

## Title page

### Original research (imaging)

1. Changing methods of education during a pandemic: questionnaire survey about examinations for nuclear medicine technology at educational institutions in Japan

2. Short Title: Survey on changes in educational format

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10. This study is not human or animal studies, and is not a questionnaire survey that includes personal information of students. In addition, we are investigating the questionnaire anonymously, and we cannot determine the individual. Therefore, it was decided that permission from the Ethics Committee of Suzuka University of Medical Sciences was not required.

## **Abstract**

Rationale: COVID-19 has spread around the world. Its effects go far beyond health care: education has to be conducted so as to prevent infection among students and faculty. Accordingly, changes have occurred in Japan's educational institutions, including methods related to examinations for nuclear medicine. To assess the quality of training for radiological technologists, we investigated the related changes undertaken at educational institutions. We investigated the lecture format for teaching nuclear medicine technology at Japanese institutions during COVID-19 and also efforts to ensure the quality of conventional education.

Methods: We sent a questionnaire to 19 Japanese institutions. It addressed the lecture format and initiatives in examinations for nuclear medicine technology in the first and second semesters of 2020.

Results: We obtained responses from 17 institutions. In the first semester of 2020, the lecture format for nuclear medicine technology included remote, hybrid (combination of remote and face-to-face), and video-on-demand lectures. To reinforce the effect of the new teaching formats, institutions adopted various methods, such as enhancing the possibility for students to ask questions, increasing the number of quizzes during lectures, delivering lectures to YouTube, and introducing an e-learning system. In the second semester of 2020, the lecture format included face-to-face, remote, hybrid, and video-on-demand lectures. In that second semester, the number of

institutions providing face-to-face lectures while taking thorough measures against infection showed a marked increase.

**Conclusion:** The institutions introduced various educational techniques and initiatives. They prioritized students' understanding of lecture content and applied what they considered the best teaching methods. Sharing information about the changes adopted at different institutions should help promote good radiological technologists—even during a pandemic.

**Key words:** lecture format, infection control, initiatives and new approaches, student education in COVID-19

## Introduction

COVID-19 has given an impact in medicine and in education. In many educational institutions, lectures have changed from a traditional face-to-face to remote or hybrid formats; the latter is a combination of face-to-face and remote lectures to hinder COVID-19 infection (1-5). Teaching has to be undertaken so as to prevent infection among students and faculty. Accordingly, changes have taken place in teaching at Japan's educational institutions, including teaching related to examinations for nuclear medicine technology. The examinations for nuclear medicine technology at university in Japan has traditionally been a face-to-face lecture. Face-to-face lectures are adopted because teachers can proceed with the lecture while visually observing the level of understanding and satisfaction of students. However, due to the spread of COVID-19, Suzuka University of Medical Science has shifted from face-to-face lectures to remote and hybrid formats from 2020. The usefulness of remote lectures has been cited (2, 5-7). It is also reported that remote lectures are becoming the standard for lectures in the future (8).

In a previous study, we obtained information from students using a questionnaire survey about their degree of understanding and satisfaction with remote lectures related to examinations for nuclear medicine technology. In that study, we reported very high levels of understanding and satisfaction with that remote format (1). To ensure the ongoing quality of training for radiological technologists, we determined in the present study the changes that had taken place in educational

methods at different institutions. We wanted to share information about the educational methods adopted by the institutions and investigate efforts toward infection control for promoting high-quality medical personnel. We investigated the lecture format for teaching nuclear medicine technology at Japanese institutions during COVID-19 and also efforts to ensure the quality of conventional education.

## **Materials and Methods**

### **Questionnaire requests**

We asked the lecturers responsible for setting examinations for nuclear medicine technology at 19 educational institutions in Japan to complete the questionnaire. We randomly selected those 19 institutions among all educational institutions teaching nuclear medicine technology in Japan. We requested that the questionnaire be completed between December 2020 and February 2021.

### **Questionnaire content**

For the first and second semesters of 2020, we requested that the lecturers provided information about the lecture format prior to examinations for nuclear medicine technology and the assessment method for assigning grades. We asked the participants to provide free descriptions about initiatives and methods for preventing infection. We inquired about the lecture formats participants

found most appropriate during COVID-19 and their reasons for choosing them. In Japan, the first semester is from April to September and the second from October to March.

