A Practice Report on CLIL in Japan: Focusing on Biomimicry at the National Institute of Technology

Informe práctico sobre el AICLE en Japón: Centrándose en la biomímesis en el Instituto Nacional de Tecnología

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ABSTRACT. This paper presents a soft-CLIL (content and language integrated learning) practice focused on biomimicry, conducted at Japan's National Institute of Technology (NIT). Biomimicry involves solving problems and creating new things by drawing inspiration from animals, plants, and other living organisms to design and enhance human-made products and processes. Learning about biomimicry aligns with the educational objectives of NIT, which aims to cultivate individuals capable of contributing to realizing a more sustainable society through innovative technologies. With this goal in mind, I implemented a soft-CLIL class focused on biomimicry for second-grade students at NIT, aged 16-17. After studying exemplary cases of biomimicry, students delivered presentations on the topic. Some students attempted to apply the concept of biomimicry to propose concrete solutions for addressing social problems.

Key words: Soft-CLIL; government-approved textbook; Biomimicry; STEAM.

RESUMEN. Este artículo presenta una práctica de AICLE (aprendizaje integrado de contenidos y lenguas extranjeras) centrada en la biomímesis, llevada a cabo en el Instituto Nacional de Tecnología (NIT) de Japón. La biomímesis consiste en resolver problemas y crear cosas nuevas inspirándose en animales, plantas y otros organismos vivos para diseñar y mejorar productos y procesos fabricados por el hombre. El aprendizaje de la biomímesis está en consonancia con los objetivos educativos del NIT, que aspira a formar personas capaces de contribuir a hacer realidad una sociedad más sostenible mediante tecnologías innovadoras. Con este objetivo en mente, impartí una clase de soft-CLIL centrada en la biomímesis para alumnos de segundo curso del NIT, de entre 16 y 17 años. Tras estudiar casos ejemplares de biomimetismo, los alumnos hicieron presentaciones sobre el tema. Algunos intentaron aplicar el concepto de biomimetismo para proponer soluciones concretas a problemas sociales.

Palabras clave: Soft-CLIL; libro de texto aprobado por el gobierno; biomimetismo; STEAM.

1. Introduction

Japan's National Institute of Technology (NIT), which is called "Kosen" in Japanese, aims to "develop individuals who can contribute to the realization of a more sustainable society through the creation of innovative technologies" (NIT, 2023, p. 10). In alignment with this educational objective, students at NIT undergo intensive technology-focused education for five years, from ages 15 or 16 to 19 or 20. This academic structure resembles a combination of high school and college within the Japanese educational system. Possibly because of this resemblance, it is common for English teachers to use an ordinary government-approved English textbook to teach English to students in NIT, although the textbook does not usually include technological topics. This can be regarded as incompatibility with the educational objective above because NIT is supposed to provide intensive technology-focused education and therefore it would be more compatible that their English textbooks include technological topics. Against this background, this practice-based article aims to report on my implementation of a soft-CLIL class focusing on a technological topic using a government-approved textbook.

2. Conceptual Framework

2.1. Content and language integrated learning (CLIL)

CLIL is defined as "an education approach in which various language-supportive methodologies are used which lead to a dual-focused form of instruction where attention is given both to the language and the content" (Coyle et al., 2010, p. 3). CLIL builds on the "4Cs framework" of Content, Communication, Cognition, and Culture or Community. The Japan CLIL Pedagogy Association (J-CLIL) summarizes these points as follows:

> "The primary characteristic of CLIL pedagogy is that teachers
> 1) emphasize content learning in the language classroom (content),
> 2) focus on learners' thinking and learning skills when learning

languages (cognition), 3) improve their communicative competence (communication), and 4) cultivate their cultural or intercultural awareness (culture)." (J-CLIL, 2022)

CLIL class can be categorized into two parts: One is hard-CLIL, prototypical content-oriented model, and the other is soft-CLIL, "an alternative version of Content and Language Integrated Learning in which, although both language and content learning aims are the focus, the emphasis is primarily on language learning" (p. 1).

Biomimicry

Lurie-luke (2014, p.1495) stated, "[t]he methodology of biomimicry is to gain an understanding of the fundamental principles of a biological process or adaptation and to subsequently adapt these concepts for bio-inspired product applications or to solve specific technical challenges." In simpler terms, implementing biomimicry involves two steps: (1) comprehending how living things exist in nature, and (2) exploring how their traits can be harnessed to create new products or technologies. Since biomimicry can be a hint of coming up with a sustainable technology (Benyus, 2004), learning about biomimicry is compatible with NIT's educational objective, which could encourage students to utilize their technological knowledge and skills for the realization of a sustainable society. In fact, Suzuki and Tataku (2009), the researchers working at NIT and teaching engineering to students, conducted research on the possibility of creating a robot that mimics human walking movements. In this case, it would be possible to expect students to get insight into how they can create something innovative by imitating a trait of a living thing, which is compatible with NIT's educational objective.

