2 Gaps in Content-Based English Enhancement in Science and Engineering

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Abstract: In the fields of science and engineering, teaching and assessment habitually makes use of calculations and drawings rather than extended writing or oral presentations. Although the ability to communicate eloquently in the disciplinary context is required of students, the development of language skills is often contracted out to language teaching units. This chapter reports on a project that aimed to devise content-based strategies to enhance students' English language skills within a technical curriculum. In a baseline survey conducted to understand students' habits and views about English, respondents self-reported a general confidence in their language use for the purpose of learning their discipline, but noted difficulties in speaking and, to a lesser extent, writing, with the fluency of both affected by deficiencies in grammar and vocabulary. Moreover, it was found that the target students' motivation for language improvement was highly instrumental, based on obtaining better jobs or better grades. The study reveals some systemic problems, such as the lack of opportunities for more extensive use of language in teaching and assessment in technical disciplines and an overall lack of motivation among students.

Keywords: English Across the Curriculum, writing across the curriculum, engineering education, science education, university education

Language Needs of Tertiary Students in Hong Kong

Most university students in Hong Kong are ESL (English as a Second Language) learners who began learning English in kindergarten. English may or may not have been the principal medium of instruction in their primary and secondary schools, but passing the English subject in the public examination is a compulsory university admission requirement (Hong Kong Examinations and Assessment Authority, 2019). Second language (L2) proficiency is crucial

for students' adaptation to university studies and for their academic success, and one of the reported difficulties in the school-to-university transition is the use of English as the medium for teaching and learning (Evans & Morrison, 2012). Several studies conducted in Hong Kong have highlighted the need for additional language support for L2 learners in the areas of academic writing and speaking, receptive and productive vocabulary, technical vocabulary, comprehension of lectures, and conforming to the specialised culture and conventions of the academic community (Evans & Green, 2007; Evans & Morrison, 2011).

How English is Valued in the Teaching and Assessment of Science and Engineering

Desmond Allison (1992) noted in an earlier study at the University of Hong Kong that the English ability of engineering students was much weaker than that of their counterparts in the arts. This phenomenon is related to the value placed on English by students and teachers in science and engineering. Surveys of tertiary students in Hong Kong (Evans & Green, 2007; Evans & Morrison, 2011, 2012) revealed that the core subjects in the undergraduate programme focus mainly on the disciplinary content and place little or sometimes no weight on English in teaching or assessment, which creates the impression that English is not important to success in these subjects. Rosalie Goldsmith and Keith Willey (2016) observed that although writing remains the main form of assessment at universities (not limited to those in Hong Kong), the practice of writing continues to be marginalised, particularly in technical disciplines such as engineering. Students are neither interested in, nor value, writing, and there is a systemic issue of writing practices not being considered developmental or intrinsic to the engineering curriculum.

The Language of Science Shapes the Use of English in Teaching and Assessment Practices

Science and engineering students are required to navigate between scientific and colloquial English in learning and communication (Lee et al., 2013). The importance of language in science (and engineering) education has been widely discussed (Wellington & Osborne, 2001; Yore et al., 2003), and English language competence is an accreditation requirement of various professional associations (Accreditation Board for Engineering and Technology, 2016; The Hong Kong e.g., Institution of Engineers, 2013).

Language shapes and is shaped by disciplinary practices and epistemologies across a wide range of specialisations, from the sciences to arts and humanities

