

スーパー・サイエンス・ハイスクールにおける インターナショナル・サイエンス・スタディと国際交流活動

International Science Study and Cultural Exchange Activity
at a Super Science High School

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1. Outline of the activity

The improvement of science and mathematics education is one of the important issues for international education cooperation. Science and mathematics should be shared and exchanged among different cultures since they handle universal natural phenomena and logics. In the Field of Mathematics and Science Education of Global Education Course of Graduate School of Naruto University of Education, staffs and students have been committed to developing effective teaching materials and methods for improving worldwide science and mathematics education. As part of the educational activities, we performed science classes in English for Japanese 10th and 11th grade students on November 12th in 2021 at Tokushima Prefectural Tomioka-nishi High School selected as a Super Science High School (SSH). The SSH school has engaged in “International Science Study” so far to nurture human resources who can act both regional and global fields with an international sense. Through the lesson practice, both we and the SSH school were able to strengthen the win-win relationship each other and to obtain fruitful results

contributing to each educational goal. In the following section, we introduce the details of the classes and the exchange activity with the SSH students.

2. Biology class for 10th grade by Sarah group (4th period, 50 min)

2.1. Theme and objectives

The theme “Creation, growth, and genetics” is one of the major parts of the Japanese curriculum on Life subject. It was first developed in the 5th grade of elementary school with the lesson: germination of plants and reproduction of animals. Then, this theme was taken up again in the 3rd grade of middle school with the lesson: “Growth and reproduction”. And later in high school, students learn the lesson: “Genes and the laws of genetics” and “Genes and how they work”.

In this context, especially for “Growth and reproduction”, the lesson we have done is about the MITOSIS cell division. The part of the lesson that we developed during the allocated time is the main feature of MITOSIS related to conformed reproduction. In this framework, the process or the different phases of cell division is the main content. To this end, some of the objectives of this lesson are:

- Students should be able to explain conformed reproduction based on the transfer of genetic material.
- Students should be able to recognize each phase of the different stages of MITOSIS.

2.2. Teaching process and materials

The teaching method is based on the Japanese problem-solving approach. The Japanese textbook was used to design the lesson plan. The main problem was: are the genetic materials of the mother cell and the new cells same or different? For this, students made their hypothesis following their observations and some examples in the introductory part. During the course, we tried to develop individual work as well as group work. In addition, student experiments and presentations were planned. This course was taught to 40 students of 10th grade, divided into 10 groups of 4 students. The lesson plan is represented in Table I.

We gave each student a worksheet (Figure 1) to assess their prior knowledge, especially regarding the role of chromosomes and their importance in cell

division. For student activities, the staining experiment was performed with the material below: Germinating onion seeds with the hypocotyl (root) 10-20 mm long, 50% glycerol solution or GW (white capped bottle), 0.5% acetic violet solution (red capped bottle), 1 mol/L HCl (yellow cap bottle), kettle, microscope, coverslips, cover glasses, any container, paper cup, thermometer, clothespin. A group worksheet also was made to explain the main task (Figure 1).

The Figure 2 shows several scenes from the lesson. Based on the visual support provided by the slides and the experimentation guide, the teacher gave instructions, which all groups followed at the same time, step by step. However, for the preparation of the slides, each student did this part individually to allow them to fully participate and observe their slides for themselves.

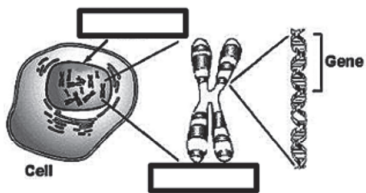
At the end of the lesson, a brief explanation with drawing material was done to understand some details of cell division that we cannot find under the microscope.

