Journal of Systemics, Cybernetics and Informatics (2022) 20(6), 43-48
https://doi.org/10.54808/JSCI.20.06.43

Multidisciplinary Learning for Multifaceted Thinking in Globalized Society

Shigehiro HASHIMOTO

Professor, Doctor of Engineering, Doctor of Medicine,
Biomedical Engineering, Department of Mechanical Engineering,
Kogakuin University, Tokyo, 163-8677, Japan
shashimoto@cc.kogakuin.ac.jp http://www.mech.kogakuin.ac.jp/labs/bio/

ABSTRACT

Multifaceted thinking is essential to address global proposal. Learning experience in multidisciplinary fields is useful. Following steps are important: multifaceted understanding the purpose of instructions to society, considering advantages and disadvantages, considering options, and considering relationship between individual behavior and society. As a multidisciplinary field, Biomedical Engineering has been applied to the present study. As a topic of case study, COVID-19 has been selected. While answering the questions, the students (in Japan, and in Thailand) noticed the multifaceted problem and the diversity of related disciplines. The education system provided the experience of linking biomedical engineering learning (statistics, biomeasurement, cellular mechanics, micromachining, designing, immunology, artificial organs) to the proposal of the solution to the global problem.

Keywords: Multidisciplinary Learning, Multifaceted Thinking, Globalized Society, Biomedical Engineering, COVID-19 and Students.

1. INTRODUCTION

With globalization, the traffic of people, goods, and information has become more active in our daily lives. The number of problems that need to be solved from a global perspective has increased [1]: climate, resources, energy, economy, etc. Infectious disease is one of the global problems. The virus is transmitted from person to person. Complete blockade in society is no longer easy, and virus blockade is not easy.

Multifaceted thinking is essential to tackle global challenges. We must understand diversity and share solutions, including coexistence with viruses in the global community. Dealing with the local community does not lead to a global solution.

Learning experience in multidisciplinary fields is useful for multifaceted thinking. Following steps are important: multifaceted understanding of the purpose of instructions to society, considering advantages and disadvantages, considering options, and considering relationships between individual behavior and society. As a multidisciplinary field, Biomedical Engineering [2] has been applied to the present study. Biomedical engineering provides multidisciplinary contents: statistics, biomeasurement, cellular mechanics, micromachining, designing, immunology, artificial organs [3]. Originally, artificial organs are used in the absence of infection [4].

In the present study, COVID-19 has been selected as a topic of case study. In the class of biomedical engineering, students (in Japan, and in Thailand) have answered to the questions related to COVID-19 [5] and have made reports on proposal to solve problems related to COVID-19 [6].

2. METHODS

Topics

COVID-19 was picked up as a topic for multifaceted thinking training. After answering questions related to COVID-19, students proposed systems (or tools) to solve problems related to COVID-19 through group discussions.

Through the above activities, students experienced the following training. Logical understanding of COVID-19. The multifaceted challenges of COVID-19. Assignments related to various disciplines through the multidisciplinary field of biomedical engineering. Differences in discipline depending on the academic field. Understanding of social globalization through pandemics.

Questions

(1) Effect of vaccine: “True” or “False”.
(2) Select your behavior in the past two weeks for “free of COVID-19 infection”.
(3) Select three effects of everyday-mask on COVID-19.
(4) Choose three answers related to COVID-19 as a method to directly reduce your chances of getting infected.
(5) Choose three answers to directly reduce the probability of passing virus of COVID-19 from yourself to others.
(6) Which is the effect of virus test? Select two choices.
(7) Choose multiple answers from the following future technologies related to COVID-19 that you consider important.
(8) Select multiple answers that may be feasible from the following future technologies related to COVID-19.
(9) Choose multiple answers from the following future technologies related to COVID-19 that you would like to realize.

3. RESULTS

The distribution of answers of students for each question is shown in Figs. 1-7. Marks of “*” show recommended answers by microbiological considerations.