3. Context

The CLIL class addressed in this paper can be elaborated on based on the 4Cs framework as follows:

Table 1. The outline of the CLIL class addressed in this paper

4Cs framework	Details
Content	The concept of biomimicry and how it can be utilized for the realization of a sustainable society
Communication	The English expressions used in the reading passage on the government-approved textbook / How to deliver a speech on the idea of biomimicry
Cognition	Explaining a unique trait of living things in nature / Generating ideas of biomimicry
Culture or Community	Considering biomimicry in the context of the sustainability of society / Thinking about biomimicry with peers

Since this CLIL class described in this paper is based on the content of a government-approved English textbook for Japanese high school students, it can be categorized as a soft-CLIL class with an emphasis on the learning of language (English). As previously mentioned, I implemented this soft-CLIL initiative for second-grade students at NIT, in November 2023. A total of six lessons were dedicated to exploring biomimicry: four lessons for input activities, one for speech preparation, and one for the speech session. These activities are described in Section 4. Each class was 90 minutes long. Prior to this practice, students had participated in four units of soft-CLIL classes, none of which were centered on technological topics. The total number of students experiencing this CLIL class was 82, divided into two classes, one of which has 42 students and the other has 40. The students were used to learning in the style of CLIL, and their English levels are approximately around the A2 level of the Common European Framework of Reference (CEFR).

4. Activities

4.1. Input Activities

This soft-CLIL class employed the 'Round-based Soft CLIL Approach' (Izumi, 2022). Students initially engaged with the topic of biomimicry by reading the text on CROWN English Communication II (Sanseido, 2022), which is a government-approved textbook. The textbook includes 10 sets of texts with different topics. It is common for these 10 texts to be used throughout one academic year in public high schools.

Every text in the textbook was divided into four sections, with each CLIL lesson focusing on one section. Following the reading of a section in class, students delved into learning vocabulary and expressions specific to that portion through various tasks. Subsequently, students progressed to additional input tasks designed to explore detailed exemplar cases of biomimicry. The additional input tasks aim to help students learn in detail about biomimicry and acquire the necessary English expressions for discussing it. The following table outlines the reading passages and the subsequent input tasks undertaken by the students during the class.

Table 2. The outline of the input activities

Content of Reading passage	Additional Input Task
The importance of Biomimicry from the perspective of sustainability	Students read an article on several other examples of biomimicry and discussed which one impressed them the most and the reasons behind their choice.
The importance of learning from nature to solve social problems	Students watched a video demonstrating how the shape of a kingfisher's beak was employed to address the challenge of a bullet train. Following this, they researched an animal with a unique trait.
Brief introduction of biomimicry cases: Lotus leaves and termite mounds	Students watched a video demonstrating how the structure of a termite mound was employed to address the challenge of the construction of a shopping mall. Following this, they researched an animal with a unique trait.

Content of Reading passage	Additional Input Task
Conclusion: The importance of looking at nature to the solution of problems	Students watched a video demonstrating how the structure of a shark skin was employed to address the sanitation challenges in a hospital. Following this, they researched an animal with a unique trait.

Additional input tasks involved watching short videos that focused on exemplar cases of biomimicry, with the exception of the first task. Initially, the teacher assigned a reading task as part of the input activities, but this resulted in students' boredom as they encountered another reading material following the textbook passage. Consequently, in the second class, the teacher introduced a watching task, which proved to be more effective. Students engaged with this input task with greater enthusiasm compared to the initial reading task. I believe that the worksheets used in the watching task played a role in maintaining students' focus and enjoyment during the input activity, and one of the worksheets is provided below.

Figure 1. Worksheet for the input task

Problem of Shinkansen

A Japanese bullet train travels (   ) – (   ) miles per hour.
➢ Inside of the tunnel, the train makes a (s   ) (b   ) at the exit.
➢ The big sound could be heard by people living (   ) meters away.
➢ Engineers had to solve this problem.
＊ one mile = 1.6 kilometers

Who solved this problem?

(E   )(N   ) was the director of the development of the bullet train.
➢ He was not only an engineer, but also a (b   ).
➢ He took pictures of a (k   ) to study the bird.
➢ The bird flies (   ) miles per hour before diving into water without making a splash.
➢ Nakatsu thought the bird can do this because of its sharp (b   ).

What did the team of the engineers do?

The engineers in Nakatsu's team did some tests.
➢ They made various shapes of shinkansen's (h   ).
➢ The most successful shape was similar to kingfisher's (b   ).
➢ Thanks to the bird, Nakatsu could solve the problem of sonic boom!