## **Results**

### **Questionnaire response rate**

In all, 17 institutions completed the questionnaire; two did not.

### **Lecture format in first semester of 2020**

Figure 1 shows the results regarding lecture format for the first semester of 2020. Figure 1A indicates the lecture format for that first semester, and Figure 1B presents the results according to the number of students in each class. One participant was not responsible for teaching nuclear medicine in that first semester; thus, Figure 1 displays the data for the other 16 institutions. For the same reason with later results, similarly, Figures 2–4 show data from 16 institutions. Figure 1A indicates that the numbers of institutions that provided the lectures in remote, hybrid, video-on-demand, and other formats were eight, five, one, and two, respectively. The other formats were a mixture of face-to-face, remote, and video-on-demand lectures (one institution) and a mixture of face-to-face and video-on-demand lectures (one institution). No institutions held only face-to-face lectures. Figure 1B indicates that many remote lectures were held at institutions where the number



of students in each class was either small or large. Most of the institutions with classes of 51 to 100 students offered hybrid lectures.

### **Regular examinations in first semester of 2020**

Figure 2 shows the results regarding the methods for regular examinations (assessment methods for assigning grades) in the first semester of 2020. Figure 2A presents details of the regular examination methods for that semester, and Figure 2B indicates the regular examination methods classified by lecture format. Figure 2A shows that the numbers of institutions that held regular examination in face-to-face, remote, reports, face-to-face plus computer-based testing, face-to-face plus reports, remote plus reports, and reports plus a little testing formats were nine, one, two, one, one, one, and one, respectively. Figure 2B indicates that when the lectures were held remotely, various examination methods were adopted to prevent infection.

### **Lecture format in second semester of 2020**

Figure 3 shows the results regarding the lecture format in the second semester of 2020. Figure 3A presents details of the format in that semester, and Figure 3B shows the results according to number of students per class. Figure 3A indicates that the numbers of institutions that held face-to-face, remote, hybrid, and other lecture formats were seven, three, five, and one, respectively. The other

lecture format, adopted by one institution was a mixture of face-to-face and video-on-demand.

Figure 3B shows that there was no difference in the lecture format according to the number of students. Some institutions held face-to-face lectures regardless of the number of students.

### **Regular examination in the second semester of 2020**

Figure 4 shows the results for regular examinations (assessment method for assigning grades) for the second semester of 2020. Figure 4A presents the findings for regular examination methods in that semester, and Figure 4B show the results for regular examination methods according to lecture format. Figure 4A shows that the numbers of institutions adopted face-to-face, remote, remote plus reports, and reports plus a little testing were thirteen, one, one, and one, respectively. There was a clear increase in the number of face-to-face examinations.

### **Free description of initiatives and approaches**

Table 1 presents the results related to initiatives and new approaches at the institutions. The comments relate to free descriptions obtained in the questionnaire responses. We obtained many comments about new approaches to infection control. Regarding remote and video-on-demand lectures, there were many comments about improving student understanding. With respect to hybrid lectures, many comments related to reducing the number of class days.

## **Most suitable lecture format during COVID-19**

Figure 5 shows the results related to the optimal lecture format during the pandemic. The numbers of institutions that chose face-to-face, remote, and hybrid lectures were seven, four, and six schools, respectively. Some of the reasons for selecting face-to-face lectures were as follows: they facilitate confirmation of students' understanding; the risk of infection is higher off than on campus; by attending lectures while taking measures against infection, students become more aware of such measures. Some of the reasons for choosing remote lectures were as follows: they prevent infection among faculty and students; the quality of conventional education can be guaranteed when designing the content of remote lectures. One of the reasons for selecting hybrid lectures was that face-to-face lectures are also necessary because remote lectures may not monitor student achievement in real time.

## **Discussion**

In this study, we investigated the lecture format with respect to teaching nuclear medicine technology prior to examinations at Japanese educational institutions during COVID-19. We also examined novel efforts to ensure the quality of conventional educational approaches and measures to achieve infection control.

