Can Writing Assignments Help Foster Engineers Who Will Thrive in a Globalized World? Comparing Students' Written English Levels and Overall Performance in Humanities Modules in Engineering Curricula

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Can Writing Assignments Help Foster Engineers Who Will Thrive in a Globalised World? - Comparing Students' Written English Levels and Overall Performance in Humanities Modules in Engineering Curricula -

Abstract

Background

This paper assesses students' English-language writing levels by analysing their written work in a 'history of Japan' module, a humanities component in the Innovative Global Program. It is a research-based engineering degree program with course content taught in English within the College of Engineering at Shibaura Institute of Technology, Tokyo. The study authors investigate connections between students' written English levels and their overall academic performance as embodied by exam grades. We explore how future iterations of the course might be enhanced, in order to increase its effectiveness as a vehicle for developing students' English writing abilities, creativity, and 'global mindset'. The student body for this module, 'Science and Religion in Japan', consists entirely of international students and the course is taught exclusively in English. To advance participants' logical reasoning capabilities, they are required to write summary-and-response papers as their one key weekly assignments. With a diverse cohort of students from countries with varying baseline levels of English proficiency, the authors have observed over several years that while most students can articulate their thoughts effectively in verbal discussions, their writing clarity varies substantially. Naturally, we want all international students to gain as much knowledge as they can from the course, without this being completely contingent on their pre-existing level of English. We therefore continuously look for ways to optimise all aspects of the course format - especially teaching materials and assessment methods - in order to match student needs as closely as possible, ensuring that the program teaches Japanese history and intercultural skills effectively to students no matter what their background. To this end, the study also investigates relationships between the CEFR-J levels displayed in students' writing assignments for individual topics, and those seen in the corresponding lecture materials. Does the level of English produced by the student closely 'mirror' that of the study material, which could indicate patch writing? This part of the research provides insights into how course materials and instructions can be better designed to prevent patch writing, and to instead encourage students to develop their own writing skills to the greatest extent possible.

Methodology

To evaluate students' written English levels, we utilised the 'CVLA (v2.0)' tool to assess students' written English levels, and then compared the results with their course grades.

CVLA stands for ‘Common European Framework of Reference for Languages (CEFR)-based Vocabulary Level Analyzer.’

Results
Using the CVLA, two CEFR-J scores for each of the 22 students taking the course were computed. The first was based on their written output in weeks 1-3 of the course, and the second was based on their output in the concluding weeks 11-13. On the CEFR-J scale, ‘Pre-A1’ is the lowest and ‘C2’ the highest score attainable. To make quantitative analysis more user-friendly, CEFR-J scores can also be expressed as numbers between 0.5 and 6.0. When we conducted quantitative analysis on the data from the first three weeks of our course, the mean average of students’ CEFR-J levels was 4.955 (B2.2-C1), whereas for the last three weeks the mean was 5.432 (C1-C2); this difference in average scores was shown to be statistically significant when the appropriate significance tests were applied.

Keywords: Common European Framework of Reference for Languages (CEFR), CEFR-based Vocabulary Level Analyzer (CVLA), Assessment of Written English Levels of International Students Majoring in Engineering, Effect of Humanities Modules in Engineering Curricula

1. Introduction

1.1. Course description

Our study on the relationship between written English levels and academic performance is an exploratory study focusing on the Fall 2022 semester, investigating 22 international engineering students’ written vocabulary levels and trends in the improvement of their vocabulary observed as they took part in the ‘Science and Religion in Japan’ course. ‘Science and Religion in Japan’ is a series of lectures that forms part of the research-based engineering program called the Innovative Global Program (IGP) within the College of Engineering at Shibaura Institute of Technology, Tokyo. All courses in this program are taught in English.

Throughout the history module ‘Science and Religion in Japan’ course, participants joined together in groups to study and discuss the simultaneous arrival in Japan of Western religion and science, the impact that the appearance of these had on Japan’s own culture and conception of science, and the lasting impact on Japanese society. It should be noted that a student body comprised of overseas students primarily from Europe, Asia, and South America, and therefore class discussion is conducted through a racial equity lens with students participating in the conversation from diverse standpoints. In addition, the course is designed - as described in the course objective in figure 1 above - in a way that challenges

students' logical thinking and creativity, offering an at-times critical perspective on the conventional view of Japanese history (figure 1).