Table 1. Lesson plan

STEPS/ DURATION	TEACHING/LEARNING ACTIVITIES	
	Teacher's role	Learner's activities / attitudes
Reminder of Prerequisites (6 min)	<p>Question: How do we call the smallest unit that can live on its own in living organisms?</p> <p>Introduction: In this picture, a man gets injured but after some time, a new skin recovered his injury. To recover the injury, how does cell multiply or reproduce?</p>	Cell multiply by division. Basic structural and functional unit of life.
Presentation of the problem and hypothesis (2 min)	<p>What can we say about the genetic material of new cells and the mother cells? Same or different?</p> <p>During cell division, how might be the transfer of genetic material?</p>	Predictions may be the genetic material of the mother cell was shared in two for two new cells.
Instruction (26 min)	<p>We will observe the microscopic view of one plant in full growth. (we used a stain which colors the chromosome)</p> <p>Teacher gives some instruction of the experimentation, and gives some awareness of dangerous tools.</p>	Students do the handling.
(4 min)	Announcement of the next task which consists of the drawing of the different cells.	Students present/make a confrontation of their result. Students do a presentation.
Instruction (10 min)	<p>Teacher names each phase and explain the repartition of chromosome and give some notice regarding the similarity of the number of chromosomes for all cell.</p> <p>The teacher explains the conformed reproduction. The chromosome plays a great role in cell division. To ensure the transfer of the genetic information, it's primarily copied and we get a double chromosome. This last is separated when the cell division occurred.</p> <p>Question: Before cell divides in two, what important preparation was carried out to allow the equal repartition of genetic material?</p> <p>Teacher gives some instruction for student and ask them to name each phase that they have found.</p>	<p>Students listen.</p> <p>Students write and reply: The chromosome was first copied and only after that divided. Students name each phase that they have found. Students reply to the question.</p>
Application of knowledge through hands-on activity		
Evaluation (2 min)	<p>Teacher takes the example of new skin and last one to illustrated the conformed reproduction.</p> <p>Teacher asks a question about the number of chromosomes before and after division.</p>	Students answer.

Questions for you!

1- Fill the missing part in the drawing of the cell below

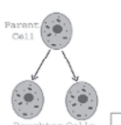


2- True or False


- Chromosomes are only visible during cell division
- Chromosomes carry the basic genetic material

3- Circle the right answer:
Based on our example: INJURY RECOVERY – GROWTH OF THE PLANK!
After the division the material genetic in the mother cell and the new cells are


SAME or
DIFFERENT



Observe and find different aspect of cell
Draw any different cells that you have found.
(One cell per sheet).
Example:



1- With this video, sort by order any typical shape that your group have found. Now using glue, stick these papers in a big one.



2- According your analysis, what is the purpose of this movement of chromosomes during cell division?

Figure 1. Individual and group worksheet



Figure 2. Different scenes during the lesson

2.3. Evaluation and limitation

At the end of lesson, an opinion survey was given to the students of grade 10. The student's response in Figure 3, shows that strongly agreed students, 48% likes, and 56% enjoyed the science lesson in English whereas, agreed 48% likes, and 36% enjoyed the science lesson in English. Also, 40% agreed and 48% strongly agreed that the lesson was meaningful for them. Finally, 60% agreed and 16% strongly agreed that they have seen chromosomes very clearly in a

microscope. However, 28% agreed and 8% strongly agreed that science lesson was difficult for them to learn in English.

There is also some time restriction due basically to the long experimentation process and also the challenge of using English for instruction. This can be seen by the incomplete responses provided by students for some exercises. Nevertheless, the word list was a great support for this lesson.

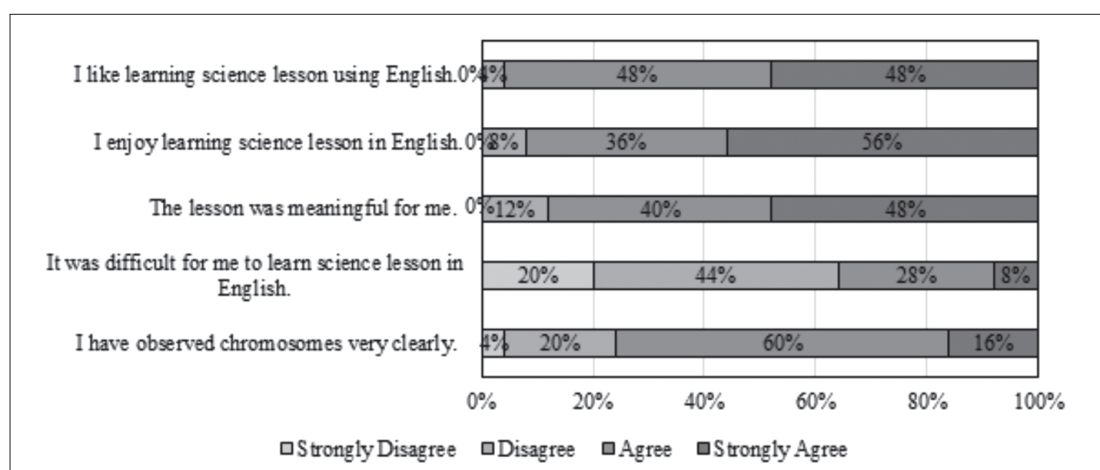


Figure 3. Responses of 10th grade students in a survey (n = 25)

2.4. Conclusions

In conclusion, science is an ideal subject for students to trace the scientific process. The lesson was designed to help students to apply their science skills. Secondly, the topic of cell division was a great way to teach about conformed reproduction during the growth of organism. Through this lesson, we hope that these students will have a broad perspective of the use of science knowledges and skills for their future studies as well as their careers.

