

教育部教學實踐研究計畫成果報告  
Project Report for MOE Teaching Practice Research Program

計畫編號/Project Number：PEE1110053

學門專案分類/Division：工程

計畫年度：111 年度一年期 110 年度多年期

執行期間/Funding Period：2022.08.01 – 2023.07.31

使用 CDIO 提升 EMI 課程專業英語口語技能

Improving professional English speaking skills through CDIO in an EMI course

SUSTAINABLE MANUFACTURING AND ECO-INNOVATION

計畫主持人(Principal Investigator)：陳兆衡

協同主持人(Co-Principal Investigator)：

執行機構及系所(Institution/Department/Program)：逢甲大學工業工程與系統管理學系

成果報告公開日期：立即公開 延後公開（統一於 2025 年 7 月 31 日公開）

繳交報告日期(Report Submission Date)：2023 年 9 月 10 日

## Improving professional English speaking skills through CDIO in an EMI course

### 一. 本文 Content

1. 研究動機與目的 Research Motive and Purpose
2. 研究問題 Research Question
3. 文獻探討 Literature Review
4. 教學設計與規劃 Teaching Planning
5. 研究設計與執行方法 Research Methodology
6. 教學暨研究成果 Teaching and Research Outcomes
  - (1) 教學過程與成果
  - (2) 學生學習回饋
  - (3) 教師教學反思
7. 建議與省思 Recommendations and Reflections

### 二. 參考文獻 References

### 三. 附件 Appendix

## 1. Research Motive and Purpose

Taiwan's Ministry of Education has implemented a bilingual policy to cultivate bilingual talent and boost the country's international competitiveness (MOE, 2018). However, when the results are broken down into 4 basic language skills: listening, reading, writing, and speaking, the receptive skills (reading, listening) are better than the productive skills (writing and speaking). The education policy should place more emphasis on English speaking and writing.

EMI courses has indicated that students acknowledge the advantages of using English to convey professional terms and concepts (Chen F, 2018). Nevertheless, they face difficulties in comprehending discipline-specific terminology, grasping course content, and actively participating in class discussions, all of which are interconnected with their command of professional English and overall English proficiency.

The Bilingual Nation 2030 report has identified four major challenges in promoting bilingual higher education. These challenges include improving English speaking and writing skills, providing professional English training in students' respective disciplines, offering adequate training and resources for university faculty, and developing effective teaching approaches for English Medium of Instruction (EMI) courses (National Development Council, et al, 2021).

Many students exhibit weaknesses in spoken English compared to their reading, writing, and listening skills. Reasons for this disparity may include students being introverted, fearing loss of face in front of peers, a lack of support or practice in spoken English, and varying levels of English proficiency within the group.

To address these issues, the research aims to investigate the use of the CDIO approach to improve students' professional English-speaking skills in EMI courses. The CDIO approach, primarily applied to engineering students, involves conceiving, designing, implementing, and operating real-world systems and products.

## 2. Research Question

Enhancing professional English-speaking abilities by CDIO in an EMI course. Spoken English is an important part of the interaction within industries on many occasions, such as exhibitions, presentations, and meetings; however, Taiwanese students are weak in spoken English.

## 3. Literature Review

### The current policy in Taiwan

Taiwan has implemented a policy to develop the country into a bilingual nation by 2030 in response to global competition and the need for professionals with strong communication skills. The policy aims to improve English proficiency among students and enhance national competitiveness. The strategy involves adopting a dynamic teaching approach that emphasizes daily English use. The objectives of the policy include optimizing English learning platforms, strengthening bilingual education systems, and enhancing people's English skills in listening, speaking, reading, and writing (National Development Council, Executive Yuan, 2018).

### BEST program

The Ministry of Education (MOE) has introduced the "Program on Bilingual Education for Students in College" (BEST) in September 2021. This program aims to enhance students' English proficiency in higher education and promote a bilingual teaching and learning environment in universities and colleges in Taiwan. The goal is to equip students with the ability to communicate, cooperate, and work globally. Beacon schools and colleges have been selected to lead the way in implementing the program, with the target of having a certain percentage of students reach effective operational proficiency in listening, speaking, reading, and writing by 2024 and 2030 (MOE, 2021).

### Bilingual Nation 2030 report

The Ministry of Education (MOE) and the British Council collaborated in 2020–2021 to evaluate the English proficiency of Taiwanese 12th graders. The survey revealed that 17.1% of students reached CEFR B2 level and 4.3% reached C level. However, only 8.27% of students demonstrated proficiency in speaking. The "Bilingual Nation 2030" report emphasized the significance of promoting English as a medium of instruction (EMI) in tertiary education in order to cultivate bilingual professionals. It highlighted students' difficulties with speaking and writing English and suggests concentrating on improving these abilities (National Development Council, et al, 2021).

### English as a Medium of Instruction (EMI) courses

EMI refers to the use of the English language to teach academic subjects in countries where English is not the majority language (Macaro et al., 2017). Its growth is fueled by factors such as the prevalence of English in academic research, the internationalization of universities, the demand for English proficiency in job applications and advanced studies, and government initiatives to promote English as a second language (Seidlhofer, 2011). However, the effectiveness of EMI is influenced by individual English proficiency, and there are concerns about its impact on course content, student understanding, course completion time, communication difficulties, code-switching, resistance, and limited classroom interaction (Galloway, 2017)

### CDIO Initiative

The CDIO (Conceive, Design, Implement, Operate) is an educational framework developed by MIT to equip engineering students with the necessary skills for real-world engineering situations. The key features of CDIO courses include project-based learning, active learning through experimentation and self-learning, integration of professional skills like teamwork and communication, and simulating real-world engineering teams to solve problems (CDIO Council, 2021)

### CDIO in EMI courses

The Global Engineers Language Skills (GELS) network, comprised of teachers from technical universities and engineering departments, aims to enhance Language and Communication (LC) teaching for engineering students using the CDIO approach. They have identified the key communication skills required by engineers, including reading documents, writing correspondence and documents, giving presentations, following complex instructions, engaging in telephone conversations, understanding information in meetings, and interacting in meetings. (Rinder J, et al, 2020)

### Cooperative learning and Student-Teams-Achievement-Divisions (STAD)

Cooperative learning, a widely used learning strategy, emphasizes the importance of learner interactions to collectively achieve goals. Techniques such as jigsaw, rally table, STAD, and TGT are employed in cooperative learning, with STAD being a simple and straightforward approach. In STAD, students are placed in teams based on their pre-test scores and encouraged to work together to improve group performance. Bonus marks may be awarded to the best-performing group. (Slavin 1995)

#### 4. Teaching Planning

The Sustainable Manufacturing and Eco-Innovation course focuses on current thinking, terminology, and knowledge in the field. It introduces tools for accelerating the transition to a sustainable industrial system. The course enables students to address environmental, economic, and social challenges, transform industrial behavior, and foster sustainability in societies, industries, and service sectors. The course is also designed to address climate change adaptation issues.

The course includes lectures, case studies, group discussions, site visits, and a project. In the project, students analyze a current product challenge related to climate change. Students take on the roles of investors and investees, with each role required to speak in turn and convince the investors to invest based on their presentation, written report, and prototype.

The assessment methods are:

- Participation 15%
- Group project 85%. Appendix 1 (Table 1) shows group project assessment rubrics.
- Bonus marks.