(Kuteeva & Airey, 2013). As noted by Fang (2005), "scientific genres are typically multimodal and scientific meanings are often conveyed through a combination of words, images, diagrams, and mathematical/graphical signs" (p. 336). This multimodality is in contrast to humanities and arts disciplines in which words constitute the primary mode of communication. This affects how science and engineering contents are taught. In the earlier stages of science and engineering education, the assessment of students' ability to "remember," "understand," and "apply" (ref. Bloom's taxonomy—Bloom, 1956 as cited in Lasley, 2010) academic knowledge and skills can be expediently assessed via accuracy in calculations (symbols), drawings, or keywords because little interpretation or elaboration is required. Conventional science and engineering classrooms create the impression that the ability to understand the concepts and express ideas in calculations or diagrams is imperative, whereas linguistic knowledge can be seen as merely supplementary. The opportunity for language use does not improve significantly when students reach university level, where they are expected to demonstrate the ability to "analyse," "evaluate," and "create" (ref. Bloom's taxonomy—Bloom, 1956 as cited in Lasley, 2010) in the disciplinary context. Rebecca Essig and colleagues (2018) reviewed undergraduate civil engineering textbooks and assessment practices and found that writing was still minimal. This finding is echoed by my previous study (Siu, 2019), which examined the undergraduate engineering curriculum in Hong Kong. In technical disciplines, writing practices are assessed but not taught or practised, but propositional knowledge is taught, practised, and assessed (Goldsmith & Willey, 2016).

As a result, for science and engineering students, common assessment items such as written assignments, tests, and examinations usually require them only to demonstrate their understanding via calculations and drawings, or at most bullet points or keywords. One may argue that these students very often need to perform experiments and write laboratory reports, both of which demand substantial writing to describe the procedures and explain the results. However, in a companion study by Siu (2019), students reported that most teachers simply assign zero weightings to language use in laboratory reports, while others even simplify the task to the completion of laboratory worksheets, upon which students are only required to write numbers and perform fill-in-the-blanks tasks. In a typical engineering curriculum, case studies, design projects, student research projects, and capstone projects usually occur only in the final year. Group discussions or presentations are considered a luxurious use of class time, so engineering students are likely to participate in about two oral presentations within their core subjects throughout their four years of university life. To sum up, students in the science and engineering disciplines have limited opportunities for language use and development, despite its importance.

Outsourcing of Language Instruction

Experiences, both overseas (such as in Goldsmith & Willey, 2016) and locally (such as in Allison, 1992), describe a status quo in the development of writing (or language use, more generally) within the disciplines, with instruction tending to be outsourced to language teaching units. Students take a handful of courses that focus on academic and (often) professional English, and the core subjects that take up most of the students' curriculum time focus almost entirely on technical concepts. Some content teachers might feel that "it's not [their] job to teach writing" (Goldsmith & Willey, 2016, p. 126) or might not feel confident in providing direct instructions about disciplinary writing. These factors have shaped the conventions of language use in science and engineering education: English has been relegated to a less important position in teaching and assessment, despite the expectations of other stakeholders.

English Across the Curriculum

In Hong Kong tertiary institutions, language improvement efforts have seen a move from remedial teaching to language enhancement (Allison, 1992) and later to a content-driven, English Across the Curriculum (EAC) approach (Evans & Green, 2007), which might be presented in the form of English for Academic Purposes (EAP) courses infused with discipline-related materials (Evans & Morrison, 2011). That language enhancement is more effectively achieved within the disciplinary context (Murray & Hicks, 2014), with writing and speaking support integrated into the curriculum is not a new idea. Indeed, the writing across the curriculum (WAC) movement is "based on the premise that writing is highly situated and tied to a field's discourse and ways of knowing, and therefore writing in the disciplines is most effectively guided by those with expertise in that discipline" (INWAC Ad Hoc Working Group, 2018).

Writing serves a variety of purposes, and students improve as learners and thinkers when teachers integrate writing as frequently as possible across the curriculum (Kiefer et al., 2018). For students, EAC promotes engaged student learning, critical thinking, and a greater facility with communication across rhetorical situations. A variety of writing and speaking activities/tasks not only enhances students' language competence, it also helps academically by providing students with a better understanding of the course content and by improving their ability to develop critical ideas about what they have learnt. Language competence and a deeper understanding of course content then enable students to interact with others effectively (i.e., communicate well) in

the disciplinary context. Teachers also benefit from EAC: marking becomes less time-consuming and less daunting due to the introduction of alternative types of shorter writing tasks; teachers can better gauge students' learning via more frequent interaction and instant feedback; as students gain competence in subject content and critical thinking, they can better achieve course goals; and teachers are recognised for their scholarship in teaching and learning (Patterson & Slinger-Friedman, 2012).