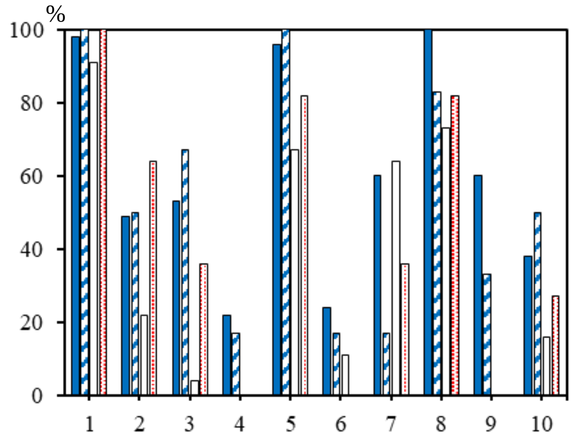

Fig. 1: Effect of vaccine of 10 items: percentage of choosing "true" (%): blue, Thai undergraduate 2nd year (number of samples *n* = 45); blue striped pattern, Thai graduate (*n* = 6); white, Japanese undergraduate 1st year (*n* = 45); red dot pattern, Japanese undergraduate 4th year (*n* = 11) in January 2021.

Fig. 1 shows the percentage of answer "true" for the question: the effects of vaccine "true" or "false". 1) Production of antibodies to the virus. 2) The vaccine causes infection. There are many misunderstandings about vaccines in the upper grades: confusing with side reactions. 3) Prevention of the virus from invading a cell. Japanese physics students do not understand the mechanism by which antibodies prevent intracellular invasion. 4) Prevention of infection. The Japanese know that vaccines cannot completely prevent infection. 5) Reduced chance of infection. Thai biomedical engineering students understand the fact that vaccines reduce the chances of infection, as do many Japanese upper grades students. 6) No more transmittance of virus to your neighbors. Japanese upper grades students understand the fact that they transmit the virus before the onset. 7) Vaccines prevent aggravated infection. The upper grades are rather confused in understanding the cell-mediated immune function of preventing aggravation. 8) Side reactions will happen. Especially Thai students are aware of side reactions. 9) The effect of vaccine lasts. The Japanese do not believe that the vaccine is effective for a long time due to the decrease in antibody titer. 10) Proof of vaccination is more effective than a negative result of a PCR (polymerase chain reaction) test. Japanese strongly believe in PCR testing rather than vaccines.

Fig. 2 shows the percentage of answer for the question: select your behavior in the past two weeks to be "free of COVID-19 infection". 1) Asymptomatic; I have been facing others in normal life. Especially upper grades understand that they can be infected even if they are asymptomatic. 2) Facing others in normal life, I have been paying attention to disinfection: masks, and distancing from others. In the early days, the lower grades believe in masks and distancing. 3)* I have been managing my own health by measuring body temperature without facing others. The upper grades understand self-isolation. 4) Facing others in normal life, I have been checking for the negative signs of COVID-19 infection by a PCR test every day. Students understand that it is difficult to prove negative with intermittent tests alone. 5) I have been facing others in normal life, taking medications to control COVID-19 symptoms. Students understand that dosing cannot control viral infections. 6) I have been facing others in normal life, after receiving the vaccine against SARS-CoV-2 virus. Students understand that vaccines do not completely prevent infection. 7) I have been facing others in normal life, after confirmation of negative signs by a PCR test after the recovery from COVID-19. Students understand the risk of reinfection after recovery from infection.

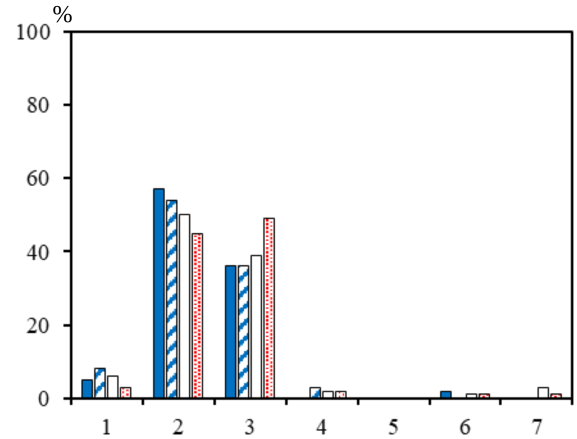

Fig. 2: Percentage of answer for question: select your behavior in past two weeks to be "free of COVID-19 infection": blue, September Japanese undergraduate 1st year (*n* = 42); blue striped pattern, December Japanese undergraduate 1st year (*n* = 39); white, Japanese undergraduate 1st year (*n* = 141); red dot pattern, Japanese undergraduate 2nd year (*n* = 146) in 2020.