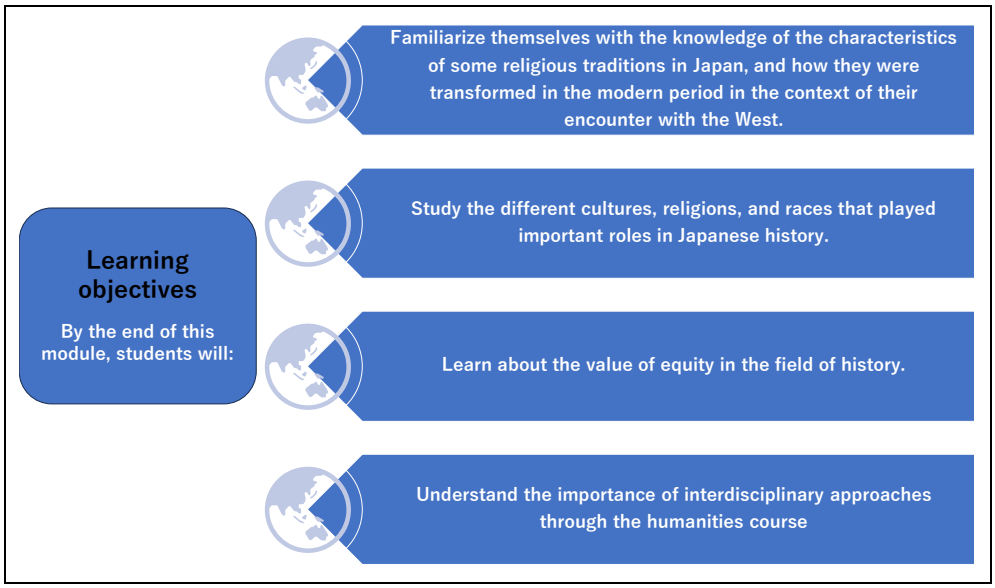

Figure 1 Learning Objective

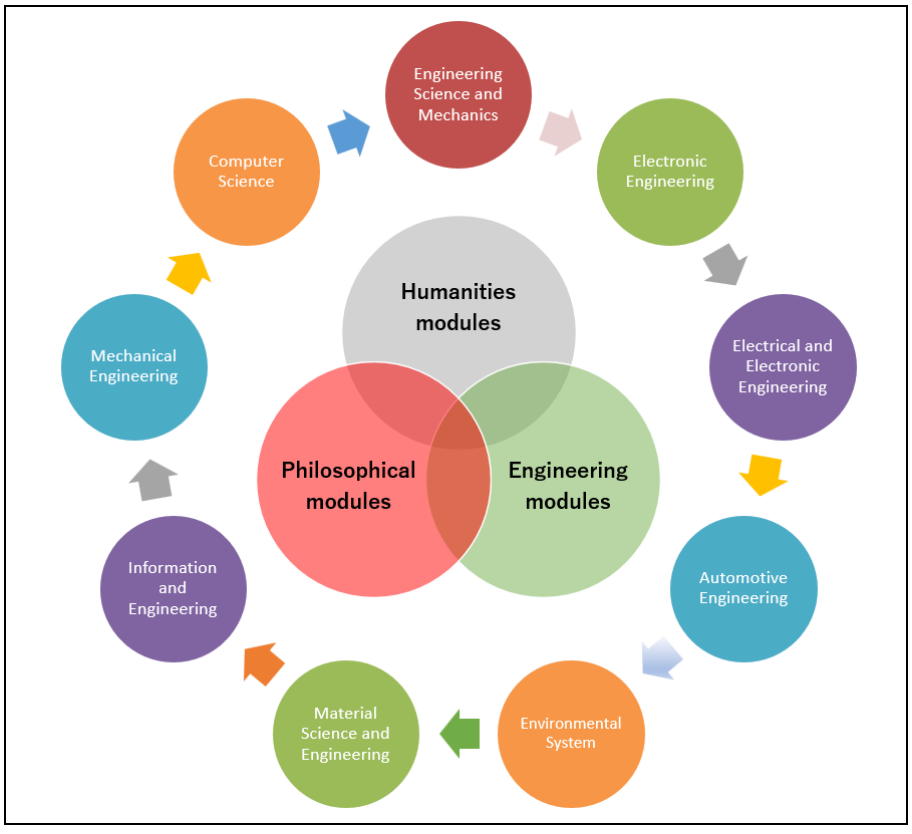

Figure 2 An image of 'Interdisciplinary' course

'Science and Religion in Japan' is regarded as an interdisciplinary module because, as shown in figure 2, it incorporates content from a range of academic disciplines, and because participating students are studying a variety of majors, with their primary subjects of study ranging from Computer Science, to Architecture, to Automobile Engineering [1]. One of the strategies that study authors implemented with the goal of enhancing students' understanding of the course concepts was the writing of 'summary and response papers' (figure 3). Being challenged on a weekly basis to write papers like this demands that students demonstrate their ability to synthesize knowledge and their creativity – both of which are required if they are to gain flexibility and a greater richness of ideas. These skills are also crucial for aspiring 'global engineers,' providing them with greater opportunities for leadership.