Despite ample evidence of the effectiveness of EAC/WAC in humanities, social sciences, and business disciplines (see Cheng et al., 2014 for local examples in Hong Kong), EAC/WAC in science and engineering is emerging and rarely studied (Essig et al., 2018). An Australian review (Dunworth et al., 2014) found that successful language enhancement at universities required strong leadership to ensure consistent policy and allocation of resources and significant involvement of both discipline teachers and language experts. Mutual recognition and collaboration in the design of lectures and assessments that target the discourse of the discipline were found to be the most effective and practical ways of helping to ensure tertiary language enhancement. This contrasts with the status quo in most science and engineering disciplines, in which the language elements are almost entirely contracted out to language experts.

In the study of EAP in science and engineering, Okhee Lee et al. (2013) noted the substantial difference between the language of science and everyday discourse, and suggested the need for a shift from the "sheltered model" in content-based language enhancement strategies. In the sheltered model, teachers receive some training in language pedagogies and are then expected to focus on both content objectives and language objectives in their teaching. For science and engineering disciplines, Lee et al. (2013) proposed a further shift to focus on creating a "language-in-use" environment that emphasises what students "do" with language as they engage in scientific enquiry and discursive practices. In that way, both content learning and language learning are promoted.

Project Background

Compartmentalisation of English teaching and discipline teaching has resulted in a lack of opportunities for students to develop skills in thinking about and presenting disciplinary knowledge in an L2. The project of which this study forms a part aims to develop a content-based language enhancement scheme for students of science and engineering subjects at The Hong Kong Polytechnic University. The main objective is to strengthen students' abilities in reading, writing, and speaking in the disciplinary context. This is to be achieved by incorporating English enhancement components into the technical subjects.

The entire project spans one and a half years. This chapter reports on the first phase of implementation, which involved content-based strategies targeting (i) comprehension of technical vocabulary, (ii) understanding and writing discipline-specific assignment types, and (iii) pronunciation. These content-based strategies were piloted in several subjects offered in the Department of Civil and Environmental Engineering.

This chapter highlights the major observations from a student survey and reveals the perceived obstacles to language enhancement in the fields of science and engineering. The survey results help to identify specific content-based resources that can address students' problems and, by helping to understand students' attitudes and self-help habits, suggest ways to better engage students in the language enhancement effort to counteract the view, deeply rooted in science and engineering education, that "language is only supplementary."

Student Survey

This chapter reports on the findings from pre- and post-course student surveys in the first semester of project implementation. These surveys help to develop a background understanding of

- students' attitudes towards learning and enhancing their English, including how students perceived their own English and the importance they place on English; and
- students' difficulties in learning and using English, and their attempts at self-help.

Survey Description

The pre- and post-course student survey questionnaires consisted of 25 and 26 questions, respectively, and were divided into three main themes:

- Section 1: Evaluate the change in students' self-evaluated confidence/competence in the use of English in the disciplinary context. This section consisted of 17 questions about students' self-evaluation of their competence in the disciplinary context with regard to reading comprehension (seven questions), technical writing (six questions), and presentation skills (four questions), reported on a five-point Likert scale.
- Section 2: Evaluate the change in students' awareness of the importance of English. This section consisted of four questions about students' awareness of the importance of English for various purposes, reported on a five-point Likert scale.

- Section 3: Understand students' specific difficulties in learning/using English, English-learning habits, and self-help solutions. This section consisted of two five-point Likert scale questions regarding students' habits using dictionaries and translation sites (e.g., Google Translate) and two open-ended questions focusing on students' major difficulties when communicating in English and what they do when they encounter English language problems.

