

インターナショナル・サイエンス・スタディに取り組む スーパー・サイエンス・ハイスクールにおける英語での理数科授業の実践

Science and Mathematics Lesson Practice in English at a Super Science High School Engaging in International Science Study

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1. Outline of the Activity

In international educational cooperation, strengthening science and mathematics education is one of the important issues. Since mathematics and science handle universal natural phenomena, they should be shared and exchanged among different cultures. In the Field of Mathematics and Science Education of Global Education Course of Graduate School of Naruto University of Education, staffs and students are focusing on not only deepening understanding of basic contents of mathematics and science, but also developing effective teaching materials and methods that make worldwide children improve scientific thinking attitudes and abilities with various knowledge and real experience. As part of this education and research, we planned and performed Science and Mathematics classes in English at Tokushima Prefectural Tomioka-nishi High School on November 15th in 2019. This school has been selected as a Super Science High School (SSH) since April 2019, and has engaged in international science study so far. The SSH school aims to nurture human resources who can be actively involved in regional and global fields with an international sense, and to develop a curriculum for human resource development that innovates local communities through scientific research activities. Through the activities, both we and the SSH school were able to achieve effective results that contribute to the achievement of each educational goal.

In the future, it is important for promoting international science and mathematics education to strengthen win-win relationship with the SSH school.

In the following section, we introduce the details of the classes and the exchange activity with the SSH students.

2. Mathematics Class for 10th Grade (4th period, 50 min)

2.1. Background

On the 15th of November 2019, there was an opportunity to implement a mathematics lesson at Tamioka-nishi High School as part of Studies in International Lesson in International Cooperation's proactive activity. The chosen topic was SOLVING SYSTEM OF LINEAR EQUATION INVOLVING REAL WORLD PROBLEMS. This topic was implemented to thirty-eight of first-year students or ten graders. This topic was chosen because it incorporates real world problems which can help students with the ideology that mathematics is not only about complicated numbers or computation, but it is essential to deal with daily life situations. Although, solving system of linear equation usually introduced in primary schools, it was an interesting topic to use their computation skills in word problems that incorporate real world scenarios. Introducing Polya's Problem Solving Method through collaborative learning was the objective of the lesson. Polya's Problem Solving Approach is composed of four steps include; Understanding the Problem, Devising a Plan, Carry out the Plan, and Looking Back. The important aspect to consider in the step of Understanding the Problem includes "what we know and what we want to know?" In Devising the Plan, we look for ways or

best way to attack the problem. For example, guess and check, drawing, making a table, make a list, or write an equation to solve. Once the idea to tackle the problem is known, try it out to see if it works. The key point in this section is to keep trying until something works. Looking back is one of the vital steps where the work needs to be revised and reflected on what worked or what did not work.

2.2. Theme & Objectives

The objective of the lesson was to use Polya's Problem Solving Method through collaborative learning to solve system of linear equations involving real world situations. The minor goal of this lesson was to exercise speaking skills, presenting skills, and collaborative skills.

2.3. Teaching Process and Materials

The sequence of the lesson was composed of the introduction of the topic and objective, activating prior knowledge activity, input, group work, group presentation, individual work, and summary¹⁾. In the prior knowledge activity, students were given a system of linear equation to solve. In the input section, the teacher tried to introduce the Polya's problem solving approach to solve a real world problem entailing system of linear equation. There were six groups assembled, and in each group there was a real world problem written in a poster for students to work collectively. Along with this poster, there was a guiding sheet that entailed the Polya's Problem solving steps for students to refer to. Figs. 2.3.1 and 2.3.2 show the poster and the guiding sheet, respectively. The question in the figures states; *'A total of 78 seats for a concert are sold, producing total revenue of 483 dollars. If seats cost either \$2.50 seats or \$10.50, how many \$2.50 seats and how many \$10.50 seats were sold?'*

After working in group, two groups were chosen to solve present their result for discussion. Students then work independently. Lastly, the conclusion was summed up stating *that knowing to solve system of linear equation can help to deal with real world situations.*

2.4. Actual Students' Learning Performance

Indeed, solving system of linear equation was an easy topic for ten graders. However, when it