Appendix 1 (Table 2) shows the course syllabus. There will be a pre-test in week 0 and a post-test (project) in week 18 to compare the result. The course consists of classroom lectures in weeks 1–10 and 12–13, a visit to a manufacturing plant or recycling center in week 11, and a presentation by an industry expert on-site. 14–18 weeks are devoted to a project and performance in either a classroom or a multifunctional studio. Appendix 1 (Table 3) shows Timetable of Sustainable Manufacturing and Eco-Innovation course.

#### 5. Research Methodology

##### Research methods and tools

The Sustainable Manufacturing and Eco-Innovation class is an elective for 1st-year graduate students in the Department of Industrial Engineering and Systems Management at Feng Chia University. Students from other departments or years (either local or foreign) are eligible to enroll. However, apart from students with English mother tongue. The study will include both quantitative and qualitative data collection and analysis. The quantitative data will be collected through tests, and a sample paired T-test will be applied to the scores of the tests to examine the improvement in professional English-speaking proficiency. The qualitative data will be gathered through passive participant observation, open-ended survey responses, and interviews with purposive-selected students.

##### Pre-test and post-test

A pre-test and post-test will be conducted to assess the participants' professional English-speaking skills. The assessment will use the TOEFL IBT Test Independent Speaking Rubrics (Appendix 2), evaluated by two assessors who will maintain reliability and validity. The scorer's reliability will be evaluated using Cohen's Kappa coefficient. The pre-test will focus on understanding and impressions of the course, while the post-test will involve a speaking interaction in the form of a drama. Each student will take part in the drama, presenting various perspectives related to the project. Assessors may ask additional questions to evaluate the students' speaking level regarding the product or project challenges.

### Passive participant observation

To analyze students' English-speaking interactions, passive participant observations will be conducted by video-recording every lecture. Students will be assigned fixed seats to facilitate the identification of their names by research assistants for transcription of field notes and video analysis after class.

### Open-end survey responses - Students self-evaluation

Students will take a descriptive self-evaluation open-end survey at the end of the course to provide qualitative data for comparison. Example questions are:

Q1: What do you think about your professional English-speaking improvement for this course?

Q2: What do you think about the activities in class for this course?

### Interviews

Purposive-selected selected students will be interviewed to focus on the comparison before and after the course. The interviews will be video-recorded and then be transcribed.

### Data collection

The quantitative data will be collected through pre-test and post-test scores of English-speaking proficiency undertaken in week 0 and week 18 respectively. The qualitative data will also be collected in the study through

- a. passive participant observation (video-recorded by research assistants)
- b. open-end survey responses
- c. interviews with purposive-selected selected students (video-recorded) at the end of the course.

### Quantitative data analysis

The score of pre-test and post-test will be analyzed by Minitab, using the paired sample T-test to determine the means of the two measurements taken from the same individual. The purpose is to determine whether there is statistical evidence that the mean difference between paired observations is significantly different from zero

The hypotheses are:

H0:  $\mu_1 - \mu_2 = 0$  ("the difference between the paired population means is equal to 0")

H1:  $\mu_1 - \mu_2 \neq 0$  ("the difference between the paired population means is not 0")

where

$\mu_1$  is the population mean of pre-test scores, and

$\mu_2$  is the population mean of post-test scores.

A Cohen's kappa coefficient on the scorer reliability will then be evaluated on both tests to ensure scorer reliability.

### Qualitative data analyses

In the qualitative data analyses (passive participant observation, open-end survey responses, and interviews), the researcher will examine if the results can confirm the findings in the above hypotheses of the quantitative data analysis.

Research Framework (Figure 1)