We found that the methods adopted by the surveyed institutions changed significantly as a result of the pandemic. In the first semester of 2020, none of the institutions undertook face-to-face lectures: they switched to such formats as remote or hybrid lectures. The spread of COVID-19 caused the Japanese government to declare a state of emergency during April and May 2020. As a result, Japan's residents were asked to avoid unnecessary outings and maintain social distance (9).

In the first semester of 2020, remote and hybrid lecture formats were introduced toward controlling the infection. We observed that educational institutions with few students in classes tended to opt for remote lectures. Accordingly, the small class sizes meant that students could communicate and interact with lecturers remotely. In that way, lecturers were able to assess the learning levels of each student, which supported the remote lecture strategy.

Institutions with many students in each class provided remote and video-on-demand lectures, which meant that students did not have to attend in person. To prevent clustering in the case of large classes, the studied institutions adopted a lecture format such that students did not come into close contact with one another.

By contrast, most of the educational institutions with classes of 51–100 students offered hybrid lectures. With the hybrid format, students who wished to take lectures remotely were able to do so, reducing the number attending face-to-face lectures. That format allowed lecturers to

monitor students' understanding and satisfaction and teach accordingly. The hybrid format allowed adequate measures against infection.

In the first semester of 2020, the face-to-face format was the most frequently applied method for conducting regular examinations. However, some institutions that used remote lectures in the first semester adopted various test formats to prevent infection. Some institutions conducted testing remotely. Among the comments received from institutions that conducted remote testing were ones indicating that such tests did not allow confirmation of students relying solely on their academic ability. When taking such tests, students had their own face on the computer monitor. However, it would have been possible to browse study materials and cheat such it would be invisible on the monitor. Remote testing can prevent students from being infected, but the biggest disadvantage is that it cannot exclude such fraudulent activities. We received many comments stating that face-to-face testing was the best approach.

In the second semester of 2020, the number of institutions offering face-to-face lectures increased significantly. The reason for that increase was that COVID-19 infection control had begun being established. The Prime Minister's Office of Japan announced in around March 2020 that the "Three Cs" should be avoided: closed spaces, crowd places, and close-contact settings. The notification was introduced owing to the increased risk of COVID-19 infection (1, 10). Educational institutions that considered face-to-face lectures more effective could conduct

teaching in that manner while avoiding the Three Cs. With face-to-face lectures, it is necessary to implement adequate infection control measures throughout the university. In the first half of 2020, there was no way of providing lectures while avoiding the Three Cs. Therefore, no educational institutions gave face-to-face lectures in the first semester.

In the second semester of 2020, the face-to-face format for regular examinations had also increased markedly. In that semester, the institutions had become accustomed to face-to-face infection control. Accordingly, regular examinations were often held in face-to-face format. But some institutions continued with remote or other examination formats owing to the infection risk.

Regular examinations are essential for assessing student comprehension. In the second semester of the regular examination, infection control measures were taken, and face-to-face methods were adopted by many educational institutions. However, it cannot be denied that there is a risk of infection. Therefore, we would like to pay attention to the method used by some educational institutions in the regular examinations in the first semester of 2020. Some educational institutions have adopted the face-to-face plus reports format for regular examinations. By adopting this method, it is possible to reduce the risk of infection and evaluate the level of understanding of students in a short amount of time. In the future, we would like to incorporate this type of regular examination into our lectures.

In the free description of the questionnaire, we received many comments from the

institutions related to methods for infection control. All the institutions that held face-to-face lectures took thorough infection control measures. Many comments related to remote lectures addressed methods of improving student understanding. Unlike face-to-face lectures, the remote format does not permit real-time evaluation of students' comprehension and satisfaction. Further, with the remote format, the lecturer is not physically present, so the comments voiced concerns about the concentration level declining with such teaching. This finding has been reported in previous studies (1). Accordingly, lecturers at institutions that conducted remote lectures devised methods such that they could obtain the same level of student understanding and satisfaction as with the face-to-face format.

