Demonstrating Engineering Experiments during Webinar Sessions with Turku University of Applied Sciences

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Abstract

In 2021, the National Institute of Technology (KOSEN), Suzuka College, reached a Student Exchange Program Agreement with Turku University of Applied Sciences (TUAS), Finland.
In 2022, based on the agreement, we dispatched two students to TUAS from August to December. In 2023, we will accept one student from TUAS from March to August.

We have already selected 4 students to send to TUAS this summer. Before the agreement, we had a series of webinar sessions with TUAS since 2021. These are not part of a temporary program due to the severe condition of Covid-19, but rather we regard them as continual. It should provide the possibility to interact with students without actual visits. Thus, we aim for the hybrid-international exchange to combine actual visits with virtual ones.

In this paper, we would like to focus on engineering experiments conducted during the webinar sessions. In 2021, as the sessions were based on PBL under the social implementation of technology, each session consisted of a lecture and a follow-up discussion. It was supposed to be difficult to conduct experiments under the strict conditions online, but in the 2022 sessions two experiments were demonstrated; one was the "Tamago Otoshi Contest," the so-called "Egg-Drop Challenge," and the other was the "Sweden Game." The "Tamago Otoshi Contest" includes designing a landing craft that protects an egg passenger when dropped from a high level. The "Sweden game" is a kind of educational gaming aimed at the educational effects on the participants. The game focuses on cost-sharing issues: who will pay the cost and how the total cost will be shared. The webinar sessions are conducted as a part of the "Special Engineering Lecture" with the approval of credits. In addition to the details of the experiments, we would like to present other content incorporated in the "Special Engineering Lecture" toward our hybrid-international exchange.

Keywords: *webinar, hybrid-international exchange, Online Lecture, egg drop challenge, Education gaming, exchange student program agreement*

Introduction

In January 2020, the first case of a new coronavirus infection was confirmed in Japan. Consequently, all international exchange events of Suzuka KOSEN were suspended or canceled. Even small events for international students on campus had to be canceled. In addition, as all regular classes in the spring semester of 2020 had to be shifted online, students were not allowed to learn physics at the college. In the fall semester of 2020, fortunately, we returned to face-to-face classes.

However, since then the overseas school excursion for the second-year students has been postponed, including even domestic factory tours. In addition, all school events such as sports and cultural festivals have also been suspended. However, under the severe conditions of international exchange, our college has tried something new.

One of the benefits resulting from the Covid-19 pandemic is that ICT has been widely used among students and faculty members through online classes. This happened not only in Japan but also in overseas educational institutions. Therefore, since 2021 we have developed an international exchange program using ICT.

Special lectures on engineering connecting overseas online

In 2021, we carried out "Special lectures on engineering connecting to overseas online" with credit instead of oversea internships. This course consisted of three parts: the English presentation-oriented classes, the online intensive lectures by the lecturers at the University of Hannover and two single lectures by US scholars, and the webinar sessions with Turku University of Applied Sciences.

First, in the spring semester, six English presentation-oriented classes were conducted entirely in English by a

native English and English-speaking faculty member. The students created English presentations at the professional level that could be given at international conferences in their respective fields of specialization.
Then, six online intensive lectures were conducted on EMC technology. Dr. Darla Goeres and Dr. Dana M. Barry, respectively, gave a lecture on their majors. Last, in the fall semester, five webinar sessions were held with TUAS. All lecturers lectured on the theme of "Social Implementation."

Lecturers were recommended from both TUAS and Suzuka KOSEN. They were not only faculty members but also a corporate researcher who conducts joint research with Suzuka KOSEN. After the lectures, students were divided into small groups of 6 students (3 Japanese and 3 Finnish) using the Break Up Room function of Teams. Each group discussed the theme given by the lecturer from the perspective of each member's major field. A summary of the discussion was presented to other groups. Participants necessarily communicated with each other in English and deepened their understanding of the social implementation of engineering from cross-cultural and interdisciplinary perspectives. Except for the English presentation-oriented class, these sessions given online were open not only to all faculty and students but also to other KOSENs. In addition, the recorded content is available on demand. Enrolled students are required to submit a report for each lecture to assess their understanding of the content of each lecture.