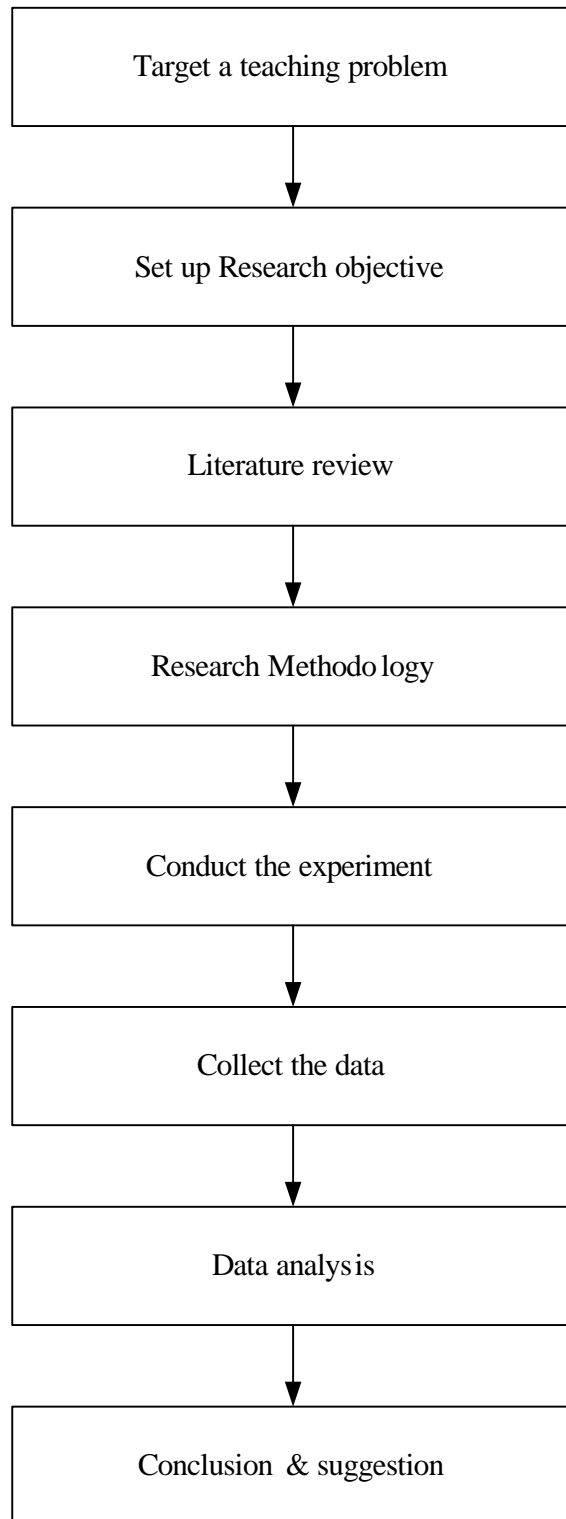


Figure 1 Research Framework

## Implementation Procedure (Figure 2)

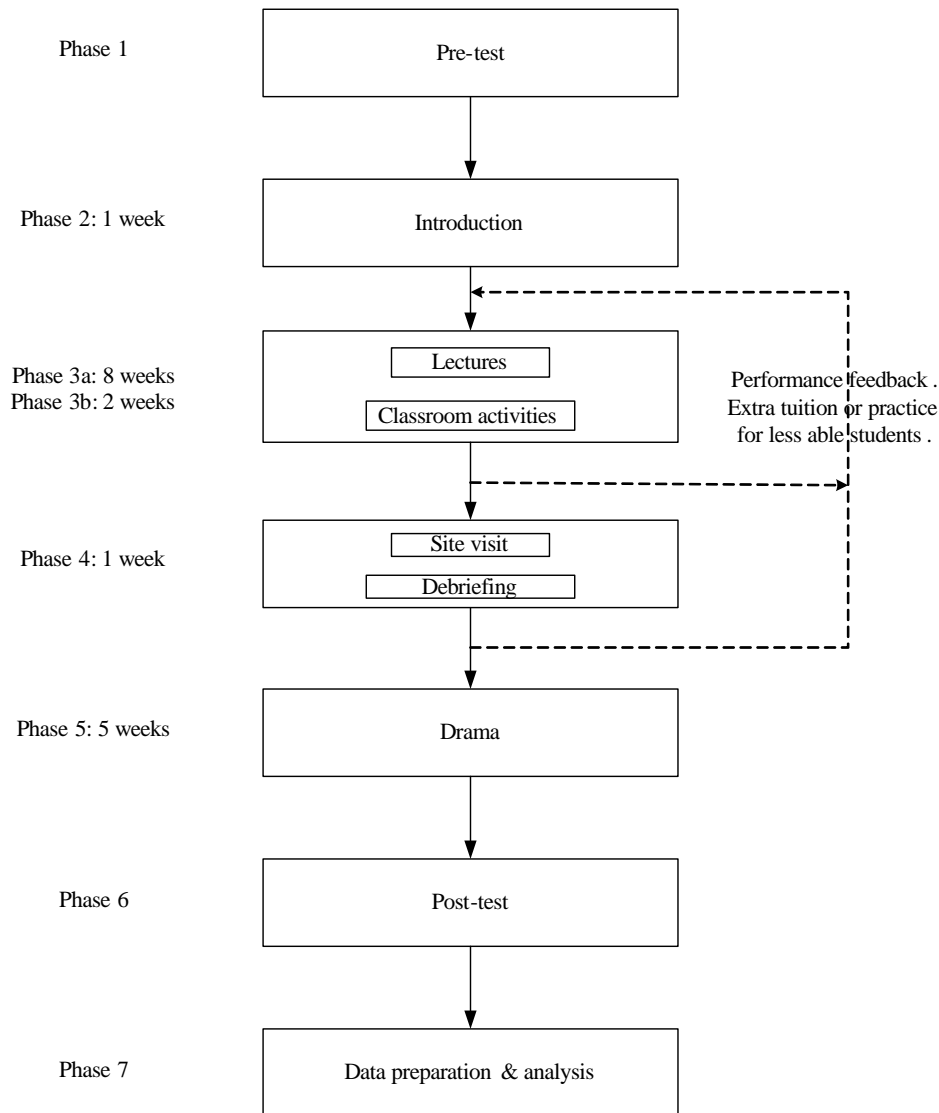


Figure 2: Implementation Flowchart

Phase 1 of the course involves a pre-test to assess students' English-speaking proficiency using the TOEFL IBT Test Independent Speaking Rubrics. Students are then grouped based on their scores.

Phase 2 of the course, the instructor provides an overview of the course structure, emphasizes the importance of classroom participation, and explains the requirements of the final project.

Phase 3a (8 weeks) and 3b (2 weeks) consist of lectures, case studies, and group discussions. Students are expected to present their ideas and discussion outcomes in English. Bonus marks are given to the team with the best performance.

Phase 4 consists of a site visit to a manufacturing plant or recycling center, where students will receive a talk by an industrial expert on sustainability practices.

Phase 5 involves the implementation of a drama by each group. Students will write an English script and allocate roles of investees and investors. The drama will consist of a presentation of the innovative product, with each member taking turns to speak and investors asking questions.



Phase 6 involves the post-test, which serves as the final evaluation of students' Professional English speaking proficiency. Assessors will assess the students' performance to determine their level of proficiency.

Phase 7 involves data preparation and analysis. Quantitative data will be collected through tests and analyzed using Minitab. Qualitative data from observations, surveys, and interviews will also be analyzed and compared with the quantitative findings for comprehensive conclusions.

## 6. Teaching and Research Outcomes

In this research, data was collected from 23 non-native English speakers. Quantitative data was collected through the use of pre-test and post-test scores. The comparison of pre-test and post-test scores allows an evaluation of whether the program of study produced statistically significant changes or improvements in the participants' professional English-speaking skills. The values of the pre-test and post-test scores obtained from the participants are shown in Appendix 3 (Table 1: Pre-test Score, Post-test Score).

### Cohen's Kappa

The Cohen's Kappa coefficient is a measure of reliability between two observers for qualitative categorization. Reliability between observers is reached when data collection observers assign the same score to the same data item. The Kappa statistic ranges between 0 and 1. The range of kappa values and their corresponding interpretations are shown in Table 1. The weighted value of kappa is calculated by summing the products of all the elements in the observation table multiplied by their respective weights and dividing by the sum of the products of all the elements in the expectation table multiplied by their respective weights.

Kappa Value	Interpretation
0	No agreement
0.1 – 0.2	Slight agreement
0.21 – 0.40	Fair agreement
0.41 – 0.60	Moderate agreement
0.61 – 0.80	Substantial agreement
0.81– 0.99	Almost perfect agreement
1	Perfect agreement.

Table 1: Categories of Cohen's Kappa

The pre-test results presented in Appendix 4 (Table 1: Pre-test Weighted Kappa) with a Weighted Kappa value of 0.737 and the post-test results presented in Appendix 4 (Table 2: Post-test Weighted Kappa) with a Weighted Kappa value of 0.687 both indicate substantial agreement among the assessors for the variables under consideration.

### Quantitative data analysis

The t-test analysis was conducted based on the average values of the pre-test and post-test scores. The average score for each participant was calculated by summing the pre-test and post-test scores and dividing the total by two. The t-test was conducted to determine the significance of the difference between the null hypothesis (H0) and the alternative hypothesis (H1).

#### H0 Statement:

The null hypothesis (H0) assumes that there is no significant difference between the means of the two groups being compared.

### H1 Statement:

The alternative hypothesis (H1) contradicts the null hypothesis and proposes that there is a significant difference between the means of the two groups.

The statistical test calculates a t-value and a p-value to evaluate the hypotheses. If the p-value is less than the predetermined alpha level of 0.05, it indicates a statistically significant difference, supporting the alternative hypothesis. Conversely, if the p-value is greater than or equal to the alpha level, we fail to reject the null hypothesis. However, it's important to note that failure to reject the null hypothesis does not imply its truth but rather indicates that the alternative hypothesis is not supported by sufficient evidence.

### Quantitative data analysis of all students

A total of 23 students enrolled in the class, including 9 females and 14 males, are shown in Appendix 3 (Table 4: Student's gender). The t-test values were calculated using Minitab software to facilitate this analysis. The t-test, Paired Two Sample for Means, was conducted to compare the means of two dependent groups in this research.

The results of the t-Test of 23 students shown in Table 2 are the statistical results of the difference between two sample means, including the descriptive statistics, estimation for the paired difference, and the test value.

#### Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
pre-test	23	2.402	0.944	0.197
post-test	23	2.663	0.906	0.189

#### Estimation for Paired Difference

Mean	StDev	SE Mean	95% CI for $\mu$ difference
-0.261	0.497	0.104	(-0.476, -0.046)

#### Test

T-Value	P-Value
-2.52	0.020

Table 2: The paired t-test on the pre-test and post-test scores of all students

A paired t-Test was conducted on 23 observations to assess the impact of the intervention. The mean pre-test score was 2.402, and the mean post-test score was 2.663. The t-Test results revealed a significant difference between the means ( $t = -2.52$ ,  $p = 0.020$ ). The p-value of 0.020, below the alpha level of 0.05, indicates a statistically significant change. Consequently, the null hypothesis is rejected, suggesting that the intervention program had a significant effect on the outcome variable.

### Quantitative data analysis of Taiwanese students

Out of the 23 students, 17 were identified as Taiwanese. However, 6 students (numbers 1, 3, 7, 8, 21, and 22) were excluded from the analysis due to their non-Taiwanese background. The purpose of focusing on Taiwanese students was to examine potential differences within this subgroup. The t-Test results (shown in Table 3) provide statistical information regarding the difference between two sample means, including descriptive statistics, paired difference estimation, and the test value.

### Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
Pre-Test	17	2.176	0.738	0.179
Post-Test	17	2.456	0.830	0.201

### Estimation for Paired Difference

Mean	StDev	SE Mean	95% CI for $\mu$ difference
-0.279	0.529	0.128	(-0.552, -0.007)

### Test

T-Value	P-Value
-2.18	0.045

Table 3: The paired t-test on the pre-test and post-test scores of Taiwanese students

The paired t-test on the pre-test and post-test scores of 17 Taiwanese students revealed a significant difference between the two time points. The mean score on the pre-test was 2,176, and the mean score on the post-test was 2,456. The t-test results indicated a significant difference between the pre-test and post-test means ( $t = -2.18$ ,  $p = 0.045$ ). The p-value of 0.045, below the predetermined alpha level of 0.05, suggests that the observed difference is statistically significant. Consequently, we reject the null hypothesis.

### Quantitative data analysis based on gender

Based on the initial sample of 23 observations, additional t-tests were conducted to investigate the potential differences according to gender between the pre-test and post-test mean scores. The purpose of gender-specific t-tests was to determine whether there were significant differences between male and female participants before and after the intervention in terms of their scores. Student 1, Student 3, Student 4, Student 11, Student 13, Student 15, Student 16, Student 17, and Student 21 were identified as females, and the remaining 14 students were categorized as males.

### Quantitative data analysis of female students

The t-Test: Paired Two Sample for Means was conducted specifically for a group of 9 female students to compare the means of their pre-test and post-test scores. The results of the t-Test shown in Table 4, shows the statistical results of the difference between two sample means, including the descriptive statistics, estimation for paired difference, and the test value.

### Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
pre-test	9	2.583	0.976	0.325
post-test	9	2.639	0.969	0.323

### Estimation for Paired Difference

Mean	StDev	SE Mean	95% CI for $\mu$ difference
-0.056	0.481	0.160	(-0.425, 0.314)

### Test

T-Value	P-Value
-0.35	0.738

Table 4: The paired t-test on the pre-test and post-test scores of female students

For the group of 9 female students, the mean pre-test score was 2.583, with a standard deviation of 0.976. The mean post-test score for females was 2.638, with a standard deviation of 0.969. There was no significant difference between the means of the pre-test and post-test scores for this subgroup ( $t = -0.35$ ,  $p = 0.738$ ). The obtained p-value is 0.738, which is greater than the predetermined alpha level 0.05, indicates that the observed difference is not statistically significant. This implies that the change in the outcome variable for the 9 female students is likely to have occurred due to chance and may not have produced a significant effect on the outcome variable for the female group. The t-Test conducted on this limited sample did not provide sufficient evidence to support the effectiveness of the intervention for this subgroup.

#### Quantitative data analysis of male students

The t-Test: Paired Two Sample for Means was conducted specifically for a group of 14 male students to compare the means of their pre-test and post-test scores. The results of the t-Test shown in Table 5, shows the statistical results of the difference between two sample means, including the descriptive statistics, estimation for paired difference, and the test value.

#### Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
pre-test	14	2.286	0.940	0.251
post-test	14	2.679	0.901	0.241

#### Estimation for Paired Difference

Mean	StDev	SE Mean	95% CI for $\mu$ difference
-0.393	0.478	0.128	(-0.669, -0.117)

#### Test

T-Value	P-Value
-3.08	0.009

Table 5: The paired t-test on the pre-test and post-test scores of male students

For the group of 14 male students, the mean pre-test score is 2.286, with a standard deviation of 0.940. The mean post-test score for male was 2.679, with a standard deviation of 0.901. There was indicated a significant difference between the means of the pre-test and post-test scores for this subgroup ( $t = -3.08$ ,  $p = 0.009$ ). The obtained p-value is 0.0088, which is less than the predetermined alpha level 0.05, suggests that there was a statistically significant change in the outcome variable from the pre-test to the post-test for this group of male students.

#### Self-assessment data analysis

The t-test analysis was conducted based on the self-assessment survey. The students' pre- and post-class self-assessment scores are presented in Appendix 3 (Table 5: Students self-assessment score). The t-test was performed to assess the significance of the difference between the null hypothesis ( $H_0$ ) and the alternative hypothesis ( $H_1$ ).

**$H_0$  Statement:**

The null hypothesis ( $H_0$ ) assumes that there is no significant difference between the means of the two groups being compared.

**$H_1$  Statement:**

The alternative hypothesis ( $H_1$ ) contradicts the null hypothesis and proposes that there is a significant difference between the means of the two groups.

### Self-assessment data analysis of all students

The t-Test: Paired Two Sample for Means was conducted to compare the means of two dependent groups in this research. The results of the t-Test shown in Table 6, shows the statistical results of the difference between two sample means, including the descriptive statistics, estimation for paired difference, and the test value.

#### Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
before	23	2.435	1.080	0.225
after	23	3.043	0.976	0.204

#### Estimation for Paired Difference

Mean	StDev	SE Mean	95% CI for $\mu$ difference
-0.609	0.583	0.122	(-0.861, -0.357)

#### Test

T-Value	P-Value
-5.01	0.000

Table 6: The paired t-test on the self-assessment of all students

The mean self-assessment at the beginning of class was 2.435, and the mean self-assessment at the end of class was 3.043. The t-Test results revealed a significant difference between the means of the pre-test and post-test scores ( $t = -5.01$ ,  $p = 0.000$ ). The obtained p-value is 0.000, which is less than the predetermined alpha level (0.05), indicates that the observed difference is statistically significant. Based on these results, we reject the null hypothesis.

### Self-assessment data analysis of female students

The t-Test: Paired Two Sample for Means was specifically conducted for a group of 9 female students, in order to compare the means of self-assessment at the beginning and at the end of class. The statistical results, as shown in Table 7, present the descriptive statistics, estimation for paired difference, and the test value.

#### Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
Female before	9	2.556	1.236	0.412
Female after	9	3.000	1.118	0.373

#### Estimation for Paired Difference

Mean	StDev	SE Mean	95% CI for $\mu$ difference
-0.444	0.726	0.242	(-1.003, 0.114)

#### Test

T-Value	P-Value
-1.84	0.104

Table 7: The paired t-test on the self-assessment of female students

For the group of 9 female students, the mean self-assessment at the beginning of class was 2.556, and the mean self-assessment at the end of class was 3.000. There was an indicated difference that was not significant between the means of self-assessment at the beginning and at the end of class for this subgroup ( $t = -1.84$ ,  $p = 0.104$ ). The obtained p-value of 0.104, which is greater than the predetermined alpha level of 0.05, indicates that the observed difference is not statistically significant.

#### Self-assessment data analysis of male students

The t-Test: Paired Two Sample for Means was specifically conducted for a group of 14 male, in order to compare the means of self-assessment at the beginning and at the end of class. The statistical results, as shown in Table 8, present the descriptive statistics, estimation for paired difference, and the test value.

#### Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
Male before	14	2.357	1.008	0.269
Male after	14	3.071	0.917	0.245

#### Estimation for Paired Difference

Mean	StDev	SE Mean	95% CI for $\mu$ difference
-0.714	0.469	0.125	(-0.985, -0.444)

#### Test

T-Value	P-Value
-5.70	0.000

Table 8: The paired t-test on the self-assessment of male students

For the group of 14 male students, the mean self-assessment at the beginning of class was 2.357. The mean post-test score for male was 3.071. There was indicated a significant difference between the means of self-assessment at the beginning and at the end of class for this subgroup ( $t = -5.07$ ,  $p = 0.000$ ). The obtained p-value is 0.0000, which is less than the predetermined alpha level 0.05, suggests that there was a statistically significant change in the outcome variable from the self-assessment at the beginning and at the end of class for this group of male students.