The free description related to hybrid lectures included means of reducing the number of class days. Lecturers wished to have direct contact with students to determine whether they understood the lecture content. Thus, institutions provided hybrid lectures and devised ways to reduce the number of attendance days.

Regarding video-on-demand-lectures, the free description contained ways of improving student understanding. Few institutions offered video-on-demand. However, there were comments about its merits because it allows multiple reviews of a lecture. It was evident from the free description that educational methods have changed completely to prevent COVID-19 infection. Each institution offered means of preventing infection and improving understanding.

In the questionnaire, we asked about the optimal lecture format for COVID-19. Evidently, there were no clear differences in a comparison of face-to-face, remote, and hybrid lectures in terms of educational suitability; each institution held different views in this regard. All the institutions made efforts to prevent infection and improve understanding: they believed it was possible to teach in a way that ensured the quality of conventional education in any lecture format.

We investigated various lecture formats and initiatives undertaken by educational institution under COVID-19. As noted above, COVID-19 has completely changed all institutions, and they have made moves away from conventional education. All the institutions we examined had addressed new educational challenges as a result of COVID-19. We wish to share these initiatives and methods adopted, thereby contributing to the promotion of medical personnel in society—even during a pandemic. In the education of 2021, we will continue to give the same lectures as in 2020. Nowadays, mutant strains of COVID-19 are also prevalent, and lectures are given with strict infection control measures. If education policy in Japan changes in the future as a result of COVID-19, it will be necessary to prepare for such changes using the findings of this study.

Finally, we would like to talk about future prospects. It is unclear whether the new initiatives and lecture formats in COVID-19 investigated this time will be used permanently. We would like to continue this survey to see what kind of changes will be brought about in the future.



In addition, we would like to investigate changes in student attitude rates and satisfaction levels and student board examination scores in lectures at each educational institution. Each educational institution may make a difference in these changes. In previous research on remote lectures, remote lectures gave students the same level of satisfaction and understanding as the conventional face-to-face lectures (1). Therefore, we believe that by designing lectures that satisfy students in any lecture format, we can provide lectures with a high degree of understanding and satisfaction in any lecture format. Moreover, regarding employment, the chances of getting in touch with radiation equipment during hands-on training are decreasing at all educational institutions to prevent infection, and many students are worried about whether they will be able to do their jobs well after getting a job. We would also like to investigate the method of hands-on training of efficient and devised radiation equipment that has taken infection control measures.

## **Conclusion**

We investigated the lecture formats used for examinations in nuclear medicine technology at educational institutions in Japan during COVID-19; we also examined new efforts to maintain the quality of education and ideas for infection control. We wish to share the related initiatives and ideas among teaching staff and to promote medical personnel who can contribute to society.

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None.

## **Disclosure**

The authors have no conflicts of interest to declare.

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## **KEY POINTS**

Question: During the period of COVID-19, how are the lecture formats for teaching nuclear medicine technology at Japanese educational institutions and the efforts to ensure the quality of conventional education?

Pertinent Findings: In case-control studies of 17 educational institutions in Japan, the lecture format during the period of COVID-19 was not the conventional lecture format, but various school-specific methods were adopted to prevent infection. Lecture-style associations were not observed in 17 institutional case-control studies.

Implications for Patient Care: By sharing the results of this survey with each educational institution, it is possible to strengthen infection control measures more than ever and to provide education that ensures the quality of conventional education.

