CLIL Practices in Science Education

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The latest advances in science are often expressed in language that students in Japan cannot directly understand, putting them at a disadvantage on the world stage. Content and language integrated learning (CLIL) approaches to language learning are widely considered successful. At Oyama KOSEN, we have implemented CLIL methods in our General Science (理科総合) class. We surveyed students in this class over a four-week period to see how their attitude and confidence in language skills have changed. This paper reports on the findings of these surveys. While integrating language in a science class can improve confidence in that language, knowing when and how much language material is still unclear.

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1. Introduction

1. 1 The Language of Science

Following the two world wars in the early 20th century, English became the language for communication in the sciences.¹⁾ It has even been coined by many as a "lingua franca."²⁾ However, unlike a true "lingua franca," which creates an even playing field by being a language that is not native to any party, the dominance of English has placed an advantage on anyone who has ability in it and to a greater extent, its native speakers. Whether English becoming the global language moves the world in a positive direction or not is beyond the scope of this paper. Instead, we will consider this change as culturally neutral and discuss about how our students can benefits from knowing and communicating in English.

Today, English is the most advantageous language to disseminate scientific work in. Articles not written in English suffer from a smaller viewership and less citations despite the quality of their science.³⁾

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Researchers who must get their work translated into English experience more hardships in financial costs, time, and general anxiety.⁴⁾ Although talks and discussion among researchers are more difficult to track down, we expect that they too favor English. Even googling the English word "science" results in over eight times more hits than googling equivalent words in other major languages.⁵⁾ From these trends, innovations and groundbreaking discoveries will likely first be in English. English proficiency has become a necessary part of anyone wanting to take full advantage of the science community.

1. 2 KOSEN's Education

The education system in Japan's National Institute of Technology (KOSEN) is unique when compared to systems around the world. In most school systems around the world, after middle/junior high school, students enter a three- or four-year high school. After graduating from high school, they may enter higher education. However, KOSEN accepts students directly after junior high school and places them into a five-year program specializing in fields of technology. After five years, they are granted with an associate degree. To obtain higher degrees of education, some students choose to continue at the same institution by entering an advanced course, or they transfer to a traditional university. The rest, about a half of all graduating students, enter directly into work related to their field. KOSEN's appeal is that can introduce specialized knowledge and skills to students at a young age. Because of this, KOSEN has played a major role in Japan's technological and economic rise.

However, the uniqueness of the KOSEN system yields many challenges for its educators. On one hand, because one of KOSEN's key objectives is to develop highly technical workers quicker than traditional liberal arts schools, students seeking a KOSEN education may be less inclined to study foreign languages or have interest in global issues. Most graduating students seek jobs in Japan that are technical, but unrelated to foreign languages or even the dissemination of science and technology. For these jobs, foreign language ability, though a positive feature of an individual, is not necessarily required. On the other hand, since the KOSEN system is already highly regarded for its high job placement rate, if we can successfully integrate foreign language and global thinking skills, then our students will be able to have a greater impact on society. We believe that in an ever-globalizing world, communication in foreign languages and knowledge of global issues ought to be a part of anyone working in science and technology in any country.

1. 3 KOSEN's Global Engineer Project

KOSEN campuses that have adopted the Global Engineer Project actively look inward and outward for potential changes moving towards higher English proficiency and globalism. Inwardly, English immersion projects and new education methods are being put into action. Outwardly, these KOSEN campuses are working with schools from many countries helping expose their students to other cultures and ideas.

One implementation of the Global Engineering Project at Oyama College was the revision of a core first-year class, 理科総合 (General Science). Previously, General Science was a class where fundamental ideas of the natural world (plate tectonics, evolution, etc.) were taught to students in Japanese. Since 2020, General Science has been revised and is now taught in English. As a result, the approaches to education and teaching methods were also broadly changed.

1. 4 General Science

General science is taught once a week to first year students. The class is yearlong, and each class is 90 minutes. General Science explores 14 topics over 32 weeks (including exam days). In a rough order they are: "Japan's Earth Science," "Volcanoes," "Plates," "Earthquakes," "Ocean Currents," "Atmospheric Circulation," "Earth's Structure," "Life and the Earth," "Cell Structure," "Evolution," "Biomes," "Element Cycles," "Energy Flow," and "Life Science Fundamentals," with various other introductory or language practice classes inserted in as necessary.