3. Chemistry class for 11th grade by Martial group (5th period, 50 min)

3.1. Background

3.1.1. Teaching chemistry as a means of developing individual skills in science

Chemistry involves measuring and experimenting with chemical products and formulas. This measurement and experimentation reveal part of the complexity of teaching chemistry because the manipulation of chemical equations, the knowledge of the different chemical elements and the multiple reactions may be a difficult concept to teach, however, fundamental in the process of building the scientific

mind of the student. The intellectual development of learners requires the mastery of different concepts in pedagogy, literature, calculation and science. Everything that is useful for mastering one's immediate environment. It is therefore necessary to teach chemistry by considering all its contribution to everyday life.

3.1.2. The difficulties encountered by the student and the teacher on this concept

It is not easy to study a chemical element invisible to the naked eye of the size of the atom where it is necessary to bring out the structure. Thus, students and teachers are limited to deduce and to complete their imagination to obtain the concrete structure, which reflects the experimental reality. Teacher and students have only explanatory models. To recognize the atomic structure experimentally some kind of large and expensive equipment which are not available in secondary schools. Therefore, we should be noticed that observation of the atomic structure is difficult for students learning this topic for the first time.

In the traditional classroom the teacher uses experimentation in which it is expected for students to correct erroneous interpretation of natural laws as well as critical thinking through seeking consistency with experimental results. In this empirical approach can lead the student to erroneous conclusions that is expected to be useful for building his critical and scientific thinking. For the topics that is not possible to demonstrate either by experiments or calculations is usually explained using models. Teachers should use the history of science by showing the difficult and contradictory path of the reasoning of the different scientists.

3.2. The purpose of the teaching unit

The objectives of this course were to bring Japanese students who are used to learning in their own language to follow a science course conducted exclusively in English by an international student by means of the tools used in Japanese teaching. Here

the management of the teaching contents through the management of the table, the representation of the atomic structure of the atom led the students for the duration of less than one hour to try the representation of an electric model of an atom. The rest of the course allowed them to state the characteristics of a chemical element but also to calculate the number of protons, neutrons and electrons of a chemical element from the formula $\frac{A}{Z}X$.

3.3. Topic

We opted to focus this lesson on "The structure of atoms". Our key question was "What does the structure of an atom look like?"

3.4. Educational processes and materials

Introduction: The lesson consisted of an introduction which included the prerequisite knowledge, a motivation, and the presentation of the objectives together with the key question. Outlining the history of the atom served as motivation of the day. The class management strategy was based on group work with individual activities (5 groups of 8 students).

Activity 1: Starting from the reasoning and their previous knowledge, the students were led to imagine and build the atomic structure of a chemical element, to represent this model of atom by highlighting the different electric charges that it carries. In order to carry out our lesson, we used their previous knowledge, to link the chemistry lesson of the day with the experimental and empirical reality of the students. The students had to build a model of the structure of an atom and represent the different electric charges (see Figure 4). Using the students' models, the structure of the atom which is composed of a positively charged nucleus around which negatively charged electrons gravitate was highlighted. Hence, the students were able to understand the notions of neutrons, protons, electrons, number of charges, number of mass and number of neutrons (see Figure 5).



Figure 4. Evidence of lesson taking place

Activity 2: Consisted in representing a chemical element according to the formula A_ZX with an application exercise where students were supposed to calculate the number of protons, neutrons and electrons of chemical elements using the formula A_ZX and then

complete a table (confer Figure 6).

Evaluation: Students were given an evaluation worksheet to test their knowledge on the lesson by calculating the number of protons, neutrons and electrons using the formula A_ZX (see Figure 7).

Activity 1: build up your own model of the structure of the atom with the coding of the different charges

Figure 5. Structure of an atom

Activity 2: Here are 3 chemical elements with their characteristics, represent them according to the formula A_ZX .

	Atoms		
	Na	N	F
A=mass number	23	14	19
Z=atomic number	11	7	9
N=number of neutrons	12	7	10

Na N F

Figure 6. Representation of an atom using the formula

Evaluation: Calculate the number of **protons, neutrons and electrons** of the following chemical elements and complete the table:

	Mass number ($A=Z+N$)	Atomic number ($Z=$ Number of protons)	Number of neutrons (N)	Number of electrons	Formula A_ZX
Oxygen					${}^{16}_8O$
Uranium					${}^{235}_{92}U$
Carbon					${}^{14}_6C$

Figure 7. Student evaluation sheet

3.5. Evaluation and limitation

The language barrier was a handicap for the teaching and learning process to run smoothly between the teacher and the students. This is due to the fact the teacher was from a French speaking country. However, with the use of the group work, students were able to work together and discuss in groups to complete the task given by the teachers and be productive. In addition, the supervision of other

teachers helped greatly. Despite, this handicap we can see that majority of the students were able to enjoy, understand and participate actively in groups during the English science lesson (see Figure 8). Regarding the allocation of time, the teacher did not take time to talk about the models produced by the students and make an appropriate comparison among the groups and also the teacher.