The webinar sessions were considered an international exchange before the actual visit of Suzuka KOSEN students and the acceptance of TUAS students. The TUAS students who participated in the webinar sessions took a course, "Destination Japan Course," including visiting Japan to study. It was a good opportunity for both sides to get to know each other. This program contributed to the development of a hybrid type of international exchange that combines online exchange and actual visits. It is also expected to establish new mobility for students and to motivate and encourage students to study abroad at educational institutes and to find a new career path after graduation from Suzuka KOSEN. This indicates a new direction for international exchange in the future. Because of these achievements, in November 2021, we concluded a student exchange program agreement with TUAS. Based on the agreement, we sent two students to TUAS in 2022 and will send students there in 2022. Now we accept one student from TUAS in 2023. We would like to focus on the details of the "demonstrating engineering experiments during the webinar sessions" conducted in 2022, in the next section.

Special Lecture for the Project for the Development of Outstanding Global Engineers

As a part of an online exchange program with TUAS, a "Special Lecture for the Project for the Development of Outstanding Global Engineers" was held.
The experiments presented in this paper are supported by the "Sakura Science Program" of JST.

Table 1 Schedule list of special lectures

17 Nov. 2022	" Building a sustainable and comfortable society by Kenji Ikoma Executive Director, AVEX Corporation
2 Dec. 2022	Education Gaming and the Experiment of Sweden Game, by Masashi Kawaguchi
7 Dec. 2022	The Egg Drop Challenge, by Tatsuya Shirai
12 Jan. 2023	The technology industry in Turku University of Applied Sciences, by Tarmo Karhu
19 Jan. 2023	Welcome to Turku University of Applied Sciences! by Hanna Hänninen

On 17 Nov., the lecture was followed by an online discussion between students from TUAS and Suzuka College. The discussion themes were presented by Mr. Ikoma as follows, "How do you foresee the changing times over the next 10 years?" and "What changes do you need to make in yourself to apply what you have learned to your work?". On 2 Dec. and 7 Dec., we held the engineering experiments "Sweden Game" and" Egg Drop Challenge" during webinar sessions. Details will be described later. On 12 Jan. and 19 Jan., TUAS and Suzuka students listened to the lecture by TUAS and answered questions. Afterward, students from both schools exchanged opinions on the presentations of Suzuka students, which were made available on demand in advance.

Demonstrating engineering experiments during webinar sessions

In the 2022 sessions, two experiments were demonstrated; one was the "Tamago Otoshi Contest," the so-called "Egg-Drop Challenge," and the other was the "Sweden Game." The "Tamago Otoshi Contest" includes designing a landing craft that protects an egg passenger when it's dropped from up high. The "Sweden game" is a sort of education gaming aiming at the educational effects on the participants. The game focuses on cost-sharing issues: who will pay the cost and how the total cost will be shared. The webinar sessions are conducted as a part of the "Special Engineering Lecture" with the approval of credits. Details are given in the next chapter.

Tamago Otoshi Contest

The "Tamago Otoshi Contest" includes designing a landing craft that protects an egg passenger when it's dropped from up high. First, a lecture is given on the physical phenomena of this experiment. Then, students discuss how to design a landing craft online, create their craft with only a B4 size paper and glue and experiment with it under almost the same conditions. "Tamago" means "egg" in English. The "Tamago Otoshi" class is conducted under the name of "Egg Drop Challenge" at many schools throughout the world. In general, "Egg Drop Challenge" doesn't set any restrictions on materials. This is an example at the Armidale School.

But this time we would like to set some restrictions on available materials. Participants can only use a designated size of paper, B4, and glue. The glue case is also available for the dropping object. Dr. Koji Ikuta, professor emeritus at the University of Tokyo, spread this “Tamago Otoshi” class widely in Japan. At this time, the experiment was conducted based on Dr. Ikuta’s rules. The rules of the “Tamago Otoshi Contest” are very simple. First, consider how to drop an egg from the 4th story of a building. And actually, drop it.

"How do you avoid breaking a raw egg when dropping it from the 4th story of a building?"

Participants can use any tools to cut the paper, but only the given glue to create the object as shown in Table 2.