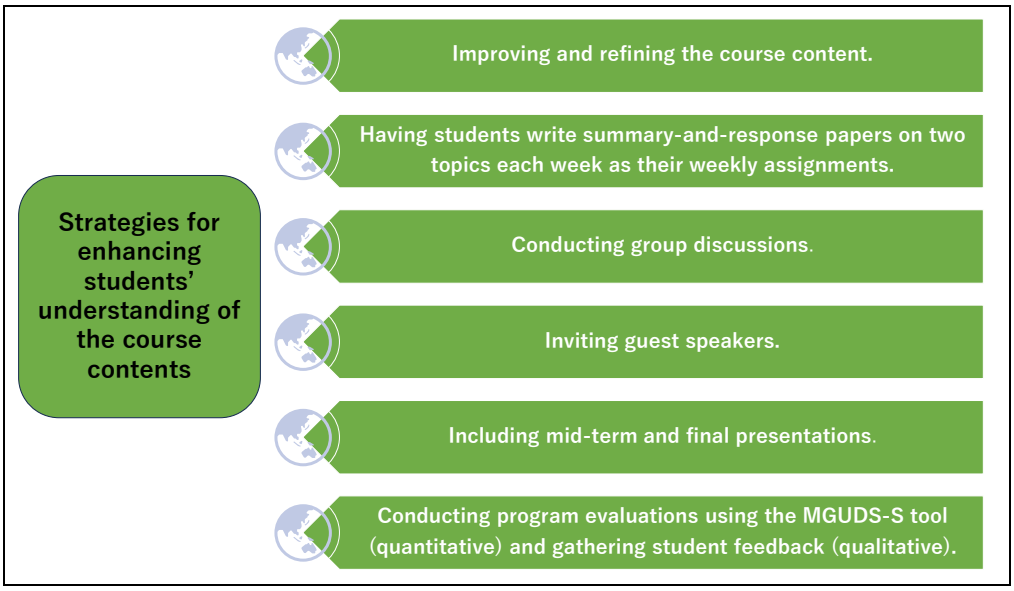

Figure 3 Strategies for enhancing students' understanding of the course contents

1.2. Research questions

The authors have observed over several years that while most international students can articulate their thoughts effectively in verbal discussions, their writing clarity tends to vary substantially. Therefore, it is worth analysing their written assignments and how these relate to their overall performance. We believe that insights from this analysis will be invaluable as we periodically review the content of the course and make refinements aimed at engaging students, with the end goal being to foster effective learning outcomes and make a positive impact on each students' educational journey. Our research questions for this paper are as follows:

1) What are the English-language vocabulary levels of the international engineering students at the time of their enrollment in the 'Science and Religion in Japan' course?

2) Can international engineering students' written English levels be improved by their participation in this module?
3) Is there a correlation between the CEFR-J levels seen in students' writing assignments for a particular lecture, and the CEFR-J level of the lecture material itself?

2. Methodology

2.1. CEFR-based Vocabulary Level Analyzer (CVLA)

The CVLA tool was created by Professor Satoru Uchida at Kyusyu University [2], with the initialism 'CVLA' standing for 'Common European Framework of Reference for Languages (CEFR)-based Vocabulary Level Analyzer.' The CEFR framework itself categorises what language learners can do at different stages of their learning - it essentially divides language proficiency into six levels and is applicable across a huge range of different languages and language learning contexts. CEFR is well established, with a document formalising it having been officially published by the European Union in 2001 after several years of development and refinement. As of 2024, CEFR is widely used across the world as a framework for language learning, teaching, and assessment [3] [4].

In Japan, the 'CEFR-J' variant of the framework was developed by adapting CEFR for the specific needs and characteristics of English-language teaching and learning in Japan [5] [6] [7]. Whereas the 'original' CEFR has six levels, the CEFR-J scale was refined to recognise twelve different levels of English fluency (Pre-A1, A1.1, A1.2, A1.3, A2.1, A2.2, B1.1, B1.2, B2.1, B2.2, C1, C2) [2] [5]. The body of reference text used for CEFR-J assessment comes from the 'Corpus book' compiled by the CEFR-J project [2] [8]. The 'Corpus', an important feature of the CEFR system, is a set of reference texts which comprise of selected excerpts from EFL/ESL textbooks which were themselves created under the CEFR framework. The Corpus used for CEFR-J is the same as that used in 'standard' CEFR assessment outside Japan, and its outputs scores are compatible with the original CEFR scale. When the CVLA tool is used to assess a particular students' level of English, it compares the work the student has submitted with relevant segments from CEFR-J's body of reference text (the 'Corpus'). It then outputs an estimate of the 'average difficulty level' of the inputted English-language passage or document.

When we conducted a literature review in preparation for our study, we noted that two pieces of research which had some similarities with ours - in that they also used the CVLA tool - were published in 2021. The first of these aimed to identify the CEFR-J levels of various reading texts [9], while the other investigated students' tendencies of engaging in 'patch writing', a form of plagiarism in which students copy 'chunks' of text directly from course

materials [10]. Both of these studies were also similar to ours in that they were carried out on students embarking on university programs taught in English, at Japanese universities.

The key difference between our study and the two mentioned above is that ours was conducted on a cohort of international students, rather than Japanese students. But the results and conclusions we saw in the literature review lent weight to our presupposition that analysing students 'English fluency' levels using the CVLA tool might be worthwhile.

Finally, it should be noted that one fairly well-known alternative to CVLA, designed for similar tasks, does now exist. Comparable examinations may be undertaken using a new, artificial intelligence-driven text analysis tool known as 'Cathoven' [11]. This software package is also capable of mapping learners' CEFR levels; since its introduction in 2022 it has proven to be a useful tool for educators in a wide range of contexts, including student assessment and development of classroom materials [12]. The makers of Cathoven claim that the software can provide an accurate analysis of the CEFR level of any piece of written material, provided that the text being analysed contains at least 30 words and at least two distinct sentences. Figures 4, 5-1, 5-2, and 5-3 demonstrate how each of the two CEFR analysis tools, CVLA and Cathoven, assess a 1,161-word writing assignment by the same student. Both output the same overall result, CEFR level C1 (figures 4 and 5-3).