The t-test analysis of the quantitative data collected through pre-test, post-test, and self-assessment surveys administered at the beginning and end of the course showed a significant difference between the means of the two groups for all students indicating an improvement in their English-speaking abilities. When the data were analyzed based on gender, it was discovered that the male group showed a significant difference between the means, whereas the female group did not. This may be due to the smaller number of female students and the possibility that some of them already had a proficient level of English, thereby limiting the improvement in their language skills that was observable.

#### Qualitative data analysis

In this study, the qualitative data collected will focus specifically on evaluating the improvement in English-speaking skills among the students in the context of Sustainable Manufacturing and Eco-Innovation. To ensure active learning and engagement, a variety of teaching methods were employed, including lectures, interactive discussions, group activities, and company visits were organized during the course. By examining qualitative data, we can gain insights into the students' perceptions of their own progress, their evolving confidence levels, and the challenges they faced during the language learning process.

The qualitative data report in this study is centered around two main points:

Q1: What do you think about your professional English-speaking improvement for this course?

Q2: What do you think about the activities in class for this course?

The first point of focus in the qualitative data report is the students' perceptions and reflections on their own professional English-speaking improvement throughout the course. The students offered diverse perspectives, highlighting the perceived advantages derived from their participation. The students specifically emphasized the increased opportunities for practicing and speaking English, expansion of vocabulary, including interactions with foreign students. The responses of several students to an open survey regarding their perceptions of their professional English-speaking improvement in this course are presented in Appendix 5 (Table 1: The responses of several students to an open survey regarding their perceptions of their professional English speaking improvement).

The second point of emphasis in the qualitative data report revolves around the students' opinions and impressions of the various activities conducted in the classroom throughout the course. Many students found the teacher's lectures engaging and expressed enjoyment during class and the factory tours. They described the course as fun, interesting, and conducive to critical thinking. Students also appreciated the teacher's dedicated and caring attitude towards their studies. The off-campus visits were particularly highlighted as interesting experiences. The responses of several students to an open survey regarding their perceptions of activities in class are presented in Appendix 5 (Table 2: The responses of several students to an open survey regarding their perceptions of activities in class).

#### Students' perspectives

Based on the students' perspectives, which aspects of the course had the greatest impact on them? The majority of students listed the factory tour as the most impressive aspect of the course, emphasizing its real-world relevance. Other responses included positive remarks about the employed teaching methods and the role of group reports, which encouraged collaborative learning and increased their knowledge of the topic. The responses of some students to the question, "What most impressed you about this class?" are displayed in Appendix 5 (Table 3: The most impressed you about this class).

In addition to the survey, interviews were conducted with selected students to gather more in-depth insights into their experiences. The interviews involved student 1, student 3, student 4, student 10 and student 12. Through these interviews, a deeper understanding was gained regarding their perceptions, challenges, and overall growth in their professional English-speaking skills. The thoughts and reflections of the students gathered during the interviews are presented in Appendix 5 (Table 4: Students thoughts and reflections).

According to passive participant observation during the class, it was observed that a subset of male students, including Student 5, Student 10, Student 19, Student 20, and Student 22, actively participated in class discussions by sharing their opinions and answering questions. Instead of for female students, student 1 and student 21 were the only female students observed actively participating in class activities with similar enthusiasm and participation. Their willingness to contribute indicates an increased level of confidence and English language proficiency. Table 9 displays the students' contributions during the class by answering questions. It provides an overview of their active participation and engagement in classroom discussions.

Gender	Students	Contributions
Male	Student 5	5
	Student 10	4
	Student 19	2
	Student 20	2
	Student 22	7
Female	Student 1	10
	Student 21	4

Table 9: Students contributions during the class

Based on the analysis of the open survey responses, several key findings emerged. Firstly, the majority of students expressed a solid understanding of the course content. Appendix 5 (Table 5: Students' level of understanding of the course content) displays the students' responses indicating their level of understanding of the course content. A rating scale ranging from 1 to 5 was used, with 1 representing a lack of understanding and 5 indicating a complete understanding. Five students assigned themselves a score of 5, nine students assigned themselves a score of 3, eight students assigned themselves a score of 2, and one student assigned themselves a score of 1. Notably, no student awarded themselves a score of zero, indicating that all students possessed a minimum level of comprehension and a high level of clarity and effectiveness in delivering the material.

Secondly, a significant portion of students, including Student 1, Student 3, Student 5, Student 6, Student 7, Student 11, Student 12, Student 13, Student 17, Student 18, Student 19, Student 21, and Student 22, expressed a willingness to enroll in additional courses taught in English. This positive attitude reflects their enthusiasm and motivation to improve their English skills through language-based learning opportunities. The majority of the class also feels that speaking English fluently is extremely important. Appendix 5 (Table 5: Students importance of speaking English proficiently) displays the responses of students regarding the importance of speaking English fluently. Using a scale ranging from 1 to 5, where 5 represents "very important" and 1 represents "not important," the results indicate that 13 students rated speaking fluent English 5 points, 8 students rated it 4 points, and 2 students rated it 3 points. Notably, no students gave it a rating of 2 or 1, indicating agreements on the importance of English proficiency.

Lastly, all students indicated their intention to participate in future courses if offered by the professor, reflecting their satisfaction and interest in continuing their educational journey. These findings collectively suggest that the course was successful in facilitating understanding, fostering a desire to improve English-speaking skills, and generating enthusiasm for further language-based learning opportunities.

#### Teacher's reflection

Students have demonstrated a genuine interest in the course, especially with regard to the topic of sustainability. This indicates that students are receptive to the subject matter, which creates a conducive learning environment. Students also demonstrate a willingness to engage in speaking practice. This eagerness to participate in oral communication activities demonstrates inspiring motivation and a desire to improve their language skills within the context of the course.

Furthermore, there has been an improvement in students' speaking abilities throughout the duration of the program. It is encouraging to observe the growth and improvement of students' speaking abilities as they actively engage in the learning process. However, it is important to recognize the constraint of limited teaching time, as classes are only held once per week.



This limited frequency of instruction makes it challenging to adequately cover all necessary material and meet the needs of students, particularly those with no engineering background. Essential to ensuring that all students can comprehend and actively participate in the course is the requirement to begin with the fundamentals and provide thorough explanations of the subject matter.

In general, the students' enthusiasm for the course, their willingness to engage in speaking practice, and a noticeable improvement in their speaking abilities contributed to the course's success. However, the limited teaching time and the diversity of student backgrounds present obstacles that can be overcome by allocating more hours for instruction and beginning with the basics.

## 7. Recommendations and Reflections

The t-test analysis of pre-test and post-test scores, there was a significant improvement in English-speaking skills for all students in the class. Specifically, when focusing on Taiwanese students, the results also indicated a significant improvement. 14 male students showed a significant improvement. However, it is noteworthy that there was no significant improvement observed among the female students.

The self-assessment data collected at the beginning and end of the course also supported the findings of improvement among the students. The t-test analysis further confirmed the significant improvement for all students, with male students showing a significant difference compared to their pre-test scores. However, no significant difference was observed among the female students.

The lack of significant improvement among the female students may be attributed to the small sample size, as there were only 9 participants in this subgroup. Additionally, it is possible that some of the female students already had a proficient level of English, limiting the observable improvement in their language skills.