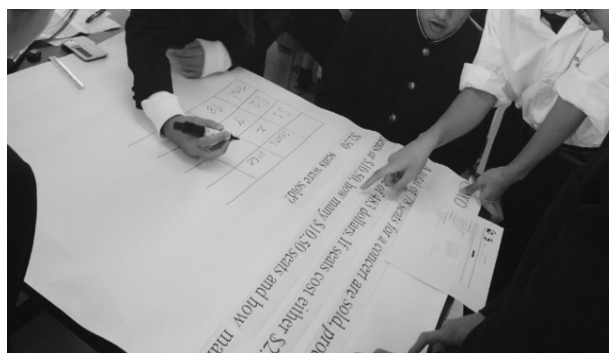


Fig. 2.3.1 An example of the posters.

came in the form of words, it was quite challenging and interesting topic for the students. In the prior knowledge activity, most students could solve the system of linear equation. When sharing their result in this part, students tend to do mental calculation and giving the answer. The expectation of the teacher was to show the work in which the student did after spent a while in the mental calculation process. Fortunately, it worked, but after the answers were detected, the process was immediately erased and the answers were kept. In the group activity, students were very engaged to share understanding collectively and collaboratively. Though, the language was an issue which made it challenging for them. Through guidance from the teacher and especially peers, students were able to finalize their result. With the use of the Polya's steps and the guiding sheet, students could able to understand the problem and follow through the problem solving approach was new for them. Figure 2.4.1 shows some of the collaborative work of students.

Out of the six groups, two groups were able to do the presentation out of the desired decision [three groups]. There were only three problems given to the group work which means that there were two groups which held the same problem. Due to time restriction, two groups holding different problems were able to present. Presenting their result was a bit challenge because it was in English. Despite this challenge, students were able to present their result for discussion. Figure 2.4.2 shows some results of group presentation. The presentation approach of students indicated that they rarely had an opportunity to present, especially in English. Students were shy, and it was an individual type of presentation. Though, it was a good experience for them to utilize their presenting skills, English skills, as well as

Group Practice			
Name _____	Grade _____	Date _____	
Direction: Direction: Please use Polya's Problem Solving Method to solve the Problem! Please refer to the steps for guidance!			
Group 3 or 4			
A total of 78 seats for a concert are sold, producing total revenue of 483 dollars. If seats cost either \$2.50 seats or \$10.50, how many \$2.50 seats and how many \$10.50 seats were sold?			
I. Understanding the Problem			
<ul style="list-style-type: none"> • a total of _____ seats are sold • Total revenue of _____ • How many seats? • Seat 1 costs _____ • Seat 2 cost _____ • What is unknown? 			
II. Devising the Plan			
<ul style="list-style-type: none"> • Which strategy will you use? <ul style="list-style-type: none"> ○ Guess and check ○ Make a table and write an equation ○ Use a formula ○ Make a list? 			
III. Carry out the Plan			
Table			
	# of seats	Price/seats	Total
Seat 1			
Seat 2			
Total			
Write equations and solve!			
Equation 1:			
Equation 2:			
IV. Looking back!			
<ul style="list-style-type: none"> • Did you check? • Looked back at what you have done • Reflect 			

Fig. 2.3.2 An example of the guiding sheets for group work.

mathematical skill. Despite these challenges, study took effort to overcome them.

2.5. Evaluation for the Lesson

2.5.1 Limitation

Language barrier is the first obstacle that limited the effectiveness of this lesson. Since the teacher barely understands Japanese, it was difficult to interact proactively. The purpose of the group work was to learn collaboratively, but to make sure that everyone is collaborating; the teacher had essential parts to assess that learning. The vital component

includes questioning the work of students individually to see that they were working together. Therefore, due to language barrier which may have led to usage of more time, this crucial part was eliminated.

2.5.2 Reflection from Students

After the lesson, there were three questions asked in regards to the lesson. These questions were basically about how was the lesson and how would I improve it. Most of the students indicated that it was interesting to be taught in a different teaching style and to use the Polya's Problem Solving approach. The