Table 2 Given Items

Thick paper（B4 size：257mm x 364mm）
Quick-drying wood glue

Table 3 The participants of raw egg

The same conditions (the same size or shape)
Moderate size and weight
Strong to the pressure on the long axis but weak to that on the short axis
Hard but weak to the impact
Easy to buy (Cheap or abundant)

Figure 1 Eggs are Dropped from the balcony of TUAS

Figure 2 Eggs are dropped from the long stick inside a high-ceiling classroom in Suzuka College

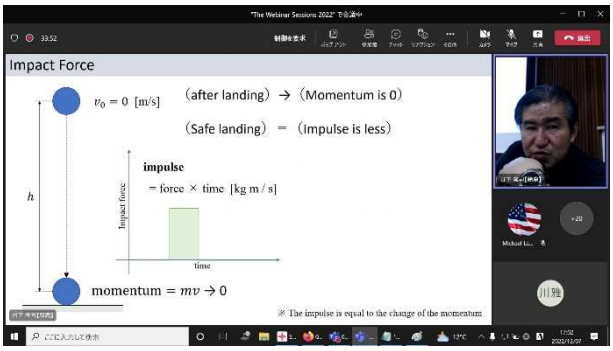

Figure 3 Webinar commentary on mechanics

A raw egg is proper for this experiment. Everyone can participate in the experiment under the same conditions. It is not too small, not too big, not too heavy, and not too light. A raw egg is strong to the pressure on the long axis, but weak to the pressure on the short axis. A raw egg is hard enough to handle but easily broken by the impact. It is easy to judge whether the experiment goes well or not because we can see the broken egg if it fails. In addition, we can buy it easily at the supermarket. This is where we experimented. We put the dropping object on the edge of the long stick and dropped it from the 4th story of the KOSEN building when we experimented with the mechanical engineering students. We covered the ground with a sheet to prevent it from getting dirty from broken eggs. We had to do it under the conditions of a sunny and windless day. But it was very difficult.

Experiment of Tamago Otoshi Contest

On the day of the experiment, each site was connected online. On the Suzuka side, the project was conducted in a classroom with a high ceiling. Inside the classroom, a stick was used to drop eggs covered with buffer material. On the Swedish side, the experiments were conducted in the university or the student’s homes. Eggs were dropped from the balcony or the roof of the home. Although the drop conditions and other factors were different for each, students from both countries were able to work together in an integrated manner on the experiment.

Game and Gaming

In recent years, gaming has gradually been recognized by many people as a new and promising tool to deal with complex problems in which human decisions have far-reaching effects on others. It has been used for various purposes such as education, training, decision-making, entertainment, etc. Along with the appearance of various types of games, continuous effort has been put forth to make existing games more exciting. In this experiment, we carried out the Sweden game and described its educational effect. The Sweden game is one kind of “Education Gaming”. Education Gaming attempts to educate and train all participants. For example, it assumes that students don’t have much interest in economics. After playing the game for a few

hours, the students noticed their lack of basic knowledge of economics, and they felt the need to learn economics more strongly. The result is that this game has a very significant educational benefit.

The management game is a kind of Education Gaming that focuses on training. It is made for people working in a middle-class stage of companies. When a person is promoted to a position that has a direct impact on the management of a company, there is the possibility of a big “Risk”. This is because when a person who lacks experience is entrusted with important business, he or she may not know the appropriate action. In such a situation, by playing a game that simulates the management of the company again and again, the person will be able to master "How to manage the company" without entailing a greater risk.

Sweden game and cost-sharing issue

” Sweden game” is a sort of education gaming aiming at the educational effects on the participants. The game focuses on cost-sharing issues: who will pay the cost and how the total cost will be shared. Six regions in the southern area of Sweden are planning to construct pipelines to cooperatively get water resources. Every area wants to minimize its financial expense for pipeline construction as much as possible. Under such a condition, students find the best solution by gaming, discussing, and using shared files online.

Figure 4 Six regions of the southeast area of Sweden, planning pipeline construction.

Figure 4 shows the six regions, A, H, K, L, M, and T in the southern area of Sweden. These six regions are planning to construct pipelines to cooperatively get water resources. The kinds of cooperation, A, H, K, L, M, and T are 2^6-1=63. We show the cost of pipeline construction in Table 4. We show the population of each region and the quantity of spending on water in Table 5. Of course, every area wants to minimize its financial expense for pipeline construction as much as possible. Under such a situation, what is the final solving conclusion? One method is the proportional distribution of an amount of demand. Another method is the proportional distribution by population. Generally, these approaches are good determination methods. In this situation, it is necessary to construct all regions of the pipeline from the whole region's viewpoint.