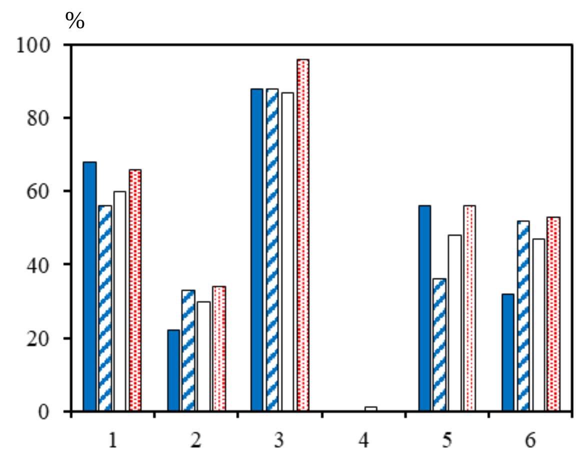

Fig. 3: Select three effects of everyday-mask on COVID-19: blue, September Japanese undergraduate 1st year (*n* = 41); blue striped pattern, December Japanese undergraduate 1st year (*n* = 39); white, Japanese undergraduate 1st year (*n* = 140); red dot pattern, Japanese undergraduate 2nd year (*n* = 146) in 2020.

Fig. 3 shows the percentage of answer for the question: select three effects of everyday mask wearing on COVID-19. 1) Prevention of the outflow of the virus. The number of students who believe that the virus does not pass through the mask is higher in the early months and in the lower grades. 2)* Enhancement of the immune capacity by maintaining humidity in the oral cavity. Students do not know that moisturizing the oral cavity can boost immune function. 3)* Reduction of splashing of water droplets including virus that accompany sneezing. Students understand that masks prevent the spread of droplets. 4) Prevention of elevation of the body temperature.

Students understand that masks are not insulating. 5) Prevention of the inflow of the virus. The understanding that virus inhalation cannot be prevented has expanded. 6)* Prevention of direct touch by your hands to your mouth (or your nose). The danger of the virus being carried from hand to mouth is becoming more and more understood over time.

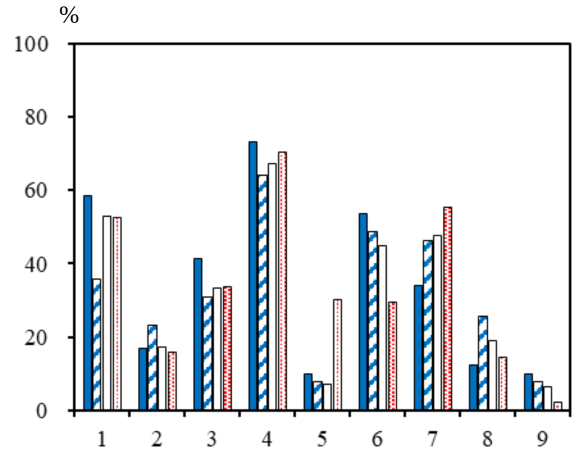

Fig. 4: Percentage of answer for question "choose three answers related to COVID-19 as method to directly reduce your chances of infection: blue, September Japanese undergraduate 1st year (*n* = 41); blue striped pattern, December Japanese undergraduate 1st year (*n* = 39); white, Japanese undergraduate 1st year (*n* = 138); red dot pattern, Japanese undergraduate 2nd year (*n* = 146) in 2020.

