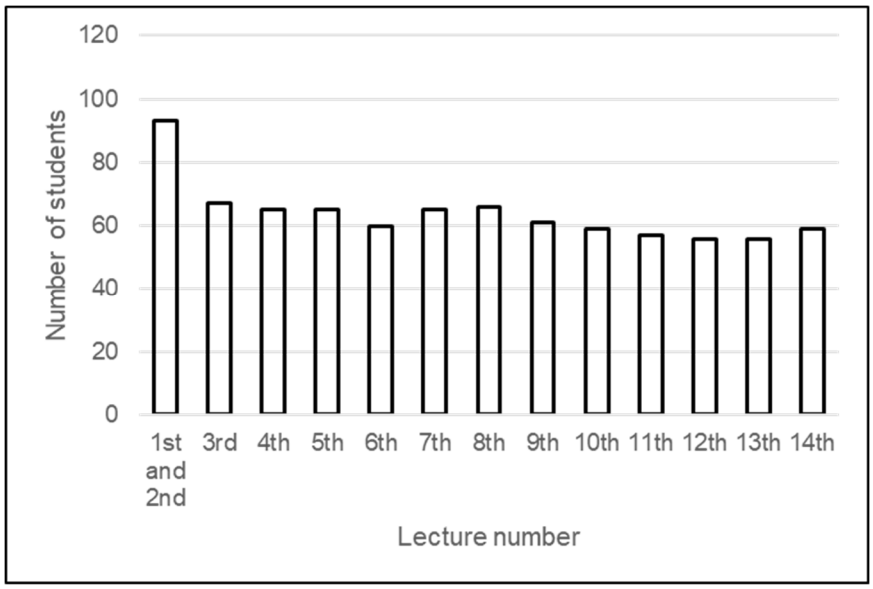

FIGURE 2. Survey results relating to face-to-face lectures being replaced by remote lectures