<u>Other merits of the new design</u>

➢ The train with the new design was running at a (   ) speed.
➢ Another merit of the shinkansen: reduce the (   ) *consumption.
    *消費
➢ The train has (   )% less *air resistance   *空気抵抗

This worksheet served as scaffolding for the input activity. Recognizing that the content of the video was interesting and insightful but had a high English level for the students, the teacher created this handout and instructed students to focus on filling in the blanks. This task allowed students to concentrate on watching the video while receiving linguistic support from Japanese notes on the handout. The teacher played the video twice and encouraged students to check their answers with their partners after the first viewing. This collaborative approach appeared enjoyable for the students as they had the opportunity to assist each other in completing the task. Subsequently, the teacher played the same video again, this time with subtitles. This especially helped those who struggled with understanding the input in English. The other two input tasks, involving watching videos, followed the same scaffolding approach, all of which worked better than the first additional input task of reading. Since the videos focused on technological topics, the students were engaged in completing the task.

4.2. Output Activities

After completing the aforementioned input activities, students progressed to the output activity, which was a speech task. Considering the educational objectives of NIT, the teacher found it fitting to prompt students to formulate ideas of biomimicry and deliver a speech in English. Through this, students are expected to integrate their technological knowledge and skills into the concept of biomimicry and apply the English expressions learned in this CLIL class. However, recognizing that this requirement might be challenging for some students, particularly those less proficient in English, the teacher opted to provide two speech prompts and allowed students to choose one. The following are the two different speech prompts.

1) Give one species in nature and explain its unique trait in English.
2) Give one species in nature and explain its unique trait in English and how its trait can be used to create a new product that contributes to the realization of a sustainable society.

The first prompt aligns with the main idea of the reading passage in the textbook, emphasizing repeatedly "If you need a solution to a certain problem, look at nature carefully." The second prompt represents a more advanced task, but it better aligns with both the content of the reading passage and NIT's educational goals. While allowing students to choose a prompt based on their English proficiency seems reasonable, the teacher anticipated three potential challenges. One was about assessment: If there was no clear benefit to choosing the second prompt, it's likely that nobody would opt for it as a speech prompt. On the other hand, if the second prompt carries too much incentive, those who choose the first one might feel significantly discouraged. The second one was about the diversity of the ideas of biomimicry: It should be difficult to come up with ideas of biomimicry on their own, so students would search for such ideas on the Internet. If a majority of the students got ideas from the Internet, it was expected that they would introduce the same kind of ideas, which would make the speech session boring and less insightful. The third one was the difficulty of English expressions that students were going to use: When students tried to explain the idea of biomimicry, they were expected to use several technical terms in their speech, which would discourage the audience from understanding the content of the speech and diminish their learning in the speech session. Taking these concerns into account, the teacher developed the following rubric.

Table 3. Rubric for the speech activity

	additional point	3 (full score)	1	0
Content	Explain an idea of biomimicry by utilizing the trait mentioned in the speech. The idea cannot be found through Google searching. (+2)	Give a name of a living thing and explain its trait in detail.	Give a name of a living thing and explain its trait.	The presenter talks about nothing related to the prompt.
Communication	Try to help the audience to understand the meaning of the difficult English words in the speech by rephrasing it or showing a picture related to the word. (+1)	Several minor mistakes of English expressions, which do not greatly interfere the understanding of the speech. In addition, the English expressions are easy for the audience to understand.	The speech has a few parts that are difficult to understand for the following reasons. 1) Several mistakes of English expressions. 2) Several English expressions are too difficult for the audience.	The speech has some parts that are difficult to understand for the following reasons. 1) Too many mistakes of English expressions. 2) Some English expressions are too difficult for the audience.
Cognition	Explain the relationship between the sustainability of society and the idea of biomimicry which cannot be found through Google searching. (+2)	Explain a trait of a living thing and express the speaker's emotion or feeling about the trait.	Explain a trait of a living thing.	Do not give one trait of a living thing.

	additional point	3 (full score)	1	0
Community / Culture	(In-person) The presenter mainly looks at the audience in the speech, while sometimes seeing the speech script, which makes the audience feel that the presenter is talking to them.	(Video) The presenter mainly looks at the audience in the speech, while sometimes seeing the speech script, which makes the audience feel that the presenter is talking to them.	Several eye contacts with the audience in the speech, which makes the audience barely feel that the presenter is talking to them.	No eye contact with the audience in the speech.

As indicated in the rubric above, the full score for this output activity is 12. If a student attempted the advanced output activity, they could earn an additional 6 points at most. The teacher anticipated that this incentive would motivate more students to undertake the more challenging yet desirable task. By presenting this rubric, the teacher instructed students to generate their own ideas on biomimicry, with the evaluation involving a check for originality by searching the idea on Google.