In the post-course questionnaire, one question (Question 26) was added to collect students' opinions on and suggestions for the project website. The full questionnaire is available in the appendix.

The survey was conducted in two undergraduate-level subjects in the Department of Civil and Environmental Engineering:

- Subject one was in the field of hydraulics. It was a second-year core subject with a class size of 94. It was a highly technical, calculation-intensive subject with lectures, tutorials, and laboratory sessions.
- Subject two was in the field of construction law. It was a common final-year core subject for students from several undergraduate programmes in the department. The subject content was technical but mostly descriptive. The class size was 240. About half of the students entered university after the public examination Hong Kong Diploma of Secondary Education (HKDSE), on which the minimum language requirement is for students to attain level three in the HKDSE English paper; the other half were students who had matriculated from other higher diploma or associate degree programmes, for which the minimum language requirement is only level two in HKDSE English.

The pre- and post-course surveys were printed, and hardcopies were distributed to students in lectures. In subject one, the subject lecturer made the return of the survey voluntary, and there were 54 and 30 returns in the pre- and post-course surveys respectively, with corresponding response rates of 57 percent and 32 percent. In subject two, returning the surveys was compulsory, and there was a higher response rate with 208 (87%) and 221 (92%) returns for the pre- and post-course surveys respectively.

Students' Self-Evaluations of English Competence

Table 2.1 to Table 2.3 show students' pre- and post-course self-evaluations of their English competence or confidence in reading comprehension, technical writing, and speaking in the academic/disciplinary context. Following these,

the overall ratings before and after the courses are compared (see Figure 2.1). The question statements were in the form of "I can fully understand . . ." or "I am confident in . . . ," and the responses were given on a five-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The key observations are as follows.

Generally Positive Confidence Levels

Students reported above-neutral self-confidence in reading, writing, and speaking in English in the academic/disciplinary context. Their level of confidence generally ranged between 3 (*neutral*) to 4 (*agree*) out of 5 in both the pre- and post-course surveys.

Areas of Confidence

As shown in the aggregate scores in Figure 2.1, in overall terms, students felt most confident in speaking, marginally less confident in writing, and least confident in reading.

- Reading: Students felt most confident in understanding tutorial notes and least confident in understanding vocabulary/sentences in textbooks and legal and official documents.
- Writing: Students felt most confident in writing with a topic sentence and least confident in using different English vocabulary.
- Speaking: Students felt most confident in answering questions in English and least confident in holding group discussions in English.

Improvements in Self-Confidence Post-Course

Students in both subjects displayed statistically significant improvements in self-confidence in the post-course survey for most items. This supported the belief underlying EAC that English language enhancement should be content-driven: when students better understand the disciplinary content, they also display higher self-confidence in the use of English. Nonetheless, in items of which self-help materials had been provided to students (technical vocabulary taken from reading materials and aids in comprehending assignment instructions and writing assignments, as marked by the symbol "+" in the respective items in Table 2.1 to Table 2.3), greater improvements in self-confidence were observed (i.e., a larger increase was seen in the ratings from the pre- to post-course survey). These findings confirmed the contribution of the content-based language enhancement approach used in this project.

Table 2.1. Self-evaluation of reading

Subject 1				
Statement: I can fully understand . . . [1]		N	Mean	Difference (Post - Pre)
English vocabulary in textbook[+]	Pre	55	3.1091	0.7576**
	Post	30	3.8667	
English sentences in textbook	Pre	55	3.2909	0.5758*
	Post	30	3.8667	
English lecture notes	Pre	55	3.1455	0.5879**
	Post	30	3.7333	
English tutorial notes	Pre	54	3.3704	0.5296**
	Post	30	3.9000	
English assignment questions	Pre	55	3.3273	0.4394*
	Post	30	3.7667	
Quiz and exam questions	Pre	55	3.2909	0.2758
	Post	30	3.5667	
English laboratory instruction	Pre	54	3.4444	0.4222*
	Post	30	3.8667	
Average of all "Reading" in subject 1	Pre		3.2826	0.5126
	Post		3.7952	