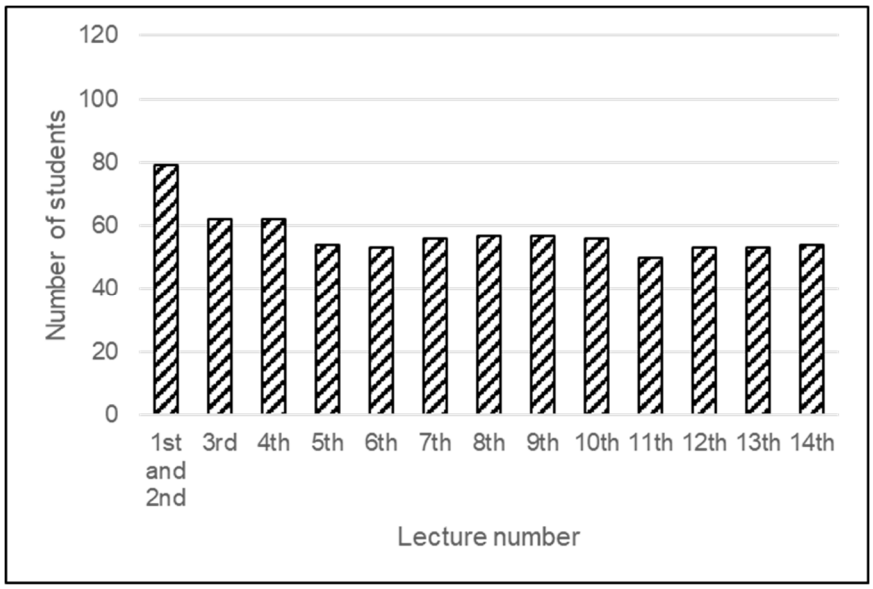

FIGURE 3. Survey results relating to the effectiveness of remote lectures

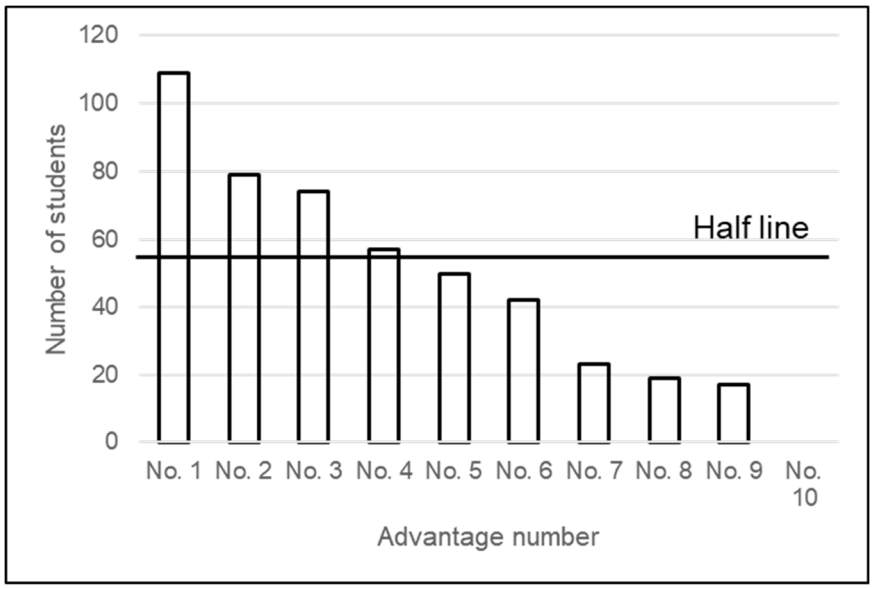

FIGURE 4. Advantages of remote lectures; the half-line indicates half the total number of participants

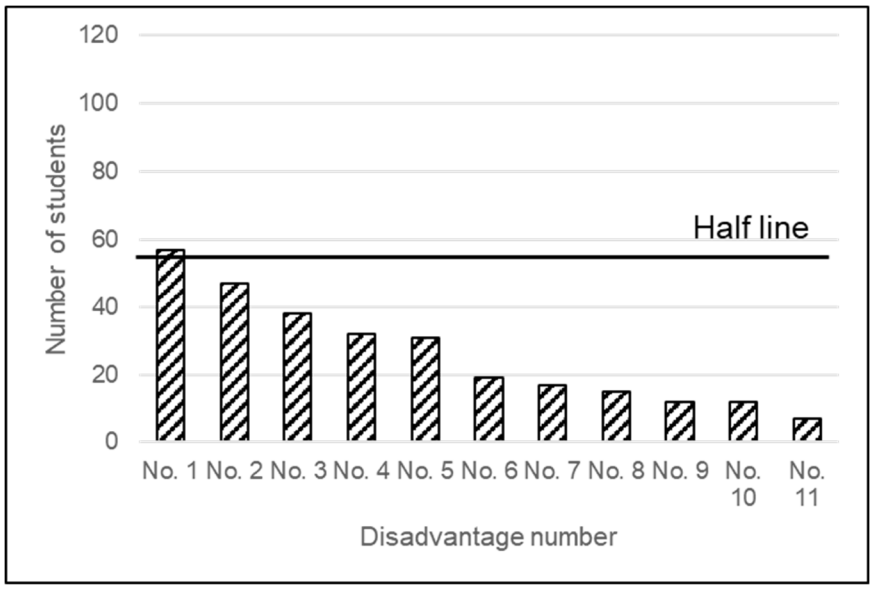

FIGURE 5. Disadvantages of remote lectures; the half-line indicates half the total number of participants