The qualitative data collected from student feedback revealed the students' perspectives on the course. The majority of students expressed favorable evaluations of the course, emphasizing its contribution to their oral English proficiency. The activities were described as entertaining, educational, and advantageous to their language development. The factory visit was cited as the most impressive component of the course.

In consideration of these results, it is recommended to consider increasing the credit hours for the course from 1 to 2. This would allow students to have more dedicated time each week to learn and practice English. By adding an extra hour to the course, students will have increased exposure to the language and more opportunities to engage in various activities. This additional time can be utilized for interactive discussions, group work, and individual practice.

Moreover, the extended duration would allow the teacher to utilize this opportunity to introduce a wider range of teaching materials and resources. Providing a diverse range of materials that will enrich the learning experience and expose students to different accents, vocabulary, and contexts will enhance their overall language proficiency.

Students will have more opportunities to practice their English-speaking skills, gain confidence, and develop fluency while the course adopts more communicative teaching strategies that emphasize the development of students' speaking and listening abilities. By obtaining more credits from this course would also motivate the students' active participation and dedication.

## 8. References

1. Chen F (2017), *Instructional Language Use in Environmental Science Classroom, English as a Medium of Instruction in Higher Education, Implementations and Classroom Practices in Taiwan*, Springer, DOI 10.1007/978-981-10-4645-2
2. Dearden, J., & Macaro, E. (2016). Higher education teachers' attitudes towards English: A three country comparison. *Studies in Second Language Learning and Teaching*, 6(2), 3–34.
3. Galloway, N. (2017). How effective is English as a medium of instruction (EMI)? British Council
4. Galloway et al. (2017). Internationalisation, higher education and the growing demand for English: an investigation into the English medium of instruction (EMI) movement in China and Japan. *ELT Research Papers* 17.02
5. Macaro et al., (2017) A systematic review of English-medium instruction in higher education. *Language Teaching*, 51, 36–76.
6. Ministry of Education (MOE) (2018-12-17). Implement in Full Scale Bilingualization of Taiwan's Educational System; Cultivate Bilingual Talents to Bring Taiwan to the World. From <https://english.moe.gov.tw/cp-13-17790-80201-1.html>
7. Ministry of Education (MOE) (April 2021). BEST The Program on Bilingual Education for Students in College.
8. National Development Council, Executive Yuan (2018). *Blueprint for Developing Taiwan into a Bilingual Nation by 2030*.
9. National Development Council, Ministry of Education, Directorate-General of Personnel Administration, Ministry of Examination, Civil Service Protection and Training Commission, (2021). *Bilingual Nation 2030*.
10. Rinder, J. et al. (2020). The Global Engineers Language Skills (GELS) Network: an update. *Proceedings of the 16th International CDIO Conference*.
11. Seidlhofer, (2011). *Understanding English as a Lingua Franca*. Oxford: Oxford University Press, 240 pages, ISBN: 978-0-19-437500-9
12. Slavin (1995). *Cooperative learning: theory, research, and practice*. Allyn and Macon.

Appendix 1

Table 1: Group project assessment rubrics.

Score	4	3	2	1
Product design	Product design has fully expressed innovation and incorporates a large number of elements of sustainable manufacturing and reducing the impact of climate change.	Product design is innovative and incorporates elements of sustainable manufacturing and reducing the impact of climate change.	Product design shows a little innovation and incorporates only a few elements of sustainable manufacturing and reducing the impact of climate change.	Product design is not innovative and incorporates insufficient elements of sustainable manufacturing and reducing the impact of climate change.
Prototype	The prototype is outstanding.	The prototype is excellent.	The prototype is acceptable.	The prototype is poor or not available.

Table 2 shows the course syllabus. There will be a pre-test in week 0 and a post-test (project) in week 18 to compare the result.

Week	Content
0	Pre-test - Preliminary test based on TOEFL IBT Test Independent Speaking Rubrics. Students are placed in groups using STAD according to their scores by an S-type sorting mechanism.
1	<i>Introduction</i> – The first lecture is to give an overview of the course and its importance in modern societies to provide an insight into the environmental impact and climate change of manufacturing activities. Introduce the history of materials, economy, and the environment. Discuss the concept of three bottom lines, planet, people, and profit.
2-3	<i>Sustainability challenges and opportunities: UN directives</i> – Introduce SDGs (Sustainable Development Goals) and the impact on the government policies, corporate social responsibility (CSR), individual habits, and lives. What we have achieved so far, what we can do further and how it is related to manufacturing activities. Case study and presentation.
4-6	<i>The regulatory environment and international policy</i> – Explain the history and the development of different stages in international treaties and agreements. How different governments adopt such agreements related to emissions, taxes, and subsidies. Explain carbon trading and its development. Case study and presentation.
7-10	<i>Design, technology, and planning for sustainability</i> – Understand the basic principles of product design in terms of design-for-environment, design-for-manufacturing, and design-for-sustainability. How the design plan should be implemented and the factors affecting such a plan. Group discussion and presentation.
11	<i>Site visit</i> – A site visit to a manufacturing plant or recycling center to enable the students to see things in action. The visit will also include a talk by an industrial expert to explain the practical implementation of sustainability in a plant or the end-of-life product waste treatment. A site-visit debriefing presentation is required in week 12.

12-13	<i>Analysis and evaluation</i> – Introduce the concept of cradle-to-cradle, cradle-to-grave, and cradle-to-gate. Explain the core procedures for achieving the result for LCA (Life Cycle Analysis) and the relevance to the economics and environment by CO2 equivalence. Introduce a useful toolkit to evaluate the improvement of the manufacturing processes in a manufacturing facility. Group discussion and presentation.
14-18	<i>Group project</i> – Each group will discuss the current challenge of a product (or an innovative product or service) including the effect of climate change, develop an improvement plan and a prototype, and design a drama with the theme to promote the product which resembles a potential investor meeting. During the performance, the members of each group are split into investors and investees randomly. The investees are required to promote the innovative product or service using an improvement plan, oral presentation, written report and prototype, etc to convince the investors to invest in the project. The investors will then ask relevant questions or queries (e.g. technical, financial, etc) to decide if they should invest. Students need to submit presentation slides, written reports and prototypes. Post-test.

Table 3: Timetable of Sustainable Manufacturing and Eco-Innovation course

Week	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Pre-test																			
Lecture, Case study, Group discussion																			
Site visit																			
Site-visit debriefing																			
Drama																			
Post-test																			

Appendix 2: TOEFL IBT Test Independent Speaking Rubrics

SCORE	GENERAL DESCRIPTION	DELIVERY	LANGUAGE USE	TOPIC DEVELOPMENT
4	The response fulfills the demands of the task, with at most minor lapses in completeness. It is highly intelligible and exhibits sustained, coherent discourse. A response at this level is characterized by all of the following:	Generally well-paced flow (fluid expression). Speech is clear. It may include minor lapses, or minor difficulties with pronunciation or intonation patterns, which do not affect overall intelligibility.	The response demonstrates effective use of grammar and vocabulary. It exhibits a fairly high degree of automaticity with good control of basic and complex structures (as appropriate). Some minor (or systematic) errors are noticeable but do not obscure meaning.	Response is sustained and sufficient to the task. It is generally well developed and coherent; relationships between ideas are clear (or clear progression of ideas).