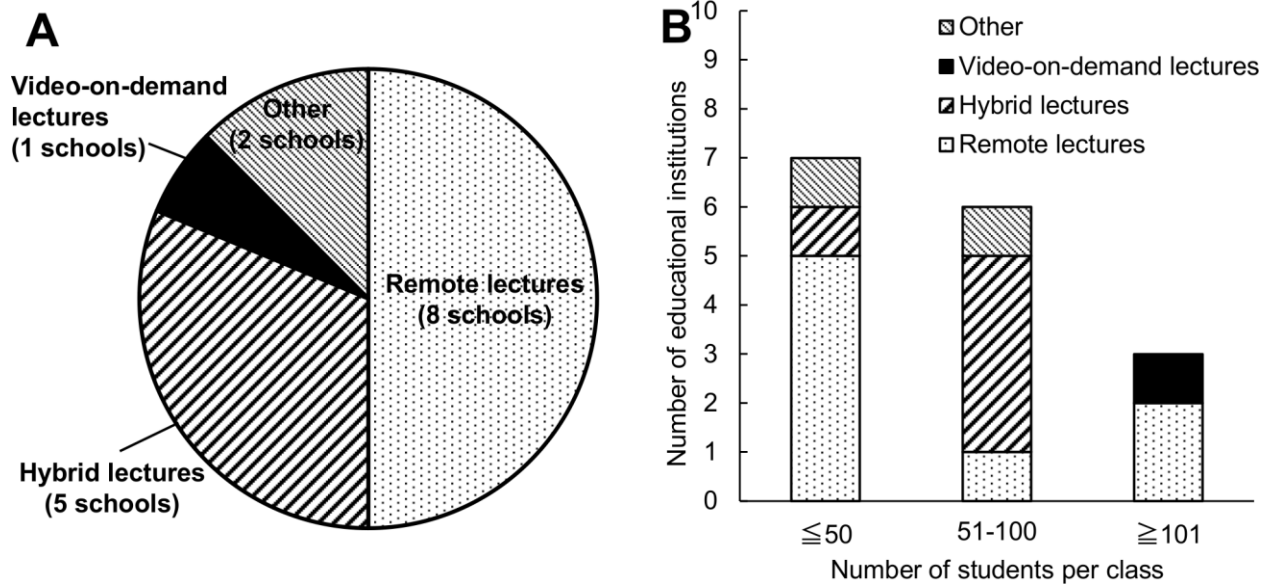
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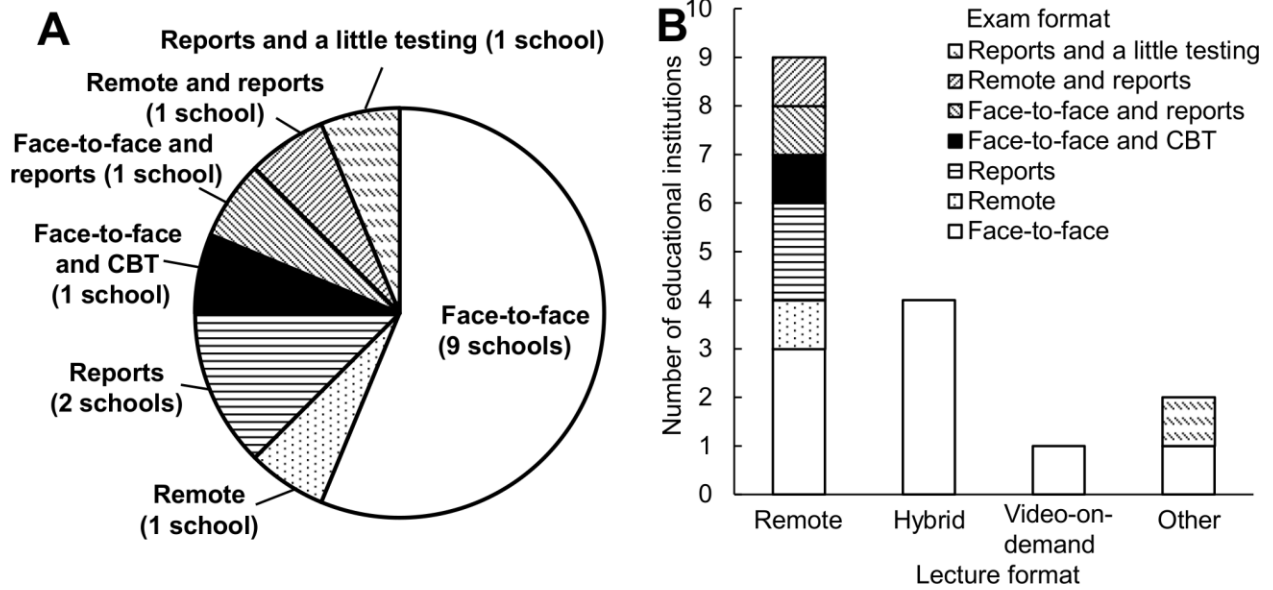
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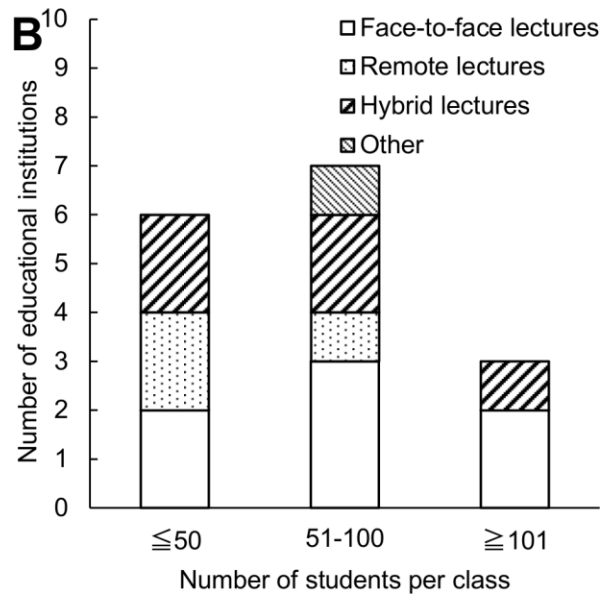
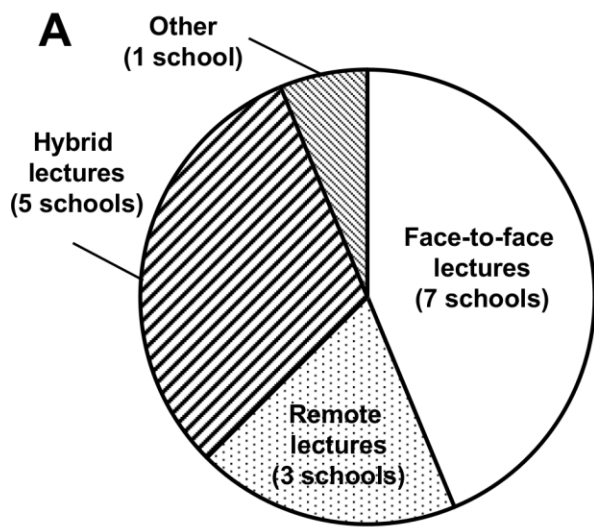
**FIGURE 1.** Lecture format in the first semester of 2020. (A) Aggregation; (B) number of students per class. Other: combination of face-to-face, remote, and video-on-demand lectures (one institution) and face-to-face and video-on-demand lectures (one institution).