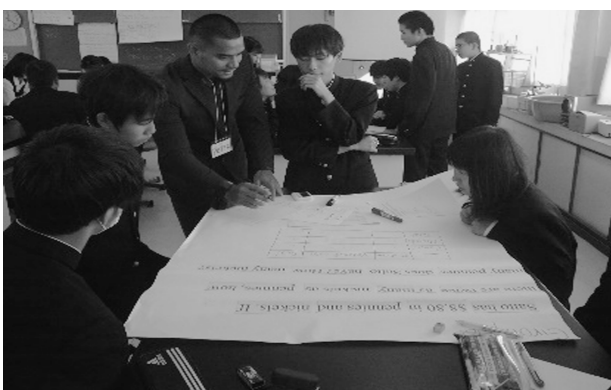
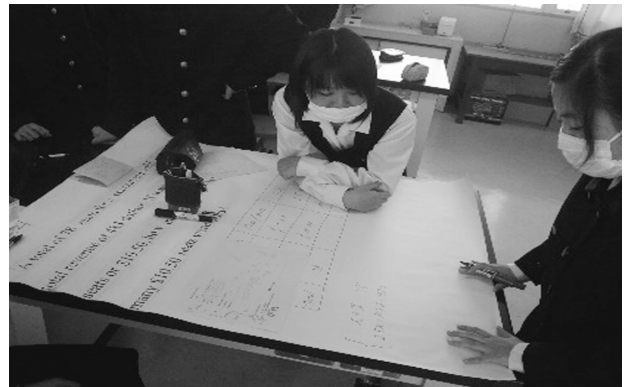
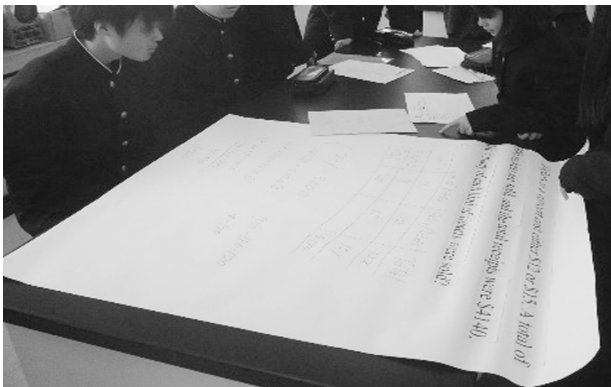


Fig. 2.4.1 Some of the collaborative work of students.

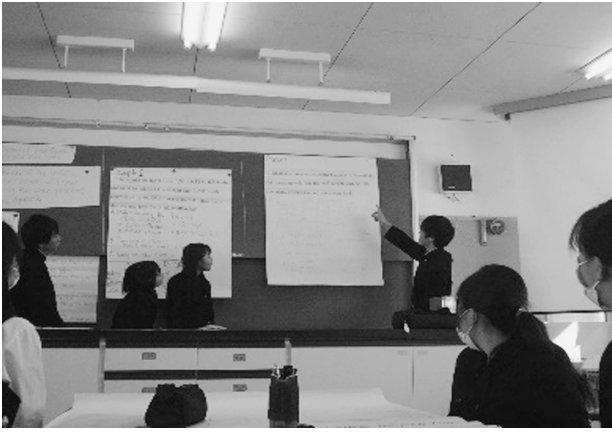


Fig. 2.4.2 Some results of group presentation.

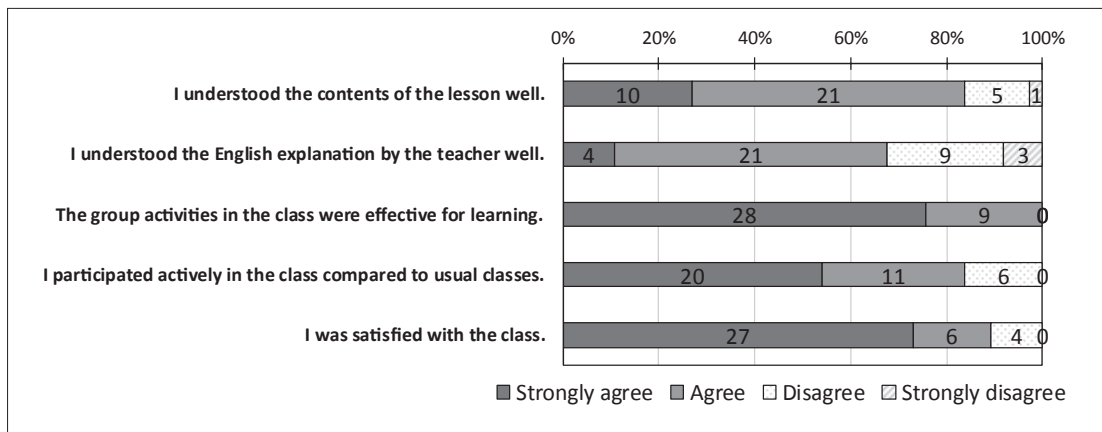


Fig. 2.5.1 Feedback results of students (n = 37) about the Math lesson.

most important aspect indicated by them to improve the lesson was to speak even slower. They even insisted that language was a barrier for them as well. Fig. 2.5.1 indicates the feedback of students about the lesson.

