

A Communicative CLIL Science Course for Engineers Eamon Watters, Akita University ewatters@gipc.akita-u.ac.jp

Goal

Deliver a communicative CLIL (content and language integrated learning) science course to 2nd year materials science and applied chemistry students.

Background

English Medium Instruction has been growing in Japan over the last decade, largely as MEXT has pushed for Japanese universities to become "more global": delivering graduates who can function in an English-speaking environment, and additionally making those universities more attractive to international students. A lot of focus has been on large universities, but many smaller universities have begun adopting EMI to some extent to satisfy MEXT requirements. EMI classes in such universities will naturally be of a different character to those in topflight institutions. Students will not have as good an ability in English, may have less self-confidence, and will find learning about and communicating about the studied subject very challenging. To account for these issues, a EMI course with a communicative focus was designed, as communication in lower-level institutions is still neglected, despite its key role in active, engaged learning (Dornyei, 1998). The course is also aligned with the core points of communicative activities (Brandl 2009).

Implementation

Instructor-produced articles were the main materials of the course. Due to Covid, the class was conducted by Zoom, which impacted the communicative aspects somewhat. Comprehension checks and written work were moved to Google Forms.

Course Overview

Course Plan

Fundamental English for Materials Science (FEfMS) is a mandatory, formerly elective course. Students are 2nd year Materials Science and Applied Chemistry students. One hundred and nine students were enrolled in this class.

Classes are science focused, constructed to gradually introduce scientific concepts and also fit the solutions-oriented philosophy of science. Thus puzzles and critical thinking were a key part of the course. Almost all classes had opportunities for students to communicate, from short exchanges at the course start, to significant discussions towards the end.

Topics introduced concepts slowly at first, so as to not overwhelm the students. Topics covered two lessons

Topic 1 Experiments. Scientific instruments, how we "see science", are introduced. 'Natural experiments", those we do in our everyday lives, introduce the Scientific Method.

Topic 2 Numbers, Symbols, and Graphs. Students learn to read numbers, compare data, say and use mathematical and scientific symbols, and talk about common graphs.

Activity 1 Three Scientific Challenges. Students prepare three paragraphs on scientific challenges of the next 50 years, shared them in class, and reported on one challenge from a partner.

Part 1: Stat

Gas (-ene

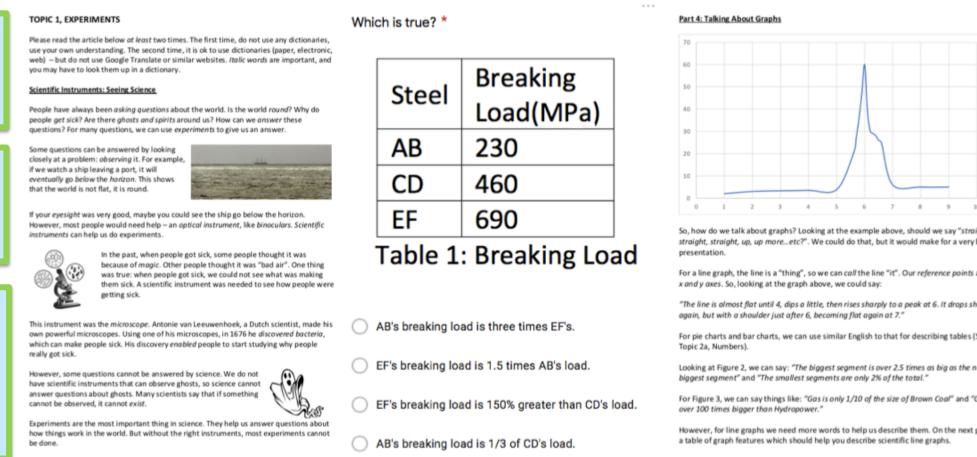
atoms or ma not held fin

Part 2: Phe changes in s

Changing fi when a gas o solid is free.