3	<p>The response addresses the task appropriately but may fall short of being fully developed. It is generally intelligible and coherent, with some fluidity of expression, though it exhibits some noticeable lapses in the expression of ideas. A response at this level is characterized by at least two of the following:</p>	<p>Speech is generally clear, with some fluidity of expression, though minor difficulties with pronunciation, intonation, or pacing are noticeable and may require listener effort at times (though overall intelligibility is not significantly affected).</p>	<p>The response demonstrates fairly automatic and effective use of grammar and vocabulary, and fairly coherent expression of relevant ideas. Response may exhibit some imprecise or inaccurate use of vocabulary or grammatical structures or be somewhat limited in the range of structures used. This may affect overall fluency, but it does not seriously interfere with the communication of the message.</p>	<p>Response is mostly coherent and sustained and conveys relevant ideas/information. Overall development is somewhat limited, usually lacks elaboration or specificity. Relationships between ideas may at times not be immediately clear.</p>
2	<p>The response addresses the task, but development of the topic is limited. It contains intelligible speech, although problems with delivery and/or overall coherence occur; meaning may be obscured in places. A response at this level is characterized by at least two of the following:</p>	<p>Speech is basically intelligible, though listener effort is needed because of unclear articulation, awkward intonation, or choppy rhythm/pace; meaning may be obscured in places.</p>	<p>The response demonstrates limited range and control of grammar and vocabulary. These limitations often prevent full expression of ideas. For the most part, only basic sentence structures are used successfully and spoken with fluidity. Structures and vocabulary may express mainly simple (short) and/or general propositions, with simple or unclear connections made among them (serial listing, conjunction, juxtaposition).</p>	<p>The response is connected to the task, though the number of ideas presented or the development of ideas is limited. Mostly basic ideas are expressed with limited elaboration (details and support). At times relevant substance may be vaguely expressed or repetitious. Connections of ideas may be unclear.</p>

<b>1</b>	The response is very limited in content and/or coherence or is only minimally connected to the task, or speech is largely unintelligible. A response at this level is characterized by at least two of the following:	Consistent pronunciation, stress and intonation difficulties cause considerable listener effort; delivery is choppy, fragmented, or telegraphic; frequent pauses and hesitations.	Range and control of grammar and vocabulary severely limit or prevent expression of ideas and connections among ideas. Some low-level responses may rely heavily on practiced or formulaic expressions.	Limited relevant content is expressed. The response generally lacks substance beyond expression of very basic ideas. Speaker may be unable to sustain speech to complete the task and may rely heavily on repetition of the prompt.
<b>0</b>	Speaker makes no attempt to respond OR response is unrelated to the topic.			

### Appendix 3

Table 1: Pre-test and Post-test score

Participant	Pre-test score			Post-test score		
	Assessor 1	Assessor 2	Average	Assessor 1	Assessor 2	Average
Student 1	4	4	4	4	4	4
Student 2	2	1.5	1.75	3	2.5	2.75
Student 3	2.5	2	2.25	3	3	3
Student 4	1	1	1	1.5	1.5	1.5
Student 5	1	1.5	1.25	1	1.5	1.25
Student 6	2	3	2.5	3	3.5	3.25
Student 7	3	3	3	2.5	3	2.75
Student 8	1	1	1	2	1.5	1.75
Student 9	2	2	2	3.5	3.5	3.5
Student 10	3	3	3	3	3	3
Student 11	2.5	2.5	2.5	2.5	3.5	3
Student 12	2.5	3	2.75	3	3	3
Student 13	3	3	3	2.5	2	2.25
Student 14	1	1	1	1	1	1
Student 15	2	2.5	2.25	2	2.5	2.25
Student 16	1.5	2	1.75	1	1.5	1.25
Student 17	3	2	2.5	3	2	2.5
Student 18	3.5	3	3.25	3.5	3.5	3.5
Student 19	3	3	3	3	3.5	3.25
Student 20	2	2.5	2.25	3	2.5	2.75
Student 21	4	4	4	4	4	4
Student 22	4	4	4	4	4	4
Student 23	1	1.5	1.25	2	1.5	1.75

Table 4: Student's gender

No	Female	Male
1	Student 1	Student 2
2	Student 3	Student 5
3	Student 4	Student 6
4	Student 11	Student 7
5	Student 13	Student 8
6	Student 15	Student 9
7	Student 16	Student 10
8	Student 17	Student 12
9	Student 21	Student 14
10	-	Student 18
11	-	Student 19
12	-	Student 20
13	-	Student 22
14	-	Student 23

Table 5: Students self-assessment score

Participant	Self-assessment at the beginning of the course	Self-assessment at the end of the course
Student 1	4	4
Student 2	3	4
Student 3	4	5
Student 4	1	2
Student 5	2	3
Student 6	3	4
Student 7	2	3
Student 8	1	2
Student 9	2	3
Student 10	2	3
Student 11	2	3
Student 12	4	4
Student 13	3	3
Student 14	1	2
Student 15	2	3
Student 16	1	1
Student 17	2	3
Student 18	4	4
Student 19	2	3
Student 20	1	1
Student 21	4	3
Student 22	3	4
Student 23	3	3

Appendix 4

Table 1: Pre-test Weighted Kappa  
Table 2: Post-test Weighted Kappa

Pre-Test									Post-Test								
Rows: Assessor 1 Columns: Assessor 2									Rows: Assessor 1 Columns: Assessor 2								
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	All		1.0	1.5	2.0	2.5	3.0	3.5	4.0	All
1.0	3	2	0	0	0	0	0	5	1.0	1	2	0	0	0	0	0	3
1.5	0	0	1	0	0	0	0	1	1.5	0	1	0	0	0	0	0	1
2.0	0	1	1	2	1	0	0	5	2.0	0	2	0	1	0	0	0	3
2.5	0	0	1	1	1	0	0	3	2.5	0	0	1	0	1	1	0	3
3.0	0	0	1	0	4	0	0	5	3.0	0	0	1	2	3	2	0	8
3.5	0	0	0	0	1	0	0	1	3.5	0	0	0	0	0	2	0	2
4.0	0	0	0	0	0	0	3	3	4.0	0	0	0	0	0	0	3	3
All	3	3	4	3	7	0	3	23	All	1	5	2	3	4	5	3	23
Measure of Observer Agreement									Measure of Observer Agreement								
Weighted Kappa   0.737									Weighted Kappa   0.687								
Table 1: Pre-test Weighted Kappa									Table 2: Post-test Weighted Kappa								

Appendix 5

Table 1: The responses of several students to an open survey regarding their perceptions of their professional English-speaking improvement.

Participant	Professional English speaking improvement
Student 1	In this class' PowerPoint, there are many difficult and proficient-level terms, so I think I can learn new words every week.
Student 3	Most speaking English is group discussion, and talk with other people.
Student 4	學習到更多關於永續製造的知識，每週也會接觸到更多英文 (Learn more about sustainable manufacturing and learn more English every week.)
Student 6	增加口說的機會 (Increase chances of speaking.)
Student 7	會令我有更想去學好英文的衝動 (It will increase my motivation for learning English.)
Student 9	讓我們努力聽取英文，並且在報告時呈現英文簡報，因此會比日常生活中，接觸更多英文機會，或許借此可以默默提升英文程度。 (Let us try our best to listen to English and present English briefings when we report, so we will have more opportunities to learn English than in daily life, and perhaps we can silently improve our English level.)
Student 10	能幫助英語聽力的提升，但我的口說還需要加強 (It can help improve listening, but my speaking still needs to be strengthened.)
Student 11	敢跟外國人對談 (Dare to talk to foreigners)
Student 12	老師會嘗試讓我們用英文回答問題，我認為可以提升英文的口說能力 (The teacher will try to let us answer the questions in English, I think it can improve our oral English skills.)