2.6. Conclusions

In conclusion, it was a great experience for me, and especially for students to build on our expertise. Although language and time were huge challenges, the learning outcome was satisfied. Student had an opportunity to be taught in a unique teaching approach and problem solving approach. The expectation of the collaborative work was to ensure that everyone was participating, especially to ensure that everyone understood the content and approach. However, due to language barrier and time, this aspect was not measured. Asking questions to the students with low-academic performance, would be the target of this collaborative approach. Even if the lesson was quite demanding for this obstacle, students showed engagement and collective effort to tackle their given

problem. Using Polya's Problem Solving approach through collaboration can be one of the helpful ways to tackle real world problems and to enhance collaborative skills and mathematical skills.

3. Science Class for 11th Grade (5th Period, 50 min)

3.1. Background

Global sea level is currently rising and is significantly affecting the areas of low-lying islands and atolls such as the Marshall Islands, Kiribati, Tuvalu, and the Maldives. Sea level rise is a result of both ocean thermal expansion and the melting of ice on land. According to NASA²⁾, "From 1961-2003, sea level rose due to thermal expansion and glacier melt (from small glaciers, ice caps, and ice sheets) at a rate of 1.11 millimeters (0.04 inches) per year. Between 1993 and 2003, the contribution to sea-level rise increased for both sources to 2.79 millimeters (0.11 inches) per year."

The effect of sea-level rise for more prominent countries might not yet be felt or urgent, but for us who live in the atolls, it is now happening and is already

damaging infrastructure, farms, and contaminating underground freshwater supply. The inundation has now become frequently experienced, and it is rising very fast.

iceberg) will not cause a rise in sea level when they melt, whereas ice on land will cause an increase in sea level when they melt.

3.2. Theme & Objectives

1) At the end of the lesson, the student will be able to interpret the results of scientific observation.

2) The student will be able to explain that the volume of water increases when it is heated and that it will cause sea level to rise through a process called thermal expansion.

3) Students will be able to draw a table and explain through group presentation that ice on water (such as

3.3. Teaching Process and Materials

We practiced the class along with following teaching plan.

Teaching Plan

Teacher: Vladimir Gulfan **Subject:** Biology **Grade:** 11

School: Tomioka-nishi Senior High School **Topic:** Effects of Sea Level Rise **Theme:** Climate Change

Date: November 15, 2019 **Duration of Lesson:** 50 minutes

Learning Outcomes:

- 1) The student will be able to interpret the results of scientific investigation.
- 2) The student will be able to explain that the volume of water increases when it is heated and that it will cause sea level to rise through a process called thermal expansion.
- 3) Students will be able to describe and demonstrate that ice on water (such as iceberg) will not cause a rise in sea level when they melt, whereas ice on land will cause an increase in sea level when they melt.

Warm-up Activities: Review the following vocabulary (5 min)

Discuss prior knowledge about "Greenhouse Effect vs. Global Warming"

Time	Flow of Learning	Student Activities	Teacher Activity/ Support
5 min	<u>New Vocabulary:</u> 1) Glaciers 2) Thermal Expansion	•Each student will be given respective roles to play in the activity.	•Discuss climate change and sea-level rise with students. Ask students to identify the causes of sea-level rise.
10 min	Hands-on Activity: •Worksheet 1-A – Melting Ice •Worksheet 1-B – Thermal Expansion	•Ask a volunteer from each group to write their answers on the board.	•Or the teacher can ask each group for their answers and write them on the board.
10 min	Observation / Results •Worksheet 1-A – Melting Ice •Worksheet 1-B – Thermal Expansion	•Students to work in their respective groups. •Record results and discusses them as a group.	•The teacher will go around and supervise. •Ask volunteers from each group to write their results.
10 min	Summary: The students will write their conclusion based on the results of their experiment.	Students to observe the data and discuss the following questions: •What happened to the water level as heat energy was added?	•Answers from the different groups will be written on the board. •Explain why the water level in the straw changed over time. What caused this?
10 min	Wrap-Up/Discussion •Students will watch a video about Marshall Islands experience with Sea Level Rise.	1. Why might we be concerned about sea-level rise? 2. What can we do to help slow this process?	•Refer to the guide questions. •Discuss with the students after the video.