Fig. 4 shows the percentage of answer for the question: choose three answers related to COVID-19 as a method to directly reduce your chances of infection. 1) Wash your hands frequently. It is beginning to be understood that it is a droplet infection rather than a contact infection. 2)* Do not eat with bare hands without washing hands. It seems that Japanese think that they do not eat with their bare hands, but it is dangerous because they eat bread and snacks with their bare hands. 3) Disinfect the area you touch with alcohol. Awareness of preventing droplet infections, not alcohol disinfection, is spreading over time. 4) Do not get together with many people. Students are trapped in the campaign to avoid the crowds. The crowd of people is an indirect cause. It is not understood that conversation bans can prevent viral infections. 5)* At the buffet, do not eat meals that are exposed to everyone's conversational space. There is not enough concentration of consciousness to be careful during meals. Awareness is improving in the upper grades. 6) Do not stay in a space with poor ventilation. In early and lower grades, students are trapped in the campaign to avoid staying in a closed space. 7) Keep distancing from others. The campaign to stay away from people has become a stereotype over time. 8)* In a room with multiple people, refrain from the following action: talking, deep breathing, and singing a song. Awareness of the dangers of multiple people singing indoors has spread over time, but it remains minor. 9) Do not shake hands with others. If you do not touch your nose or mouth with your hand, you will not be infected.

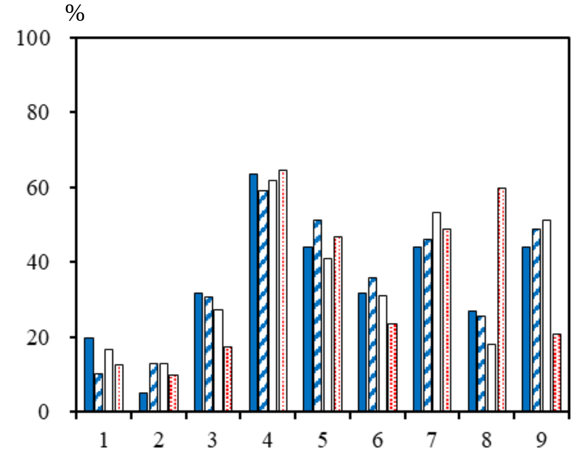

Fig. 5: Percentage of answer for question "choose three answers to directly reduce probability of movement of COVID-19 virus from yourself to others": blue, September Japanese undergraduate 1st year (*n* = 41); blue striped pattern, December Japanese undergraduate 1st year (*n* = 39); white, Japanese undergraduate 1st year (*n* = 138); red dot pattern, Japanese undergraduate 2nd year (*n* = 146) in 2020.

Fig. 5 shows the percentage of answer for the question: choose three answers to directly reduce the probability of the movement of COVID-19 virus from yourself to others. 1) Wash your hands frequently. Initially, the response rate is high. In COVID-19, the risk of contact infection is relatively low. 2)* Wear a mask when singing. Response rates increase slightly over time, but singing is misunderstood as having nothing to do with splash spread. The low awareness of users has led to restrictions on the use of karaoke boxes. 3) Use alcohol to disinfect your hands, and the areas you touch. Too many students are trapped in disinfection campaigns. In the upper grades, other items have higher priority. 4) Do not enter a crowd. Too many students are trapped in the campaign to avoid crowds. 5)* For sneezing and coughing, cover the mouth and the nose with sleeves or a handkerchief. Awareness of the danger of splash spread improved over time and in the upper grades. 6) Do not stay in a space with poor ventilation. Ventilation is important but indirect. In the upper grades, other items have higher priority. 7) Keep a distance from others. Students are trapped in a campaign called "social distance" to prevent close contact. 8)* Wear a mask when speaking. Awareness to prevent the spread of droplets is relatively low. Awareness improved significantly in the upper grades. 9) Do not touch where many persons touch. Students are trapped in the risk of contact infection. In the upper grades, other items have higher priority.

Fig. 6 shows the percentage of answer for the question: "Which is the effect of virus test? Select two choices". 1) To find a positive for isolation. Quarantine is understood to be the primary purpose of virus test. 2) For statistics. The upper grades have the impression that the statistical significance is great. 3) To find the infection route. In Japan, tracking the route of infection by hearing is a top priority. 4) Negative check for occupation: medical care, nursing. Depending on your profession, you may need to be inspected frequently to perform your job. 5) Certificate for a negative test. Many students expect a negative proof. However, positive detection is the original purpose. The timing of the test is important for negative proof. 6) Getting an infection during the test: contact with patient. The test is carried out while paying attention to the low risk, but it is necessary to take infection control before and after the test. In the lower grades, some students are worried about the risk.