1. 5 Language Education and CLIL

When we imagine how people come to speak a language early on in their lives, though it isn't clear what goes on in the brain of the individual, we somewhat intuitively know how they learned it; they learned language through babbling and making countless mistakes when attempting to communicate with others. However, for language acquisition at a later age in life, we tend to imagine that the individual either spent years studying the language itself, or that they must have spent a long time abroad in "sink or swim" language situations. In education, these have manifested respectively as the traditional grammar class and the taking of a class taught completely in a different language. Although these approaches are not completely ineffectual, numerous flaws with their approaches have been identified.^{6), 7)} In short, the former does not encourage communication, and the latter does not develop "productive" skills such as writing or speaking well.

Compared to the two approaches noted above, Content and language integrated learning (CLIL) takes a middle-ground approach to language education and education in general. Although definitions greatly vary, the basic CLIL objective is to include language education at the same time as subject matter. CLIL's roots are in European policy making,⁸⁾ but it has been implemented in education across the continent and is widely considered a successful method of attaining language ability.⁹⁾ Since then, CLIL has been used all around the world for effective language education. ^{10), 11), 12)}

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1. 6 Objective

Oyama College presents us with many challenges and opportunities to learn effective language education. Because our first-year students exhibit extremely high diversity in English ability and knowledge of the natural world, we found it was best to not just teach subject matter in English, but also the language necessary for understanding and sharing about it. In doing this, we have implemented many ideas inspired by CLIL into our General Science class. This paper is a report on this class based on observations of the class and on the analysis of surveys of a four-week period.

2. Methodology

Of the 14 classes listed above, this study looked closely at two consecutive topics over a four-week period. We surveyed the students before and after the four weeks to see how thought and opinions have changed. Time was taken in class to allow students to take the surveys. We made the surveys using Microsoft Forms and students took them using their smartphones or on paper. The surveys were done in Japanese and then translated to English for this study. To thank the students for their participation they were given grades equivalent to one short-test for each survey taken.

3. Survey Results



Graph Set 1: The blue/left values (percentages) are from the pre-survey and the grey/right (percentages) are from the post-survey. A total of 198 students took the pre-survey and 192 took the post-survey.

3. 1 Analysis

The difference in the number of participants can be attributed to student absence or students not properly submitting the survey on their smartphones. These students were given a month to submit the survey. As seen in Graph 1, students generally feel positive towards English. Graph 2 suggests the total number of hours spent studying English outside of school and other formal education has decreased slightly in the last few weeks.

Graphs 3 and 4 represent how students perceive their productive abilities (speaking and writing). Our students have low confidence in these abilities. Graphs 5 and 6 represent the students' confidence in their receptive abilities (reading and listening) which are slightly higher than their productive abilities. Graphs 7 and 8 represent students' opinions on making presentations. Overall, though slight, students' opinions of making presentations improved throughout the four weeks.

Graphs 9 and 10 show how students' opinions of the class subjects changed (ocean currents and atmospheric circulation respectively). Both show a small increase in "no" and "somewhat" suggesting that students may be finding out if they like a certain subject or not. However, these differences are likely too small to be significant.

3. 2 Analysis of Graph 3

Graph 3 presents the survey results for the question "Do you think you can talk about the topics brought up in class in simple English?" with four possible answers **[no]**, **[not really]**, **[somewhat]**, and **[yes]**. **[no]** is the most negative answer and **[yes]** is the most positive with **[not really]** and **[somewhat]** being in between.

The answer **[not really]** dropped 10 percentages making it the biggest change in this study. **[somewhat]** went up 5 percentages, **[yes]** went up 2 percentages, and **[no]** went up 2 percentages. There were 64 students who changed their answer for this question. 41 of these students moved in a positive direction while 23 moved in a negative direction.