Table 4 The cost of pipeline construction. (Unit: 100,000 crones)

Team	Cost	Team	Cost	Team	Cost	Team	Cost
A	219.5	KM	314.5	HKM	425.5	AKLT	707.2
H	170.8	KT	328.9	HKT	449.4	ALMT	734.1
K	108.1	LM	311.0	HLM	458.1	HKLM	480.7
L	158.8	LT	378.6	HLT	469.8	HKLT	492.4
M	208.1	MT	394.1	HMT	564.9	HKMT	593.5
T	219.8	AHK	407.4	KLM	420.1	HLMT	644.1
AH	346.9	AHL	432.2	KLT	487.7	KLMT	566.1
AK	328.6	AHM	555.0	KMT	503.2	AKMT	722.7
AL	378.3	AHT	566.7	LMT	514.6	AHKLM	697.6
AM	427.6	AKL	487.4	AHKL	489.5	AHKMT	774.2
AT	439.3	AKM	534.0	AHKM	602.5	AHLMT	830.0
HK	229.6	AKT	548.5	AHKT	627.2	AHKLT	709.3
HL	250.0	ALM	530.5	AHLM	640.3	AKLMT	739.7
HM	378.9	ALT	598.1	AHLT	652.0	HKLMT	664.6
HT	390.6	AMT	613.6	AHMT	741.0	AHKLMT	838.2
KL	267.9	HKL	272.6	AKLM	639.6		

Table 5 Population and the quantity of spending water in each region.

	A	H	K	L	M	T
Population (1000)	85.0	176.3	26.8	69.0	287.3	59.5
Amount demand (Mm^3/Year)	6.72	8.23	3.75	3.53	14.64	5.39

Table 6 Proportional distribution of a population

	A	H	K	L	M	T	計
Population (1000)	85	176.3	26.8	69	287.3	59.5	703.9
Proportional	101.2	209.9	31.9	82.2	342.1	70.9	838.2
Single	219.5	170.8	108.1	158.8	208.1	219.8	1085.1

Table 7 Proportional distribution of the amount of water demand

	A	H	K	L	M	T	計
Amount demand (Mm^3/Year)	6.72	8.23	3.75	3.53	14.64	5.39	42.26
Proportional	133.3	163.2	74.4	70.0	290.4	106.9	838.2
Single	219.5	170.8	108.1	158.8	208.1	219.8	1085.1

Table 8 Proportional distribution by the single construction cost

	A	H	K	L	M	T	計
Proportional	169.5	131.9	83.5	122.7	160.8	169.8	838.2
Single	219.5	170.8	108.1	158.8	208.1	219.8	1085.1

However, as shown in Tables 6 and 7, these are not necessarily proportional to the construction expense. Table 6 shows the proportional distribution of a population. In this situation, regions H and M have

complained. Because their shoulder costs are 209.9 and 342.1 respectively, but single construction costs are only 170.8 and 208.1 respectively. For regions H and M, it is better to withdraw from the partnership. Table 7 shows the proportional distribution of the amount of water demand. In this case, region M has complained. Because its shoulder cost is 290.4, but the single construction cost is only 208.1. For Region M, it is better to withdraw from the partnership. Table 8 shows the proportional distribution by single construction cost. At first glance, this method of determining the shoulder cost seems to be good.

In this case, the subtotal cost of H, K, and L is 338.1. Because 131.9+83.5+122.7=338.1. However, the cost when HKL is joined up is 272.6, as in Table 4 and the surplus is 338.1-272.6=65.5. Advantageous agreement with only three districts, H, K, and L. These three regions are better to withdraw from the partnership. And A, M, and T have to pay more shoulder costs. This situation is also not a perfect condition. When such difficulty arises, the method of dividing equally is often used. Table 9 shows the assessed contribution according to the Shapley value, Nucleolus, and SCRB. No matter which method is used to determine dues, each region will still be unfairly burdened. For example, region A would favor the SCRB, which is less shoulder cost, while Region H would favor Shapley's method. One useful solution to this problem is gaming.

Table 9 The answer of the following methods.

	A	H	K	L	M	T
Shapley value	200.1	107.1	66.1	103.7	169.4	191.8
Nucleolus	203.5	120.6	50.0	86.1	186.0	192.1
SCRB	195.4	132.8	56.2	109.0	166.6	178.2

Figure 5 Explain to the students about Sweden's game

The experiment of Sweden's game

Each team wants to decrease the amount of their contribution as much as possible. However, if one team tries to save on the shoulder cost, other teams may not join them. When each team cooperates with the others a surplus as large as possible can be attained. However, the best condition is that 6 teams, "AHKLMT" construct a tie-up and the amount of the maximum surplus is just zero. Furthermore, in the situation where the maximum surplus is just zero for the six teams "AHKLMT" due to cooperation, each team must save the suitable shoulder cost.