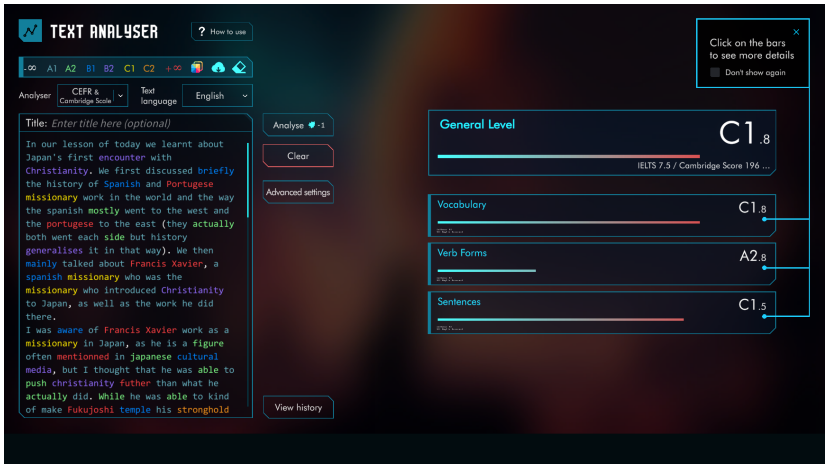

Figure 4 How Cathoven returns a result of analysing student's writing assignment

In the view of the study author's, a main drawback of Cathoven is that its text analysis capacity is limited to 500 words unless an ongoing subscription is purchased, whereas CVLA is free of charge and can analyse bodies of text of up to 2,000 words. In the context of our university and areas of research interest, we frequently wish to get a broad impression of students' CEFR levels based on fairly large outputs of written work (for example, several thousand words over a period of weeks). Therefore, for this study we chose not to adopt

Cathoven and to instead continue using the CVLA tool for analysis of student assignments as well as lecture slides, due to its greater flexibility.

2.2.How to use CVLA

In order to enable categorisation, the assessor carrying out CVLA analysis simply copies and pastes a piece of the students' written assignment text (or the text version of their spoken material) into the whitespace (figure 5-1). When we need to determine the CEFR level of lecture slides - rather than student output - with the tool, then the slides should similarly all be converted into text files first. It is important to note that to ensure the generation of accurate results, the input text to be analysed in one increment should be of not less than 400 and not more than 2000 words. Nowadays, academics needing to carry out CVLA analysis invariably use the public website [13]. The person carrying out an assessment simply confirms whether the text they are analysing came from 'written' or 'spoken' content, and the CVLA tool quickly returns a result, categorising the text into one of the aforementioned 12 CEFR-J levels (figures 5-1, 5-2). CVLA also indicates, as shown in figure 5-3, four indices of textual features: ARI (Automated Readability Index), VperSent (verbs per sentence), AvrDiff (the average of word difficulties), and BperA (the ratio of B-level content words to A-level content words).

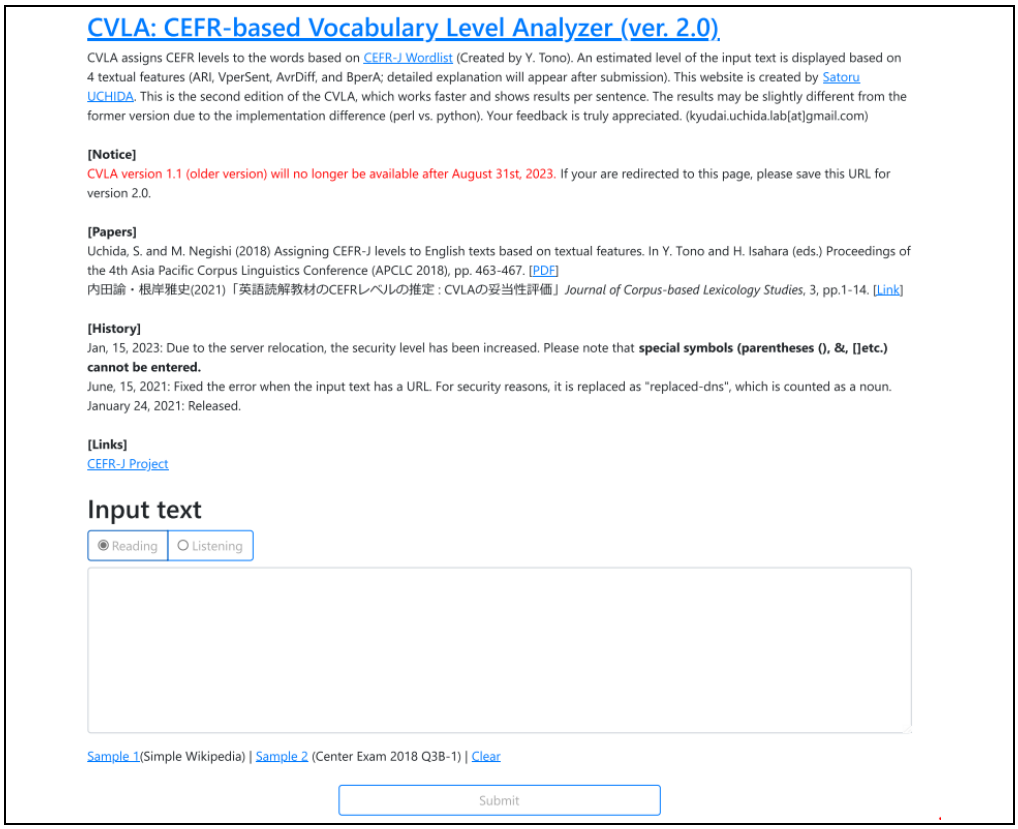

Figure 5-1 Interface of CVLA (ver.2)