**FIGURE 2.** Regular examinations in the first semester of 2020 (assessment method for assigning grades). (A) Aggregation; (B) categorization by lecture format. CBT, computer-based testing

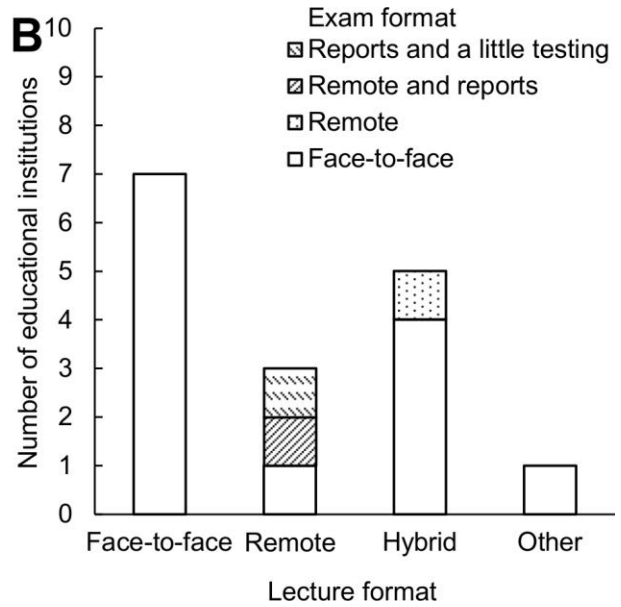
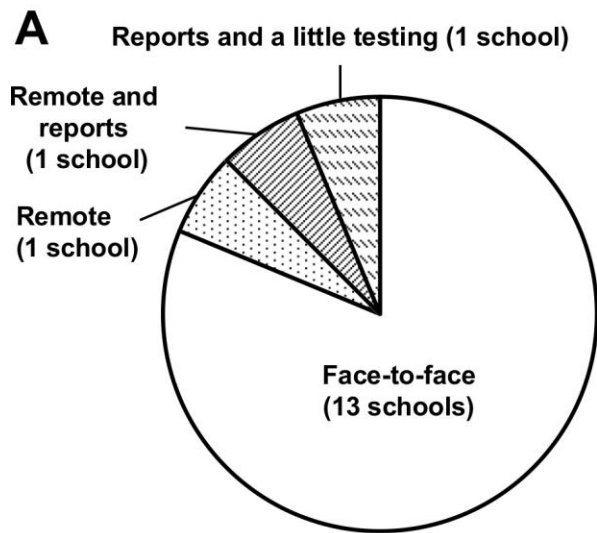