To understand the change in **[not really]** we must first know how many answers changed *to* **[not really]**. Overall, 16 changed to **[not really]** with 14 moving negatively from **[somewhat]** and 2 moving positively from **[no]**. From **[not really]**, only 6 moved negatively to **[no]**, while 29 moved positively from **[not really]** to **[yes]**. Even though 14 students' answers moved negatively to **[not really]**, about twice as many (29) answers moved positively away from **[not really]**. Additionally, 7 moved in a positive direction from **[somewhat]** to **[yes]**. Only 3 answers moved two steps positively from **[no]** to **[somewhat]**. 2 moved negatively from **[yes]** to **[somewhat]**. Only 1 moved two steps negatively from **[somewhat]** to **[no]**. In summary, we see an overall positive shift in the students' confidence in their speaking ability.

4. Discussion

4. 1 Polarizing of Students

Some of the graphs above may be showing polarization in the students. Some students may have felt that their English skills are inadequate, and the activities of General Science only further made them less confident. Other students may have gained confidence through the same activities. To see whether this is really happening or not, we would need surveys over longer periods of time. In either case, the overall attitude of English, despite changes in confidence, remains largely unchanged throughout the four weeks.

4. 2 Confidence in Talking in English

In the week prior to the first day of this study, General Science dedicated one class to speaking English. The goal of the class was to improve students' public talking skills by specifically training them in volume, eye contact, and talking speed. No scientific content was taught in this class and no assessments were done. We did not originally intend the speaking class to be a part of this study, so we did not survey the students beforehand. However, as described below, it may have influenced some shifts in our survey.

We can see that students gained confidence in their speaking ability somewhere in the four weeks of this study (Graph 3). We can also infer that the English-speaking class taught the week before influenced students' thinking in a positive way since we did not see the same shift in their other language skills (Graphs 4, 5, and 6). Teaching students English-speaking skills needed for the class's presentations, and then giving them the opportunities to present, could have helped students gain confidence in speaking English.

General Science integrates language education in two main ways. One way is through small activities inside the science classes. The other way is through dedicating an entire class to a language skill. All four skills (speaking, writing, listening, and reading) are practiced in daily General Science classes to varying degrees, but the only visible shift in the four weeks studied occurred in speaking. Since General Science has only held a class dedicated to English-speaking and not any other skill, this implies that the speaking class helped boost students' confidence in speaking. It also implies that integrating language skill activities inside of a class may not enough to raise student confidence. An entire class dedicated to a specific skill used in the course may be needed. However, since this study was done over only four weeks, it is also possible that the effects of small language activities in class won't show unless the students are surveyed over a longer period.

In either case, balancing between how much language and how much subject matter to teach will ultimately be the challenge for any educator seeking to implement CLIL. Although each school will be

faced with different challenges, the following are general recommendations for implementing CLIL in a classroom.

4. 3 Recommendations

- Specifically teach a skill and then give students multiple opportunities to demonstrate; many smaller projects are preferred over a single large project.
- Associate words related to the content such as "earthquake" and "occur" as often as possible.
- Avoid overly theoretical grammar or vocabulary points and teach only enough language to learn about the content.
- Avoid "sink or swim" situations. These situations cause a lot of anxiety and even fear, inhibiting learning.

4. 4 CLIL in KOSEN

First year KOSEN students are 15 to 16 years old, making them much younger than most college students around the world. They generally have a positive attitude towards English, though their confidence in their language ability is low, especially in productive skills. This tells us that students are interested in foreign languages and that we, as instructors, are tasked with finding the right methods to take advantage of this interest. More work is needed to properly assess how much their language ability has actually improved. However, we believe that integrating language learning within content learning increase students' confidence in their language ability.

In response to rapid development around the world, KOSEN campuses across Japan are seeking new methods and approaches to education to develop foreign language and global thinking skills in their students. KOSEN's appeal is its early educating of students in highly technical content. Increasing the number of classes or adding more conditions for students to graduate may hinder students' education and/or graduation. Using CLIL approaches, we can safely integrate language education into Oyama College's curriculum without the need to make overarching systematic changes. Because of this, we believe that CLIL approaches to language education naturally fit in with KOSEN's system of education.

4. 5 Limitations of this Study

- This study only looked at two topics over four weeks. Ideally having data over a year or even a student's entire time at a school would be more informative.
- Since the classes studied were for currently enrolled students, we could not do control classes.
- A survey before the English-speaking class would be informative.

• The surveys only measured students' perception of their own ability and not their actual language ability.

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