CVLA: CEFR-based Vocabulary Level Analyzer (ver. 2.0)

[Legend]
A1: example, A2: **example**, B1: example, B2: **example**, C1: example, C2: **example**, NA content words: example, NA others: example
#You can sort the table by clicking the table header.

ID	Sentence	Words	Verbs	AvrDiff
1	In our lesson of today we learnt about Japan 's first encounter with Christianity .	14	1	1.4
2	We first discussed briefly the history of Spanish and Portugese missionary work in the world and the way the spanish **mostly** went to the **west** and the portugese to the **east** (they **actually** both went each side but history generalises it in that way) .	44	4	1.38
3	We then **mainly** talked about Francis Xavier , a spanish missionary who was the missionary who introduced Christianity to Japan , as well as the work he did there .	27	4	1.11
4	I was aware of Francis Xavier work as a missionary in Japan , as he is a **figure** often mentionned in japanese cultural media , but I thought that he was able to push christianity futher than what he **actually** did .	39	7	1.91
5	**While** he was able to kind of make Fukujoshi temple his stronghold **during** his mission , and the first church was built in Hirato in 1551 , it **seems** at the end of his mission of Japan in 1552 , he was only able to amass around a **thousand followers** who **converted** in Japan **compared** to more than a ten **thousand** in Japan , and that the people who **followed** him , **including** jesuit Torres , **continued** his work to better **success** after he left from Japan .	81	13	1.8
6	Torres was also responsible for the first Christmas celebration in Japan .	11	1	1.5
7	It is also notable that Francis Xavier is **recorded** to have introduced the first pair of glasses of Japan when he **presented** them to Daimyo Ouchi .	26	6	1.57
8	In class we were asked why we thought that christianity was more **popular** in India than in Japan .	18	4	1.6
9	India is a **country** that has a long history of **accepting** foreign religion due to it 's strong polytheistic history .	20	3	1.44
10	**While** Hinduism and Buddhism were very strong at the time , some particularity of these religions , **especially** the former , are hard to **follow** for a large **part** of the **population** .	29	3	1.73
11	The indian caste **system** structures the different people in India in such a severe way that it **justifies** the poverty and **lack** of **education** of the **lower casts** through their scriptures saying that it is because in their previous lives they commited deeds that **justifies** their current status .	48	6	2.39
12	**Compared** to that , christianity has the Beatitudes , that says that the Kingdom of Heaven **belongs** to those who are poor in spirit .	22	5	2.0
13	I also believe that confucianism has had a very strong **influence** in Japan that directly **opposes** christianity .	17	4	1.57
14	**While** christianity pushes people to fight **against institutions** who oppresses man , confucianism promotes obediance to the **state rather** than God .	20	4	2.22
15	There is also the **fact** that the emperor is deified in Japan due to being a **direct descendant** of deity Amaterasu , and the introduction of christianity which denies any **god** that is n't the God of the Bible conflicts directly to the japanese spirit of revering the emperor .	48	7	2.58
16	**Continuing** are lesson of today , we learnt of the Warring State period of Japan , where different Daimyos were **all** in conflict with each other **during** period where they **all** fought for the **control** of Japan and to unify it .	39	6	1.71
17	**During** that period , three people came out on top as the Three Great Unifiers of Japan : Oda Nobunaga , Toyotomi Hideyoshi , and Tokugawa Ieyasu .	23	1	1.0
18	Hideyoshi was in the **beginning** a retainer of Nobunage , who would often **call** him Saru (or Monkey) .	17	2	1.5

Figure 5-2 How CVLA returns a result of analysing student's writing assignment: An excerpt

CEFR	ARI	VperSent	AvrDiff	BperA
A1	5.73	1.49	1.31	0.08
A2	7.03	1.82	1.41	0.12
B1	10.00	2.37	1.57	0.18
B2	12.33	2.88	1.71	0.26
Input	14.85	4.68	1.75	0.28
Estimated level	C1	C2	B2.2	B2.2