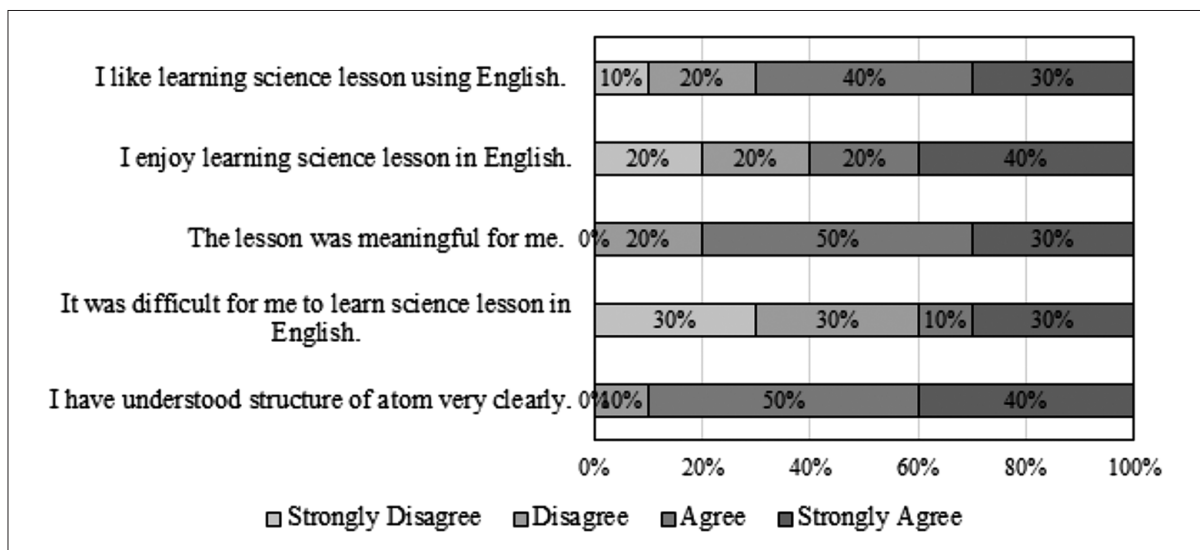


Figure 8. Results of questionnaire conducted for 11th grade students (n = 10)

3.6. Conclusions

Throughout the preparation for this course the plan was to synthesize contents from the teaching method of Burkina Faso and Japan. The content of the lesson was adopted from Burkina Faso curriculum and the presentation of the lesson was the Japanese model. It was a challenging experience, however, with the help of all parties involved the lesson was carried out according to the lesson plan. All in all, we were very satisfied with this lesson presentation which remains a great experience for us in our teaching career using the Japanese model.

4. Exchange Activity with High School Students

The day ended with an exchange activity between the international students and the high school students. Figure 9 shows several scenes of the activity. The international students made a short presentation introducing their home countries namely Burkina Faso, Madagascar, Seychelles, Nepal and China. They presented the geographical location, culture and customs,

tourist spots, traditional dances as well as dishes of their home countries. This was a good opportunity for the senior high school students to enhance their knowledge of the world and develop appreciation for various cultures. Following the presentation by the international students, the high school students introduced their school and expressed their appreciation for the English science lesson. According to their representative, it was a very enriching experience for them. It is important to note that the students made their presentation entirely in English. After that, the international students were presented with a small canvas name plaque written in katakana by using the art of calligraphy as a token of gratitude.

Finally, the students carried out two exciting demonstrations, firstly the Japanese martial art of archery called Kyūdō followed by the Japanese Kendo which is a type of martial arts that uses bamboo sword accompanied with a protective armor. The event was a real satisfaction for all the people who worked to make it happen. We hope to meet again in the future, with more activities and interactions.



Figure 9. Scenes of the exchange activity

Acknowledgements

The lesson was conducted in fine conditions thanks to the great help from the staffs in Tomiokanishi High School and the precious support from teachers at Naruto University of Education. Following that, students were able to conduct some experiments

by themselves. The students also used English and were able to participate in the course.

We would like also to express our special thanks of gratitude to the teacher Prof. Yoshihiko YONEZAWA who gave us the opportunity to prepare the experimental part under his supervision and his important guide.