<text><text><text><text><text><text><text><text><text></text></text></text></text></text></text></text></text></text>	tates of Matter Niverse, we can observe many states of matter. We have the normal solids, liquids, is that make up our world, but we also have some strange states of matter – like and Bose-Einstein condensates. It would be another to another: we add or subtract energy, the time changes and the matter changes state. This is shown in figure 1.		Part 1: Equations Back in Topic 2 we talked about numbers and graphs. This was because graphs are a good way of showing data (numbers). The numbers shown in graphs are <i>linked</i> , as we saw in the graph of temperature vs. year (fig. 1). Each year has a <i>linked</i> temperature.	How do you say the equation below?	Topic
<text><text><text></text></text></text>	energy) -> Liquid (+energy) -> Gas (+energy) (Melting) (Evaporation) ting energy we see : nergy) -> Liquid (-energy) -> Solid (-energy)		Temperature vs. Year	<i>f</i> (x) = X ³	million and mo
$f_{x} = \frac{1}{2} \int_{a} \int_{a} \int_{a} \int_{b} \int_{a} \int_{a} \int_{a} \int_{b} \int_{a} \int_{a} \int_{b} \int_{a} \int_{b} \int_{a} \int_{b} \int_{a} \int_{a} \int_{b} \int_{b} \int_{a} \int_{b} \int_{b} \int_{a} \int_{b} $	Changes of State see how the normal states of matter are <i>organised</i> in figure 2. Solids are <i>made up of</i> <i>molecules</i> which are <i>held</i> in a <i>definite shape</i> . In liquids, the atoms or molecules are firmly, and so can move around a little. In gases, the matter is not held at all, and	It is important for protecting riverbeds: bigger rocks on top resist erosion. It also me boulders to the surface of some asteroids, like Itokawa, which was investigated by t	We also saw other graph types in Topic 2, and some of these, like the exponential rise (fig.	f of x equals 2 to the power of x	Topic
The track and so for each value of X (1, 2, 3, 5, etc) Y is 2° (2, 4, 8, etc) As you can	Liquid Gas Organisation of Matter (Credit: Wikimedia) henomena	A CONTRACTOR	rise more quickly. It can be described by an equation, the exponential function.		Activ
C course, scientistis have an official name for the Biabil nut effect. It is granular set the gas cools to become a liquid it is condensation, and a liquid cooling to become a recezing. C fof x equals x to the power of x [*] . How do we say it? We say "fof x equals 2 to the power of x [*] .	g from a solid to a liquid is <i>melting</i> , and from a liquid to gas is evaporation. And gas cools to become a liquid it is condensation, and a liquid cooling to become a	Of course, scientists have an official name for the Brazil nut effect. It is granular sep These are only a few of the strange phenomena that make science so interesting. V	see from the graph, this equation can <i>reach</i> very big numbers.	f of x equals x to the power of 3	essay or

Topic 5 Equations and Life. Introducing equations with reference to Topic 2, how to say them, and what an equation for life in our galaxy could mean for alien contact. There was also a full discussion on align life and the implications of its discovery



was launched from Cape Canaveral in t nited States of America. Its target: Man he fourth planet from the Su The rocket carrying it, a Delta II, used over 600,000 pounds of thrust to launch the 2 eter-tall, 6 foot-wide probe from the Earth and set it on a course for Mars journey to the red planet. As the probe neared Mars, everything seemed fine the 638 kilogram probe. Computers, power, communications, and propulsion were operating at 100%. At 9 a.m. on the 23rd of September

e probe folded away its solar panel, a turned to fire its 640 newton rocket ene t did this to slow down, so it cou

It 9:05 a.m. communication with *mission control suddenly* stopped. They tried have tore contact between Mars and Earth. Finally, after many attempts, the probe leclared last on September 25^t



ocket power. However, mission ontrol used newtons to control rock wer. To see how this caused the proble k at the simple conversion equation

C 3 Units and Errors. Topic was introduced by a story about the loss of a multidollar space probe due to a maths error. A short discussion on space exploration oney followed.