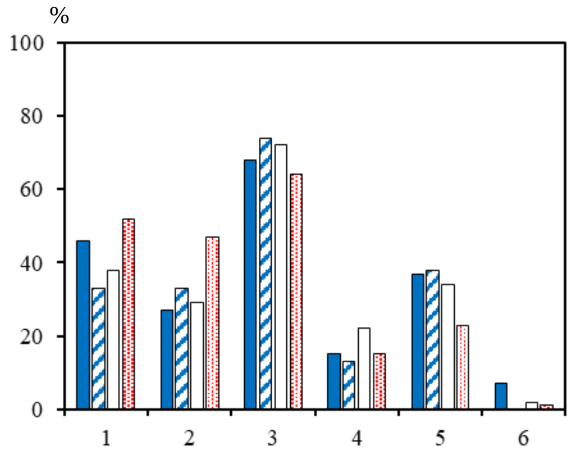

Fig. 6: Percentage of answer for question: "Which is the effect of virus test? Select two choices": blue, September Japanese undergraduate 1st year (n = 41); blue striped pattern, December Japanese undergraduate 1st year (n = 39); white, Japanese undergraduate 1st year (n = 138); red dot pattern, Japanese undergraduate 2nd year (n = 146) in 2020.

Fig. 7a shows the percentage of answer for the question: choose multiple answers from the following future technologies related to COVID-19 that you consider important. Fig. 7b shows the percentage of answer for the question: select multiple answers that may be feasible from the following future technologies related to COVID-19. Fig. 7c shows the percentage of answer for the question: choose multiple answers from the following future technologies related to COVID-19 that you would like to realize. 1) Automatic generation of vaccine. The importance of automated vaccine production is recognized. Expectations are high. The upper grades feel technical difficulties, probably because they have a deeper understanding of vaccine development process. However, the degree of expectation is the highest among the options. 2) Automatic determination of effectiveness of vaccine without clinical trials. 3) Detection of cytokine (substance secreted by cells) release syndrome. 4) Diagnostics without facing the patient. Expectations for non-face-to-face diagnosis increase over time. 5) High-speed diagnosis of inspected data by artificial intelligence (AI). Rapid diagnosis by AI is popular. In the upper grades, the importance is slightly reduced. 6) Prediction of infection. From the viewpoint of reducing the number of infected people, the first graders in September thought that infection prediction was very important. The ratio that is technically feasible increases over time. The expectation is high. The upper grades feel technical difficulties. Japanese students are enrolled in April. The first-year students were in trouble in April in 2020. 7) Portable respirator. 8) Implantable oxygenator. 9) Technology that reduces oxygen consumption in living tissues. 10) Face-to-face communication technology without vocal conversation. 11) Telemedicine. Telemedicine has become more popular over time. 12) Medical robots. Medical robots have become more popular over time. 13) Remote care. 14) Nursing robot. The nursing robot is not aware of its relationship with COVID-19. In the lower grades, it is judged that the technical potential is high over time. Expectations for their feasibility are increasing. 15) Remote childcare. 16) Childcare robot. 17) Barber robot. 18) Artificial reality. 19) Remote sports. Expectations for the remote sport are increasing over time. 20) Self-driving car. Autonomous driving is not recognized for its relevance to COVID-19. Lower grade students judge that they have high technical potential. There are great expectations for its feasibility. 21) Everyday activity tracking technology. 22) Everyday behavior monitor.

While answering the questionnaire, students learned a multifaceted view of COVID-19, exchanged ideas in group work, and created a report. The following is an example theme: new mask idea, non-contact daily movement assistance, communication tools that do not rely on conversation, symbol display for making friends.

4. DISCUSSION

How should we understand diversity and utilize it in society? Is it possible to protect yourself by protecting society from a pandemic? Statistics [7] are useful for the quantitative evaluation of society as a whole. Statistics is a collection of past data, so it may not be useful for predicting the future. There are limits to how it can be applied to individual forecasts. A logical inference about causality helps to understand the essence. In the global society, information sharing is required regardless of language and culture. A single message is easier to convey: "follow instruction A". However, the social message and the personalized message may need to be expressed differently. Receiving multifaceted explanations requires the understanding of the recipient. The recipient should make the decision. Multifaceted thinking training based on multiple disciplines is effective.