Student 13	更會使用英文報告 (Can use English report.)
Student 14	上台報告可以提升自己的口說能力 (Reporting on stage can improve your oral and speaking skills.)
Student 15	有固定的時間練習英語口說 (Have a fixed time to practice oral English.)
Student 16	報告時強迫一定得說話 發現沒那麼困難 (Forced to speak when reporting, found it not that difficult.)
Student 17	提升英文對談能力！(Improve your English conversation skills.)
Student 18	有機會能認識更多單字 提升字彙量
Student 19	讓我開始嘗試說英文(Let me try to speak English.)
Student 20	短暫期間內稍加可以和外籍生交流 (Can communicate with foreign students in a short period of time.)
Student 23	有機會用英文對話 (Have the opportunity to speak in English.)

Table 2: The responses of several students to an open survey regarding their perceptions of activities in class

Participant	Activities in class for this course
Student 1	Teacher's lectures were interesting and also factory tour was also fun.
Student 2	很好玩 (A lot of fun.)
Student 3	That's interesting, the teacher is encouraging us to think more.
Student 4	老師真的超級好，非常認真，也很關心我們的學習 (The teacher is really nice. He is very serious and cares about our study.)
Student 5	This course is probably the most enjoyable I had been attended, it's comfortable to speak in class, no worries.
Student 7	很好 (Very good.)
Student 8	有趣 (Interesting.)
Student 9	非常用心，獲益良多。(Very attentive and benefited a lot.)
Student 11	很有趣也可以學到不同領域的東西 (It's fun and you can learn things in different fields.)
Student 12	可以學到很多有關永續環境的知識，也有透過參訪學到不同領域的專業知識 (You can learn a lot about the sustainable environment, also learn professional knowledge in different fields through visits.)
Student 13	學習如何利用英文去討論及學習 (Learn how to use English to discuss and study.)
Student 14	課程還有校外參訪，很有趣的課程。 (The course also has off-campus visits, which are very interesting courses.)
Student 15	很有趣 (Very Interesting.)
Student 17	若能在課堂上增加，團體英文對話，增加口說對談能力。 (If it can be added in the classroom, group English conversations will increase the ability of oral dialogue.)
Student 18	參訪的部分是很好的經驗 (The visiting part is a good experience.)
Student 20	很輕鬆 (Very relaxing.)
Student 21	It was very good experiences, to visit company, to see how is inside the atmosphere.
Student 23	希望能有更多與外國同學互相交流之機會 (Hope to have more opportunities to communicate with foreign students.)

Table 3: The most impressed you about this class

Participant	What impressed you the most about this class?
Student 1	There are many Japanese technologies in sustainable manufacture so for Japanese it was the point that I impressed.
Student 2	看車車 那些車超炫 (Look at the cars, those cars are amazing.)
Student 3	Joining the visiting
Student 4	去工廠參訪 (Visit the factory.)
Student 5	When I and my classmates speaking, the teacher's feedback is always good and positive, even if they are wrong.
Student 6	團體合作 (Teamwork.)
Student 7	老師教學方式 (Teacher teaching method.)
Student 8	參訪 (Visit.)
Student 9	產品設計的重要性、以及團隊合作創造產品的過程 (The importance of product design, and the process by which teams work together to create products.)
Student 10	在 DFE 那堂課講述 puma 的外包裝設計 (Talk about the outer packaging design of puma in the DFE class)
Student 11	去工廠參訪 (Visit the factory.)
Student 12	製作模型並用英語演出一個劇 (Make a model and act out a play in English.)
Student 13	全部的同學努力用英文表達報告的內容 (All the students tried their best to express the content of the report in English.)
Student 14	校外參訪可以體驗不同專業領域的公司 (Off-campus visits allow you to experience companies in different areas of expertise.)
Student 15	期末的團體報告 (Final Group Report.)
Student 17	到梧棲參訪，讓我們了解到永續發展及自動化手臂增加產能與節能中做平衡 (Visiting Wuqi, let us understand the balance between sustainable development and automation arm increasing production capacity and energy saving.)
Student 18	參訪與期末報告 (Visits and Final Report.)
Student 19	老師很 nice (The teacher is very nice.)
Student 20	我被外籍生說有荷蘭血統 (I was told by a foreign student that I have Dutch ancestry.)
Student 21	To have different languages with different culture. To get together and improve our team work and our behaviour.
Student 23	有外國組員 (There is a foreign team member.)

Table 4: Students thoughts and reflections

Participant	Interview
Student 1	<ul style="list-style-type: none"> <li>• I interested in environmental issue.</li> <li>• I feel it is an interesting topic.</li> <li>• I join a lot of events. I learn more about SDG.</li> <li>• In the future I want to focus in ecofriendly business that's why I take this class</li> <li>• Teacher teaches us more in SDG term so we can get understand more.</li> <li>• But all the student is Taiwanese all most of the student still learning English. Actually, I didn't have more opportunity to learn English.</li> <li>• I also try to speak English slowly so people can more understand</li> </ul>

	<ul style="list-style-type: none"> <li>I really enjoy in this class. I think the PPT is really helpful there are many new terms and a lot of knowledge. But sometimes is very difficult for me because there are a lot of technical word</li> </ul>
Student 3	<ul style="list-style-type: none"> <li>I am glad to join this class</li> <li>The first one I interesting in life cycle</li> <li>Learn very basic about sustainable</li> <li>Thru this class, sustainability class, we learn more about the topic sustainability and he prepare so many contents, for example the PPT.</li> </ul>
Student 4	<ul style="list-style-type: none"> <li>我覺得比較多是英文</li> <li>當然還有學一些就是工業製造、永續製造相關的</li> <li>會有幫助，修了這堂課，我 每個禮拜必須要聽三個小時的英文</li> <li>我覺得這堂課滿好的，</li> <li>老師人很好</li> <li>Before 兩分， 上完之後 5 分</li> <li>其實真的對英文有幫助</li> <li>我覺得我的聽有進步的</li> <li>想我就是覺得這老師很好，然後我看到他有開課，我就會修</li> </ul>
Student 10	<ul style="list-style-type: none"> <li>I am have interested in sustainability, I learn about LCA.</li> <li>70% understand, by translate the PPT maybe 7.</li> <li>Outdoor teaching.</li> <li>Because I can understand from the enterprise for the different opportunity for sustainable.</li> <li>Right, my favorite is Tainan.</li> <li>我看到了很多他們可能用膠類累 to make something sustainable, 我覺得這部分滿有趣的.</li> <li>I will recommend to my 學弟妹.</li> </ul>
Student 11	<ul style="list-style-type: none"> <li>參訪， we go to Earth Chain, I have learned magnetic can do a lot of things.</li> <li>Number for the course 8 from 10.</li> <li>期末， 那個 teacher want we to think of a project, that activity I feel interesting.</li> <li>Teacher share his things for us, not just in the class but also in the relax time, 就是願意跟我們講很多.</li> <li>經過這課，就是覺得說還是英文很重要.</li> <li>Speaking, I prefer speak.</li> </ul>

Table 5: Students' level of understanding of the course content and importance of speaking English proficiently.

Participant	Level of understanding of course content	The importance of speaking English proficiently
Student 1	4	5
Student 2	4	5
Student 3	4	4
Student 4	3	4
Student 5	4	4
Student 6	3	3

Student 7	5	5
Student 8	3	4
Student 9	4	4
Student 10	3	4
Student 11	4	5
Student 12	4	4
Student 13	4	5
Student 14	3	5
Student 15	3	4
Student 16	2	5
Student 17	5	5
Student 18	5	5
Student 19	5	5
Student 20	4	5
Student 21	5	5
Student 22	3	5
Student 23	3	3