For the students' activities A and B, we prepared and used below materials.

Activity A (Melting Ice on Land & Melting Ice on Water)

Materials	Quantity
Beaker (300 mL)	2 Per group
Clay (can be replaced by rocks)	Depending on the number of groups
Ice cubes	(5 for each beaker) Depending on the number of groups
Water	Fill beakers up to 200 mL
Permanent Marker (thin pointer)	1 per group
Paper towel	1 box

Activity B (Thermal Expansion)

Materials	Quantity
Flask (300mL)	1 per group
12-inch Thermometer (can be glass/digital)	1 per group
Glass tubing (12 inch)	1 per group
Lamp (with 200-300W bulb)	1 per group
Permanent Marker (thin pointer)	1 per group
Rubber stopper with 2 holes	1 per group
Water	Fill the flask up to the brim

3.4. Actual Students' Learning Performance

Some examples of the students' actual work are shown in Figs. 3.4.1 and 3.4.2.

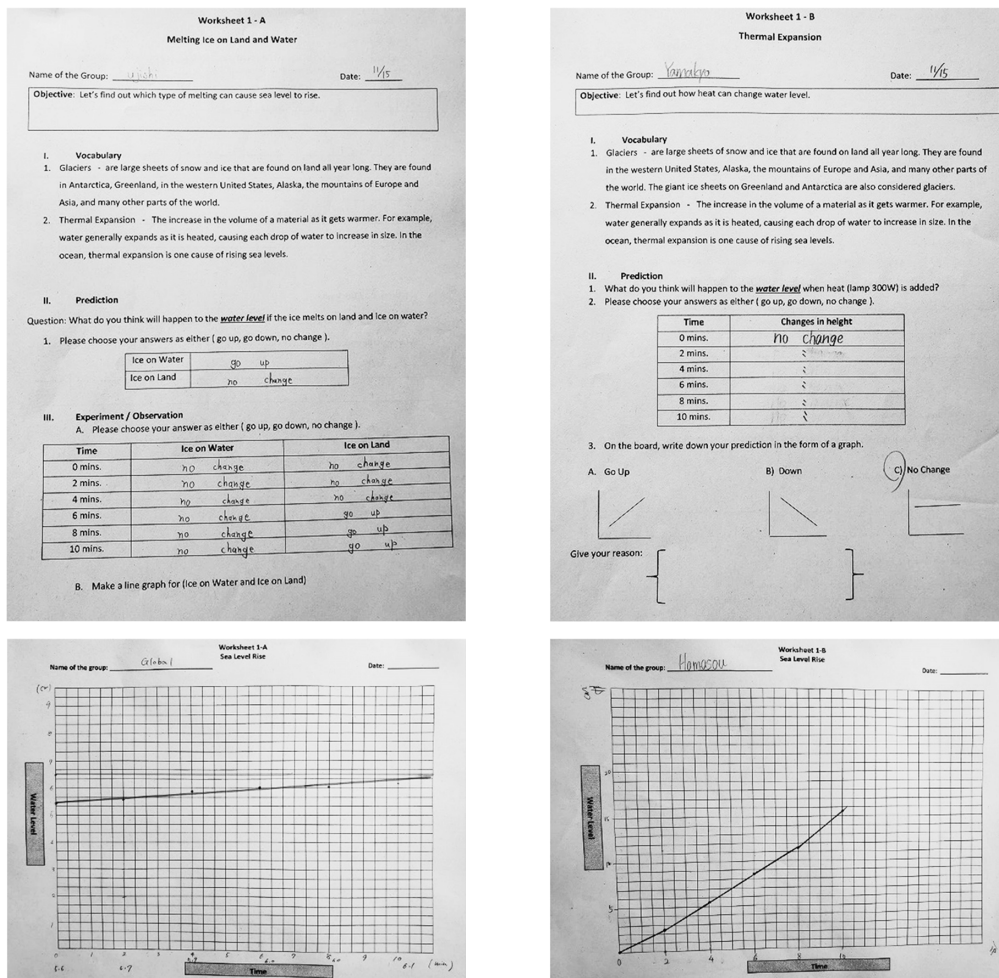


Fig. 3.4.1 Examples of students' worksheets for A) melting ice on land & melting ice on water (left) and B) thermal expansion (right).