For example, mandatory vaccination has become a hot topic. The practice effect of the vaccine reduces the probability of aggravation during infection (purpose). As a society as a whole, increasing the number of vaccinated people can be expected to have the effect of reducing the number of severely ill people. It is expected to prevent the spread of infection, reduce the medical burden, and maintain social activities. As an individual, on the other hand, vaccinations tailored to individual differences are required. Pregnant women with complex immune functions need special attention. There is also a need to develop vaccinations for newborns and children.

You can get antibodies by vaccination (advantage). There is a risk that practicing infection by vaccination might damage your health (disadvantage) [8]. When you do not vaccinate, you will avoid contact with people to prevent infection (option). If it is obligatory, there will be responsibility (guarantee) on components, compatibility with the vaccine due to individual differences, and accidents. Differences in effects due to individual differences are also a problem. A large side reaction of the vaccine (defect) may mean a greater practice effect (another perspective). Smaller side reactions may correspond to insufficient antibodies (opposite perspective). It may correspond to knowing your immune response in advance (another perspective). Do you start vaccination from the elderly? The goal is to reduce the severity of the disease by vaccination from people who tend to become severe. In the elderly, pneumonia is one of the leading causes of death, as well as COVID-19. On the contrary, do you start vaccination from young people? When young people are infected and the sequelae increase, the social loss is great. Clinical trials can only be done in epidemic. Is it appropriate for the elderly to start vaccination? Is it appropriate for the elderly to start vaccination? Pregnant women, newborns and children should be protected from infection. Is the order of clinical trials good later?

For example, mandatory masking has become a hot topic. The main purpose is to reduce the spread of the virus by using a mask [9]. Indoors, removing scattered viruses can be time consuming. There is a risk of virus transfer to others except in a personal space. If you do not have a mask, you can use a handkerchief instead (option). If you do not have a mask, you can prevent virus from scattering by prohibition of vocalization (option). Immune function can be maintained by humidifying the oral cavity (advantage). It is also an advantage that you do not touch your mouth or nose directly with your hands. Suffocation with a mask is a disadvantage. The reduction in viral inhalation by the mask may be linked to the acquisition of innate immunity.

The purpose of the obligation to install partitions is to prevent splashes including virus. On the contrary, partitions interfere with ventilation. Adsorption plate is effective. An air purifier is effective indoors.

5. CONCLUSION

Case studies in the multidisciplinary field will train students from multiple perspectives. The education will lead to the development of human resources to solve global issues.

ACKNOWLEDGMENT

The author thanks Dr. Jackrit Suthakorn and Dr. Norased Nasongkla of Mahidol University for collaboration to the student education program.

REFERENCES

[1] S. Hashimoto, "Communication Training in Multidisciplinary Field: Biomedical Engineering and Symbiosis Engineering", **Journal of Systemics Cybernetics and Informatics**, Vol. 17, No. 5, 2019, pp. 106–111.

[2] R.A. Linsenmeier and A. Saterbak, "Fifty Years of Biomedical Engineering Undergraduate Education", **Annals of Biomedical Engineering**, Vol. 48, 2020, pp. 1590–1615.

[3] S. Hashimoto, "Does Multidisciplinary Learning Help Global Problem: Covid-19 by Biomedical Engineering?", **Journal of Systemics Cybernetics and Informatics**, Vol. 18, No. 7, 2020, pp. 1–6.

[4] S. Hashimoto, "Cross Cultural Seminar Inspires Multidisciplinary Learning: from Biomedical Engineering to Gerontechnology", **Journal of Systemics Cybernetics and Informatics**, Vol. 16, No. 4, 2018, pp. 1–7.

[5] S. Hashimoto, "Does Learning Multidisciplinary Field of Biomedical Engineering Help Pandemic of COVID-19?", **Journal of Systemics Cybernetics and Informatics**, Vol. 19, No. 9, 2021, pp. 1–6.