**FIGURE 3.** Lecture format in the second semester of 2020. (A) Aggregation; (B) categorization by number of students per class. Other: combination of face-to-face and video-on-demand lectures (one institution).

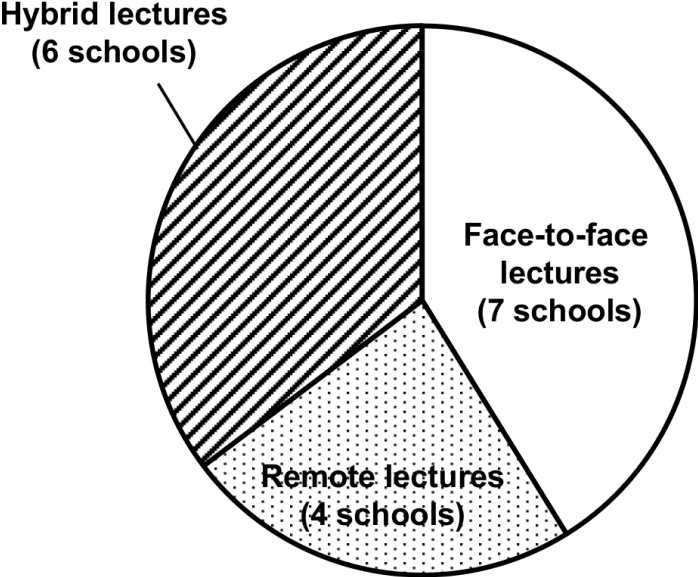




**FIGURE 4.** Regular examination in the second semester of 2020 (assessment method for assigning grades). (A) Aggregation; (B) categorization by lecture format.