Fig. 3.4.2 Students' group experiments on A) melting ice on land & melting ice on water (left) and B) thermal expansion (right).

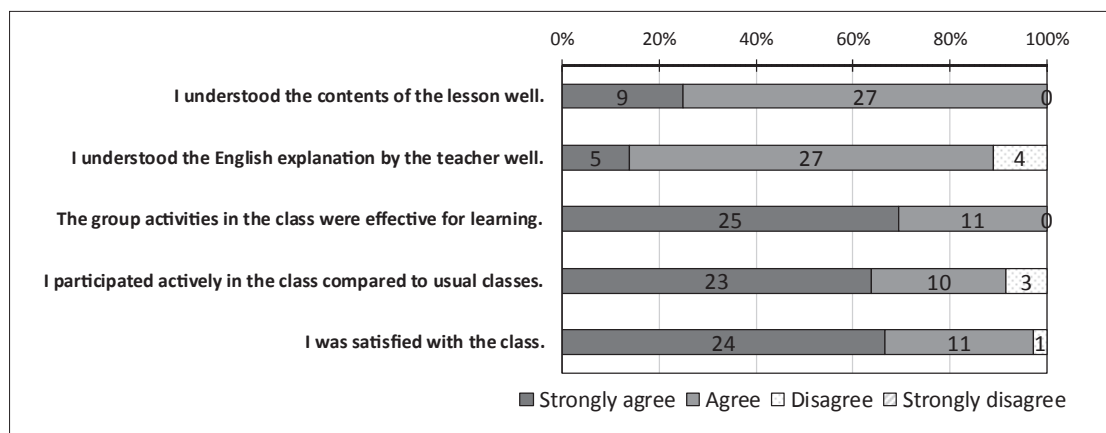


Fig.3.5.1 Feedback results of students (n = 36) about the Science lesson.

3.5. Evaluation for the Lesson

To investigate students' responses to this lesson, we asked some questions to the students after the lesson. Fig. 3.5.1 shows the feedback results of students about the lesson. We also asked below points and obtained students opinions as follows:

•**Question 1. What did you learn in this lesson?**

Most of the students' response was that they were able to learn and understand more about greenhouse effect vs. the global warming. Some replied that they learn about the effect of sea level rise and thermal expansion.

•**Question 2. What is interesting in this lesson?**

Majority of the students' response was that they were able to experiment with the effects of climate change particularly on the topic concerning sea level rise. Some likes the comparison between the experiments on melting of ice on water vs. melting of ice on land. Other students wrote that they began to understand clearly when they saw the actual events on the video.

•**Question 3. What can you suggest to improve the**

lesson?

Some students suggested that if possible to speak a little bit of Japanese while others point out that they will be given ample time to think and answer the questions.

3.6. Conclusions

There were 38 total number of students who participated in the science lesson and were separated into two groups. The first group was assigned to do an experiment about ice that melts on land and ice that melts on water, while the second group was doing thermal expansion experiment.

The flow of the lesson went a bit slow; this is because mainly of the language barriers. It was a bit challenging to finish the whole lesson in fifty minutes since there were two different experiments. Giving instructions for both experiments takes much time, and also the students' presentation as well.

Overall, the students not only learn about what causes sea level to rise, but they also enjoyed lessons through cooperative learning by discussing and



Fig. 4.1 Q&A session scenes and a group photo with the 10th and 11th grade students.

working together as a group.

4. Exchange Activity with 10th and 11th Graders of the SSH School (6th Period, 50 min)

The exchange activity with the students was very fruitful because despite the students' English proficiency is concerned, they were able to prepare and share their culture, daily school activities, and their extracurricular programs through a powerpoint presentation. After the students' presentation, we had a chance to introduce our country, culture, and our condition concerning sea-level rise. The students were surprised when they saw the video for the reason that the Marshall Islands has no mountain and is very much vulnerable to sea-level rise. The average land height is only between 2 to 3 meters above sea level. Moreover, how to greet in our language and "slang" words were the most common questions the students ask.

The exchange with the students was friendly and exciting as shown in Fig. 4.1. I really appreciated

their desire to know the culture of our countries. The questions asked by the students perfectly sum up Japan's openness to the rest of the world. I also learned a lot with them, especially the place of mathematics and sciences in their training. Organizing classes for group work, and conducting the lesson are the aspects that I could experiment in my country.

Acknowledgements

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References

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