[6] S. Hashimoto, "How Are Students Motivated for Learning Multidisciplinary Field: Biomedical Engineering?", **Journal of Systemics Cybernetics and Informatics**, Vol. 18, No. 7, 2020, pp. 42–49.

[7] S. Hashimoto, "**Introduction to Biomechanical Engineering**", Tokyo Japan, Corona Publishing Co. Ltd., pp. 1–151, 2013.

[8] S. Hashimoto, "Interdisciplinary Background Helps Communication in Pandemic: Learning Multidisciplinary Field of Biomedical Engineering", **Journal of Systemics Cybernetics and Informatics**, Vol. 19, No. 9, 2021, pp. 51–56.

[9] S. Hashimoto, "Communication Training for Students in Multidisciplinary Academic Field", R.V. Nata ed., **Progress in Education**, Vol. 73, New York, Nova Science Publishers, 2022.

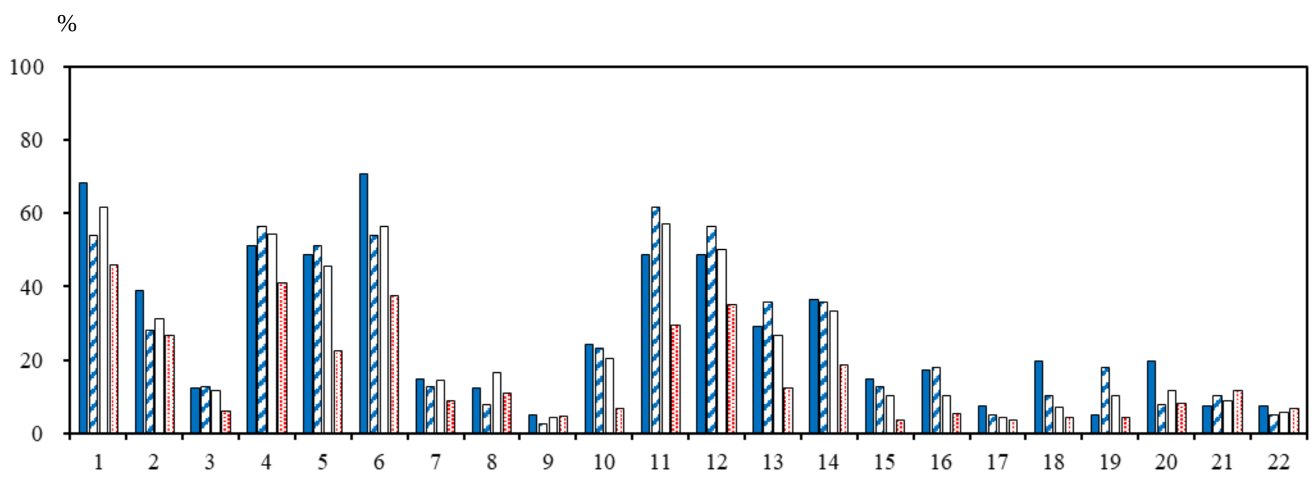

Fig. 7a: Future technologies related to COVID-19 that you consider important: percentage of multiple choosing "yes" (%): blue, September Japanese undergraduate 1st year (*n* = 41); blue striped pattern, December Japanese undergraduate 1st year (*n* = 39); white, Japanese undergraduate 1st year (*n* = 138); red dot pattern, Japanese undergraduate 2nd year (*n* = 146) in 2020.