C 4 Matter and Phenomena. The many states of matter, and the strange mena of matter were explored, from freezing hot ice cream, to bumpy asteroids.

vity 2 Writing the introductory and concluding paragraphs for an teacher-provided on global warming.

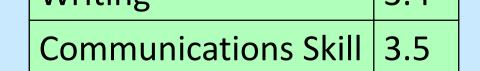
Student Output The majority of comprehension questions were correctly answered, but for mathematical questions, some were challenging. Graph questions were well done, as were most of those on matter and phenomena. Questions on equations were mainly

also a full discussion on allen me and the implications of its discovery.	as were most of those of matter and phenomena. Questions of equations were mainly
	well-answered.
Final Homework Students construct introductory and concluding paragraphs for	Student preparation for discussions and essays were easy to understand, reasonably well-
their Activity 1 work, making one complete scientific essay.	formed, and scientifically valid.

Student Perceptions

Students were given a Google Forms questionnaire at the end of the course covering the areas of English Skill Improvement, Course Opinions, and Topic Opinions. Most questions were Likert-scale, with 1 signifying total disagreement, and 5 signifying total agreement. Other questions involved topic ranking. The results are given in the tables below. All numerical values are medians of the Likert results, n=78.

Course Qs: Course Progression			Course Qs: Impact of Stdnt Science Knowledge (SK)			Course Qs: Student General		
As course progressed, new article understanding increased 3.7		SK helped me guess meaning of difficult words 3		3.7	I had interesting discussions with my classmates	3.4		
As course progressed, English nervousness decreased 3.3		SK helped me guess article's meaning 3		3.8	I learned a lot from my classmates	3.4		
Discussion skills improved as course progressed 3.5		SK helped me learn English words		3.7	I learned new scientific knowledge	3.9		
			SK helped me	unc	derstand English sentences	3.8	I want to study English more after this course	3.7
Topics: General		SK helped me understand English articles		3.8	Class discussion was professionally relevant	3.7		
Prefer science English topics to general English topics3.5		3.5			English is professionally relevant to me			
Course topics professionally useful for me 3.8		3.8			I tried to use English a lot in this course			
Course topics professionally interesting for me 3.8				I used translation software a lot in this course				
Topics: Most Interesting (n=58)	Topics: Most Usefu	ul (n=!	58)	Тс	opics: Most Difficult (n=58)		English Skill Improvement	
1 T4: Matter & Phenomena	1 T2: Numbers, Symbols, & Graphs			1	T5: Equations & Life		Listening 3.5	
2 T5: Equations & Life 2 T3: Units & Errors			2	T4: Matter & Phenomena		Speaking 3.3		
3 T1: Experiments & Scientific Method 3 T4: Matter & Phenomena			iena	3	3 T3: Units & Errors		Reading 3.7	
4 T2: Numbers, Symbols, & Graphs 4 T1: Experiments & Scier			ientific Method	4	4 T2: Numbers, Symbols, & Graphs		Writing 3.4	
5 T3: Units & Errors 5 T5: Equations & Life			5 T1: Experiments & Scientific Method		lethod	Communications Skill 3.5		



Areas of note are in impact of science knowledge; communications skill, reading, and listening improvement; new article understanding; and the students' professional opinions on the

course and English. It is also noteworthy that the two most difficult topics were also the two most interesting topics, and also that the two most useful were the two least interesting.

Final Points

The course was originally intended to be given face-to-face, with much more interaction possible between students, based on Tohoku University's Prepare, Discuss, React (PDR) Method. Aspects of the PDR method were, however, incorporated in the discussions. It is to be assumed that the communications skill would have increased under these circumstances, with related increases in listening and speaking. Some students groups also failed to participate in discussions, but these were less than 10% of the students enrolled.