Mode: R, Estimated Text Level: C1

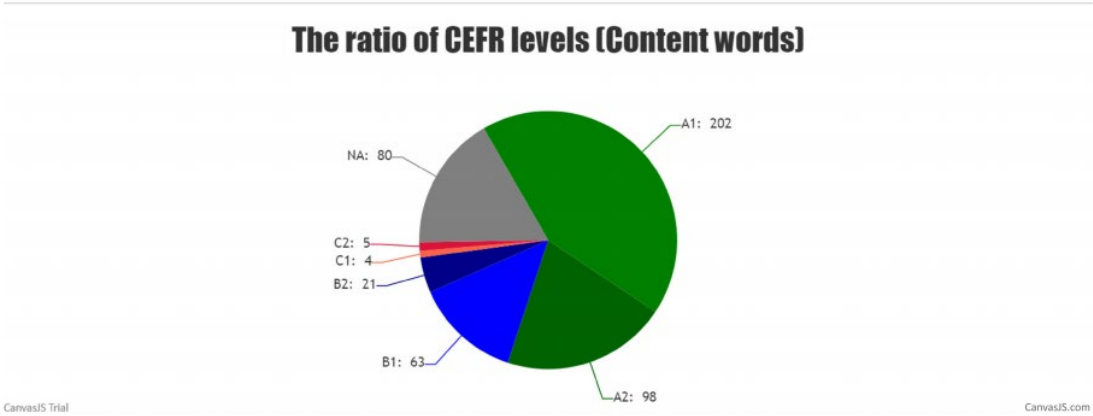

Figure 5-3 A result of CEFR mappings and four indices of textual features

3. Results

3.1. Student vocabulary improvement

To investigate whether there was an improvement in the English vocabulary level of international students taking our program in the fall 2022 semester we began by computing two CEFR-J scores for each of our 22 students, one representing their ability at the 'beginning period' and the other at the 'concluding period' of the course. The first score was calculated based on the first 2000 words submitted by students in their writing assignments in weeks 1-3, and the second was calculated by applying CVLA to the last 2000 words they submitted in assignments in weeks 11-13. More specifically, for the *i*th student, we define the number of words n*(i)* as n*(i)* = min (2000, total number of words in week 1-3 assignments, total number of words in week 11-13 assignments). We then compute CEFR-J levels for that student's first n*(i)* words and last n*(i)* words.

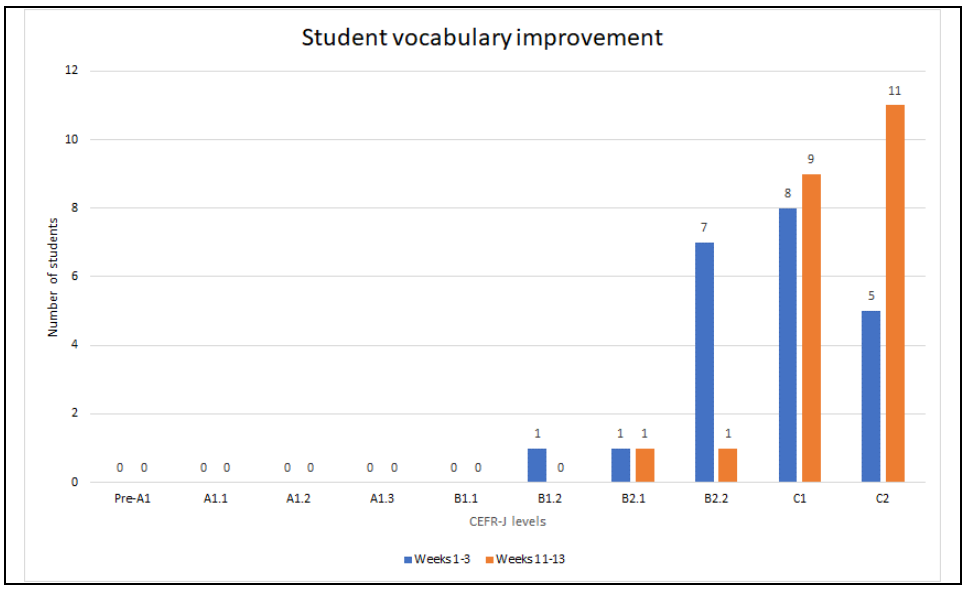

Figure 6 Student English vocabulary improvement

Looking at their first CEFR-J levels, one student was found to exhibit their English vocabulary level at the B1.2, another one student at the B2.1, 7 students at the B2.2, 8 students at the C1, and 5 students at the C2. Regarding their last CEFR-J levels, one student was found to exhibit vocabulary at the B2.1, another one at the B2.2, nine students at the C1, and eleven students at the C2. It is noteworthy that the number of international students who exhibited their English vocabulary levels at the B2.2 decreased from 7 to 1 whereas the number of students with the C2 levels increased from 5 to 11 from the beginning of the course toward the end (figure 6). With Pre-A1 being the lowest and C2 being the highest, the calculated CEFR-J levels were then expressed in numerical form using the standard system whereby level 'Pre-A1 maps to a numeric score of 0.5, A1.1 maps to a score of 0.84, A1.2 maps to 1.17, A1.3 maps to 1.5, A2.1 maps to 2.0, A2.2 maps to 2.5, B1.1 maps to 3.0, B1.2 maps to 3.5, B2.1 maps to 4.0, B2.2 maps to 4.5, C1 maps to 5.0, and C2 maps to 6.0 [2][8].