In the 'communication' criterion, students were encouraged to assist the audience in understanding challenging words or phrases using various methods. The teacher expected this approach to enhance the insightfulness of the speech session for the audience.

Using the provided rubric, students prepared for the speech session. During the session, they initially delivered speeches within small groups comprising 5-6 students. Following this, each group selected the student who delivered the most outstanding speech as their representative. Subsequently, only these representatives presented their speeches to the entire class. The teacher implemented this process to prevent audience boredom that might arise from individual students giving speeches one by one. This competitive setup appeared to function effectively in my affiliation.

The 'Community/Culture' criterion in the rubric stipulates that students can earn additional points by delivering speeches in-person. That means only the representatives, who emerged victorious in the small-group preliminaries, were eligible for these additional points. The other students gave a speech again at home, recorded the output, and sent it to the teacher. The teacher assessed the recorded speeches in the same rubric with the representatives.

Out of 82 students, 68 submitted recorded data of their speech or delivered it in person. Among these 68 students, 38 introduced their unique ideas of biomimicry in English, indicating that more than half of the students who presented their speeches to the teacher in either way shared their own biomimicry ideas in English. Remarkably, only a few of the 38 students introduced the same species, highlighting a considerable variety in the contents of the ideas of biomimicry. The following table shows some of the ideas of biomimicry presented by the students.

Table 4. Students' ideas of biomimicry

Student No.	The trait of a species introduced in the speech	Biomimicry idea
1	Kangaroos have a strong Achilles tendon, which enables these animals to move really fast.	Shoes with a strong spring inside that assist the elderly in walking.
2	Giant amazon water lilies have a unique structure, which enables themselves to float on the surface of water.	Shoes with a structure similar to water lilies that enable humans to walk on the surface of water.
3	Marlins can swim really fast in the ocean, thanks to their body designs.	Submarines with a design similar to marlins that move really fast in the ocean.
4	Polar bears can survive in a cold place. Their fur has a unique design that traps heat and keeps them warm.	An outer clothes with a fur similar to polar bears' on its surface that traps heat and keeps people warm.
5	Crabs can breathe on land and in the ocean. Their unique gill makes the breathing possible.	A mask with a design similar to crabs' that enables people to breathe in the ocean.

4.3. Students' Self-assessment

After the speech session, students conducted a self-assessment of their learning using the following items based on 1-5 scale (5 is best and 1 is worst). The results are presented in the table below.

Table 5. Students' self-assessment items and its results

Self-assessment Items (1-5)	*Avg	Mdn	*SD
(1) I improved my English-writing skills by learning about biomimicry in English.	4.3	4	0.6
(2) I improved my English-speaking skills by learning about biomimicry in English.	4.1	4	0.7
(3) I improved my English-listening skills by learning about biomimicry in English.	4.2	4	0.8
(4) I improved my English-reading skills by learning about biomimicry in English.	4.3	4	0.6
(5) I can think more deeply about the relationship between the traits of living things and material production through this English class.	4.6	5	0.7
(6) I enjoyed learning about biomimicry in English.	4.4	5	0.8
(7) I could deepen my thought through the communication with my classmates.	4.5	5	0.7

* Rounding off to the second decimal point

Items (1)-(4) pertain to English learning, (5) focus on content learning, (6) gauge the level of intrinsic motivation among students in the English class, and (7) assess collaborative learning. Since all the averages are above 4.0, with standard deviations less than 1.0, the majority of students seemed to feel improvements in their English skills, deeper learning on biomimicry, enjoyment in the English class, and success in collaborating with classmates.

After self-assessing their learning based on the items above, students were given the opportunity to provide optional comments about this English class in the end of the questionnaire. One student expressed, "I imagined that someone in my class would realize his or her own biomimicry idea in the future, which is really impressive!" Although this student couldn't generate his own biomimicry idea,

he seemed to derive enjoyment and excitement from listening to his classmates' ideas.

Another student, who presented her own biomimicry idea in person, remarked, "Someday, I really want to realize my idea." This suggests that the English class might encourage students to contemplate how to contribute to a more sustainable society through technology, even though only one student explicitly mentioned it.

However, there were also several negative comments regarding the difficulty of learning about the topic in English. For instance, one student mentioned, "It was difficult to communicate with my partner in English due to the complexity of the topic." This implies the necessity of more linguistic support when providing this class for the students in my affiliation.

Conclusion

This paper introduced a soft-CLIL practice centered on biomimicry, carried out at Japan's National Institute of Technology (NIT) using a government-approved English textbook. Judging from the outcome of students' self-assessment, it would be safe to say that it is possible to implement a soft-CLIL practice focusing on a technological topic using a government-approved textbook in NIT. However, this research focused only on my affiliation, which is one of the limitations of my research. In addition, considering the several negative comments on this soft-CLIL class, more linguistic scaffolding would be necessary for some of my students.

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