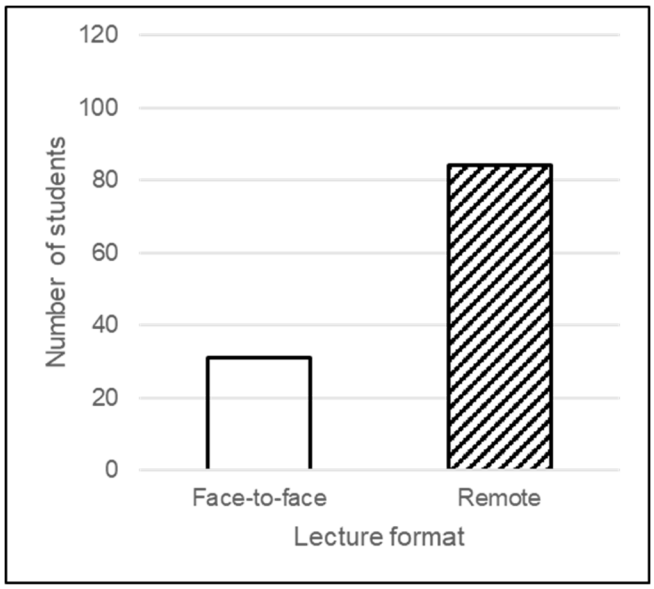

FIGURE 6. Preference for future face-to-face or remote lectures

TABLE 1. Titles of the face-to-face lectures

Titles of face-to-face lectures in Nuclear Medicine Examination Technology I	
1st 2nd	Nuclear medicine examination; what is a radio isotope?
3rd	About radiopharmaceuticals, single photons, in vitro examination, and positrons
4th	In vivo examination system, Section 1
5th	In vivo examination system, Section 2
6th	Other nuclear medicine examination equipment
7th	PET (PET / CT) equipment, Section 1
8th	PET (PET / CT) equipment, Section 2
9th	Equipment related to PET (cyclotron, synthesis of radiopharmaceuticals, automatic quality control equipment, and hot cells)
10th	Imaging technology (characteristics of nuclear medicine imaging)
11th	Image processing
12th	SPECT image reconstruction
13th	Various SPECT correction methods (scattering correction and attenuation correction)
14th	Various SPECT correction methods (non-uniform absorber correction, position resolution correction, and various PET corrections)

PET, positron emission tomography; PET/CT: positron emission tomography/computed

tomography; SPECT, single photon emission computed tomography

TABLE 2. Titles of the remote lectures

Titles of remote lectures in Nuclear Medicine Examination Technology II	
1st	Artifacts, dynamic function test analysis method, image display, and image output
2nd	
3rd	Safety management laws (nuclear medicine practice and the law)
4th	Safety management laws (radiation protection in nuclear medicine, prevention of medical accidents)
5th	Equipment performance evaluation and safety implementation maintenance inspection (gamma camera and SPECT)
6th	Equipment performance evaluation and safety implementation maintenance inspection (PET)
7th	Mid-term examination (range, 1st to 6th lectures)
8th	Gamma camera examination (cerebral nervous system; cerebral blood flow scintigraphy)
9th	Gamma camera examination (cerebral nervous system; nerve receptors and cerebrospinal cavity scintigraphy)
10th	Gamma camera examination (cardiovascular system; myocardial perfusion scintigraphy)
11th	Gamma camera examination (cardiovascular system; analysis method, electrocardiogram synchronization SPECT, and QGS)
12th	Gamma camera examination (cardiovascular system; exercise load and resting myocardial blood flow SPECT, and cardiac pool scintigraphy)
13th	Gamma camera examination (cardiovascular system; myocardial fatty acid metabolism, myocardial sympathetic nerve, and myocardial pyrophosphate scintigraphy)
14th	New examination method for neurodegenerative diseases

SPECT, single photon emission computed tomography; PET, positron emission tomography;

QGS, quantitative gated SPECT

TABLE 3. Advantages of remote lectures

Advantages of remote lectures	
No. 1	Don’t have to travel to university
No. 2	I can take lectures while relaxing
No. 3	I’m able to cover all the lecture content
No. 4	I can study at my own pace
No. 5	The online environment makes it easy to look up unknown terms
No. 6	It is easy to concentrate on the lecture content owing to the absence of other students
No. 7	A high learning effect can be achieved
No. 8	It is easier to study with remote lectures rather than from books
No. 9	The lectures are like watching YouTube, which makes studying easy
No. 10	None

TABLE 4. Disadvantages of remote lectures

Disadvantages of remote lectures	
No. 1	It’s difficult to follow lectures if the communication environment is poor
No. 2	I can’t study with my friends
No. 3	Logging in can be a problem
No. 4	It is hard to hear what is being said
No. 5	I’m not motivated with remote lectures
No. 6	It’s easy to leave off if there’s something you don’t understand
No. 7	The learning effect is low
No. 8	They are harder to understand than face-to-face lectures
No. 9	I’m unable to ask questions
No. 10	The screen is difficult to see properly
No. 11	None