Table 1 demonstrates the full set of results that demonstrate the improvement in 22 student's levels of English vocabulary throughout the fall 2022 semester. We computed two CEFR-J scores for each of our 22 students; one at the start of the program, and one towards the end. F indicates the result of Weeks 1-13 whereas L indicates the result of Weeks 11-13. The mean of our students' CEFR-J levels as measured at the start of the course was 4.955 (B2.2 – C1), whereas the mean of their last recorded CEFR-J levels was 5.432 (C1-C2). We conducted several statistical tests to assess the significance of this increase; in one-sided tests, the difference was found to be statistically significant. Before we explain these tests, we first report the results of Shapiro-Wilk normality tests that we conducted to assess whether the

values in datasets F and L datasets, as well as those in the difference dataset L-F are normally distributed [14].

As table 2 indicates, our normality test was not entirely conclusive. The p-value for L-F is above the standard threshold, whereas those for L and F are below it. For this reason, we have conducted several non-parametric Wilcoxon tests suitable for datasets that are not necessarily normally distributed as well as t-tests that are suitable for normal data [15]. Furthermore, we have also conducted two-sided (two-tailed) and one-sided (one-tailed) tests as well as two-sample and paired tests. We report all results that we have obtained in the following tables. We remark that our results indicate that the difference between F and L is proven to be statistically significant with small p-values.

Table 1 Student vocabulary improvement: Comparison between first and last three weeks

F	4.5	4.5	5.0	3.5	4.0	6.0	5.0	5.0	5.0	5.0	5.0	4.5	5.0	6.0	4.5	4.5	6.0	4.5	6.0	5.0	6.0	4.5
L	5.0	6.0	6.0	6.0	6.0	6.0	4.0	5.0	6.0	5.0	5.0	5.0	6.0	5.0	6.0	6.0	5.0	6.0	4.5	5.0	5.0	6.0

Mean of F: 4.955 (B2.2-C.1) (Standard Deviation: 0.688)
Mean of L: 5.432 (C1-C2) (Standard Deviation: 0.596)
Median of F: 5
Median of L: 5.5

Table 2 Shapiro-Wolk Normality test

1. **Shapiro-Wilk for F**
   At 5% significance level, Shapiro-Wilk concludes that F data is not normally distributed (p-value = 0.01011)
2. **Shapiro-Wilk for L**
   At 5% significance level, Shapiro-Wilk concludes that L data is not normally distributed (p-value = 0.000144)
3. **Shapiro-Wilk for L-F**
   At 5% significance level, Shapiro-Wilk suggests that L-F may be normally distributed (p-value = 0.2215)

Table 3 Wilcoxon test

(V/W, p)	**One-sided**	**Two-sided**
Paired	(V=32.5, p=0.02908)	(V=36.5, p=0.05817)
Two-sample (Mann-Whitney)	(W=145.5, p=0.008413)	(W=145.5, p=0.016827)

In the table 3 above W is the test statistic in two-sample Wilcoxon test (Mann-Whitney test) indicating the number of times a CEFR-J level from F is less than a CEFR-J level from L. Furthermore, V is the test-statistic in the paired Wilcoxon test indicating the sum of the elements of L-F (difference dataset) that are positive. Table 4 indicates the t-statistic.

Table 4 t-test

(t, p)	One-sided	Two-sided
Paired	(t=-2.1712, p=0.02914)	(t=-2.1712, p=0.05829)
Two-sample (Welch)	(t=-2.5757, p=0.0102)	(t=-2.5757, p=0.0204)

3.2. Result 2: Student vocabulary improvement based on their final grade

This section reports how mean CEFR-J values increased for particular 'sets' of students was analysed. Students were segmented into three groups based on their final grade for the 'Science and Religion in Japan' module: Top 7 students, middle 8 students, and lower 7 students. Our results showed that students in the 'lower' group displayed a greater increase in CEFR-J levels than 'top group' students (table 5 and figure 7).

Table 5 Grade-based analysis

Grade class	Weeks 1-3 (Mean CEFR)	Weeks 11-13 (Mean CEFR)
Top-7	5.071428571	5.428571429
Mid-8	4.857142857	5.428571429
Bottom-7	4.928571429	5.5