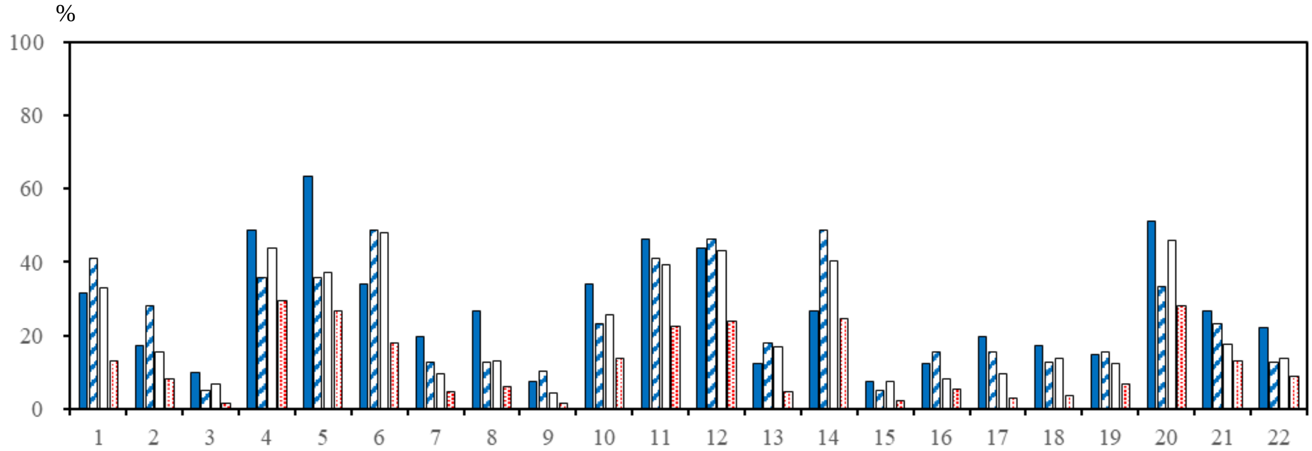

Fig. 7b: Select multiple answers that may be feasible from the following future technologies related to COVID-19: percentage of multiple choosing "yes" (%): blue, September Japanese undergraduate 1st year (n = 41); blue striped pattern, December Japanese undergraduate 1st year (n = 39); white, Japanese undergraduate 1st year (n = 138); red dot pattern, Japanese undergraduate 2nd year (n = 146) in 2020.

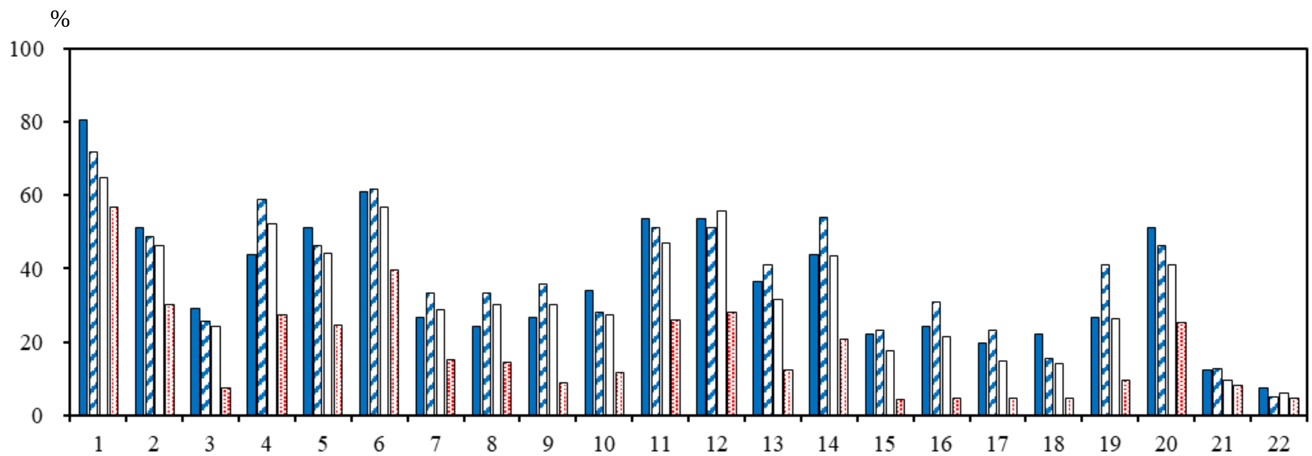

Fig. 7c: Choosing multiple answers from the following future technologies related to COVID-19 that you would like to realize: percentage of multiple choosing "yes" (%): blue, September Japanese undergraduate 1st year (n = 41); blue striped pattern, December Japanese undergraduate 1st year (n = 39); white, Japanese undergraduate 1st year (n = 138); red dot pattern, Japanese undergraduate 2nd year (n = 146) in 2020.