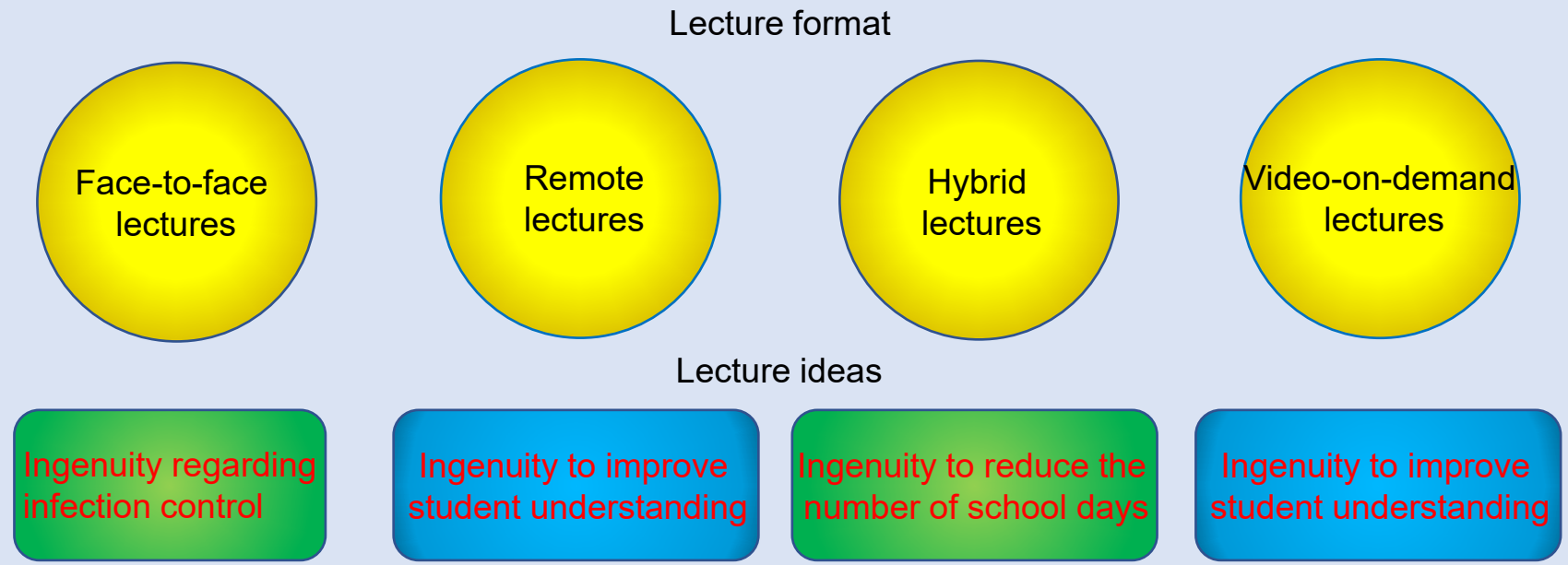
**FIGURE 5.** Optimal lecture format during COVID-19



**TABLE 1.** Free description of suggested initiatives and approaches during the pandemic

Face-to-face lectures	Remote lectures	Hybrid lectures	Video-on-demand-lectures
<p>Distribute COVID-19-related information all at once so that students, faculty, and staff can keep up with the latest information on COVID-19.</p> <p><b>Strengthen infection control.</b></p>	<p><b>Always administer quizzes online (e-learning system).</b></p> <p>Remote lectures provided more assignments than the face-to-face lectures assignments, giving more time to review.</p>	<p>Video distribution of board-style lectures with Keynote presentation software.</p> <p>Record the lecture for the day, and distribute it on YouTube.</p>	<p>Two videos of 40-minute recorded lectures are screened in a 90-minute lecture. At the end of each video, 10 review questions are prepared, and the answers are submitted.</p>
<p>Distribute health observation cards, and require students to measure their temperature and check their symptoms every morning.</p> <p><b>Stagger the start time of lectures in each major so that student traffic will not be dense.</b></p>	<p>Post videos and lesson materials online, and distribute all slides in PDF format.</p> <p>Provide increased explanations and figures in handouts.</p>	<p>For small classrooms, the capacity of the classroom is set to 50%, and lectures are given in two classrooms (teachers move between two classrooms). For large classrooms, the capacity will be 50%, and lectures are given in the classroom.</p>	<p><b>The recorded video can be reviewed many times later.</b></p>
<p>Give lectures in classrooms that can accommodate more than twice the actual number of participants.</p> <p>Maintain distance between students, and secure social distance. Always open a window.</p>	<p><b>Take questions in real time using chat.</b></p> <p>Communicate with students via chat or email to eliminate points of confusion.</p>	<p>Limit school days by study year.</p> <p>Reduce school days.</p> <p><b>Divide the class in half and alternate between face-to-face and remote lectures every other week.</b></p>	
<p>Install acrylic dividers, students always wear masks, disinfect microphones, disinfect hands before entering the room, disinfect desks after lectures, and always ventilate.</p>	<p>Remote lectures eliminate the time it takes to travel to the school, allowing more time for studying.</p>	<p>For students who do not have a remote study environment, <b>we have established a style that allows students to attend school by setting up a listening area on campus.</b></p>	

# Changing methods of education during a pandemic: questionnaire survey about examinations for nuclear medicine technology at educational institutions in Japan



Note: Hybrid (combination of remote and face-to-face)

## Implications:

COVID-19 has completely changed all institutions, and they have made moves away from conventional education.