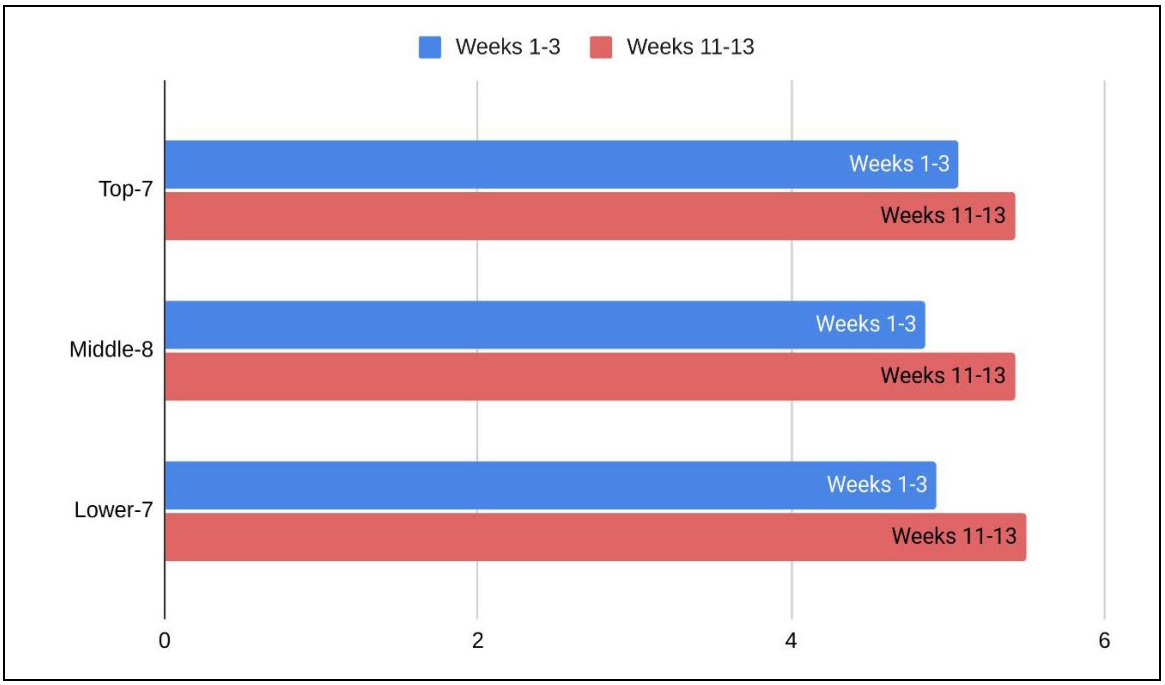

Figure 7 Student vocabulary improvement based on their final grade

3.3. Result 3: Analysis of the Level of Correlation Between CEFR-J levels of Students' Written Assignments and Related Lecture Materials

During weeks 1-3 and 11-13, students submitted 207 individual assignments with word count above 400 for different questions. These assignments are each associated with lecture slide sets which were created by the study authors. In this section, the study authors investigated their tendency to engage in 'patch writing', a form of plagiarism in which students copy 'chunks' of text from course materials and from other sources without really developing their writing skills or fully understanding the content. This part of the research should provide insights into how course materials can be better designed to prevent patchwriting and instead encourage students to develop their own writing skills to the greatest extent possible. We conducted a Spearman correlation test for slide-set CEFR-J values and student-assignment CEFR-J values [16]. There is positive correlation with Spearman's rank correlation coefficient 0.2907279. The null hypothesis of true rank correlation coefficient being 0 is rejected at 5% significance level with p-value 0.00002242.

3.4.Discussion

This study aims to analyse the written English vocabulary levels of international students majoring in engineering. The results of this paper can be summarized into the following points which can also serve as answers to the research questions asked by this paper:

1) International students' English vocabulary levels at our institution were found to range from the B1.1 to C2 CEFR-J levels at the beginning of the course, whereas they ranged from the B2.1 to C2 CEFR-J levels – Answer to RQ1.
2) The mean of international engineering students' vocabulary CEFR-J levels as measured at the beginning period of the course was 4.955 (B2.2-C1), whereas the mean of their recorded CEFR-J levels in the concluding period was 5.4532 (C1-C2) –Answer to RQ1. Their increase in CEFR-J levels in writing was observed; the difference was proven to be statistically significant – Answer to RQ2.
3) Students in the 'lower' group displayed a greater increase in CEFR-J levels than 'top group' students. – Answer to RQ2.
4) There is a positive correlation of the CEFR-J levels seen in student writing assignments and the CEFR level of the lecture material itself, but it was very small –Answer to RQ3.

The results demonstrated in item 1 and 2 above offer several benefits. Firstly, understanding students' English proficiency allows educators to tailor their instruction to meet the diverse needs of the class. It may also lead to an effective lesson planning. Additionally, it allows for thoughtful grouping in discussion activities. As indicated in item 3, students in the 'lower'

group displayed a greater increase in CEFR-J levels than students in 'top group.' This may be because grades for the earliest assignments were made known to students halfway through the course. It seems plausible that awareness of their poor performance led the 'lower group' students to make an extra effort in the latter part of the course, resulting in a more significant improvement in their English. This would also fit with the fact that the length (in terms of raw wordcount) of 'lower' group students' essays increased significantly in the later set of writing assignments - whereas the volume of 'top group' students' written output remained reasonably constant. The result in item 4 suggests that 22 international students in the history module 'Science and Religion in Japan' in the 2022 fall semester did not resort much to 'patch writing'. One possible explanation for the small correlation between the CEFR-J levels seen in student writing assignments and the CEFR-J level of the lecture material is that for a certain technical terminology in the lecture slides cannot be rephrased by other words and phrases.

4. Conclusions

This preliminary study aimed to demonstrate how humanities components could provide substantial educational benefits to students currently majoring in engineering. Regarding the overall effect of the course on students' written assignments, the results of this study suggested the following conclusions. The findings from this paper indicate that the written English vocabulary proficiency of international engineering students improved through their participation in the 'Science and Religion in Japan' module in the 2022 fall semester by completing their weekly assignments to write a 600-word summary-and-response paper based on that week's covered topics. This outcome is viewed as a positive and somewhat unexpected by-product resulting from the incorporation of humanities modules into the IGP, a research-based engineering degree program, with all course content taught in English. We will monitor the course in the next following semesters to see if these trends continue. The results of this study are anticipated to play a role in optimizing the course and providing support for the academic success of the international students in engineering programs.

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