Before starting the game, we explained to the students in advance the pipeline construction cost of all combinations as shown in Fig. 5. One group has 6-person, A, H, K, L, M, and T. The six members of one group were composed of a mix of both countries. The goal was to achieve an optimal solution through collaborative work by gaming. An Excel-shared file was prepared and the contributions of each district were entered from the group whose contributions were determined. The maximum surplus value was calculated, and the combination of teams was shown when the maximum surplus value was reached. These were calculated by Microsoft Excel and shown to the students by projector as shown in Fig. 6. Although an optimal solution was not obtained, participating students were able to think about the cost-sharing problem while having fun as shown in Table 10. For reference, Table 11 shows good solutions obtained in past gaming classes.


Figure 6 Explain the gaming result using a shared file

Table 10 Gaming results on 2 Dec. 2022

A	H	K	L	M	T	Maximum	Combination
151.1	175	92.2	87.8	207.5	124.7	82.4	HKL
161.6	140	75	120	180	161.6	62.4	HKL
149.8	179.7	90.9	86.5	208.1	123.4	84.4	HKLM
170	150	80	108.2	160	170	65.6	HKL

Table 11 Example of a good answer, each shoulder cost, the combination is "AHKLMT" and maximum surplus is "0" in the past gaming process

A	H	K	L	M	T	Maximum	Combination
184.8	126	55.8	90	199.8	181.8	0	AHKLMT
200.2	119.9	52.9	99.7	172.2	193.3	0	AHKLMT
200	123.3	52.1	90	165	207.8	0	AHKLMT
196.7	109.3	64.8	98.4	178.4	190.6	0	AHKLMT
192.3	107.8	60	84	197	197.1	0	AHKLMT

Conclusions

Due to the pandemic of Covid-19, online exchange programs are getting more and more active. However,

no matter how hard we try, there remain some restrictions to online lectures and activities, compared with face-to-face programs. Since 2021, Suzuka KOSEN has held not only lectures but also PBL-style webinar sessions, thanks to the exchange student program agreement with Turku University of Applied Sciences. In the following year, as we mentioned above, the engineering experiments were conducted online. It was a great achievement for both students to participate in the experiment together and share the results online.

Face-to-face exchange programs should be the best, but online PBL classes and experiments also contribute to the promotion of further internationalizing the programs. In the future, we are considering organically combining actual dispatch-acceptance programs and various online exchange programs. The challenge is to further improve the international exchange programs.

Acknowledgments

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References

Kusaka, T., Mori, I., Kawaguchi, M. & Lawson, M.E. (2022) Online International Exchange Connecting to the World - Toward Hybrid-International Exchange to Combine Actual Visits with Virtual Ones-, Tokai Society of Engineering Education, KOSEN subcommittee report, 16, pp19-20,

Koji Ikuta, professor emeritus at the University of Tokyo, spread this “Tamago Otoshi”
https://resemom.jp/article/2014/06/13/18949.html

The Museum of Science and Industry, Chicago,
https://www.msichicago.org/science-at-home/hands-on-science/egg-drop-challenge/

The Armidale School,
https://www.as.edu.au/national-science-week/egg-drop/

Powers, P. (1980). Duss, R., Norton, R.: THE COMMONS GAME Manual. In: IIASA

Baba, N. (1986). PC-9801 Personal Computer Gaming System. Nikkan Kogyo Publishing Company

Baba, N., Kita, T., Takagawara, Y., Erikawa, Y., Oda, K. (1996). Computer Simulation GamingSystems Utilizing Neural Networks & Genetic Algorithms. Proceedings of SPIE 2760, 495-505 (Invited Paper)

Baba, N., Takeuchi, Y., Kawaguchi, M. (2010). Foundations of Computer Information Processing and Applications. Kyoritsu Publications, ISBN 978-4-320-12249-9

Kawaguchi, M., Atsumi, K., Baba, N. (2012). The Experiment of Sweden Game and the Effect of Students Education, Frontiers in Artificial Intelligence and Applications Volume, 243, 1972-1980.

Kawaguchi, M., Kanematsu, H., Baba, N. (2015). The Experiment of Sweden Game and the Evaluations of Gaming Result, Procedia Computer Science, 60, 1170-1177.

Kawaguchi, M., Baba, N. (2016). The Efficient Method of COMMONS GAME Experiment and the Effect of Students Education, JASAG2016, 40-44