Subject 2				
Statement: I can fully understand . . . [1]		N	Mean	Difference (Post - Pre)
English vocabulary in textbook[+]	Pre	210	3.0600	0.2100
	Post	223	3.2700	
English sentences in textbook	Pre	210	3.1400	0.1300
	Post	223	3.2700	
English lecture notes	Pre	210	3.3048	0.1033
	Post	223	3.4081	
English tutorial notes	Pre	208	3.3077	0.1587
	Post	223	3.4664	
English assignment questions	Pre	208	3.2837	0.2724**
	Post	223	3.5561	
Quiz and exam questions	Pre	208	3.1779	0.0789
	Post	222	3.2568	

Table 2.1. Self-evaluation of reading (continued)

Subject 2				
Statement: I am confident in . . . [1]		**N**	**Mean**	**Difference (Post - Pre)**
English legal and official document	Pre	210	2.9857	0.2206**
	Post	223	3.2063	
Average of all "Reading" in subject 2	Pre		3.1800	0.1677
	Post		3.3477	

1. All responses were given on a five–point Likert scale (1 = strongly disagree; 5 = strongly agree).
* Results significant at level of significance; ** results significant at level of significance;
+ items where discipline–specific materials were developed and provided to students.

Table 2.2. Self-evaluation of writing

Subject 1				
Statement: I am confident in . . . [1]		**N**	**Mean**	**Difference (Post - Pre)**
Writing assignments in English	Pre	55	3.2909	0.6091**
	Post	30	3.9000	
Summarising major ideas in a paragraph	Pre	55	3.2545	0.6788**
	Post	30	3.9333	
Using different English vocabulary	Pre	55	3.2909	0.5758**
	Post	30	3.8667	
Writing with a topic sentence	Pre	55	3.4909	0.4091**
	Post	30	3.9000	
Reporting on figures findings in English	Pre	55	3.3091	0.5909**
	Post	30	3.9000	
Writing laboratory reports in English+	Pre	55	3.3636	0.6364**
	Post	30	4.0000	
Average of all "Writing" in subject 1	Pre		3.3333	0.5833
	Post		3.9167	
Subject 2				
Statement: I am confident in . . . [1]		**N**	**Mean**	**Difference (Post - Pre)**
Writing assignments in English	Pre	210	3.0476	0.2887**
	Post	223	3.3363	
Summarising major ideas in a paragraph	Pre	210	3.3571	0.1541
	Post	223	3.5112	

Table 2.2. Self-evaluation of writing (continued)

Subject 2				
Statement: I am confident in . . . [1]		**N**	**Mean**	**Difference (Post - Pre)**
Using different English vocabulary	Pre	210	2.8810	0.406**
	Post	223	3.2870	
Writing with a topic sentence	Pre	210	3.4857	0.0638
	Post	222	3.5495	
Reporting on figures findings in English	Pre	210	3.2476	0.2098**
	Post	223	3.4574	
Writing case study critics in English[+]	Pre	208	3.0240	0.2540**
	Post	223	3.2780	
Average of all "Writing" in subject 2	Pre		3.1738	0.2294
	Post		3.4033	

1. *All responses were given on a five–point Likert scale (1 = strongly disagree; 5 = strongly agree).*
* Results significant at level of significance; ** results significant at level of significance;
+ items where discipline–specific materials were developed and provided to students.

Table 2.3. Self-evaluation of speaking

Subject 1				
Statement: I am confident in . . . [1]		**N**	**Mean**	**Difference (Post - Pre)**
Asking questions in English	Pre	55	3.3636	0.5364**
	Post	30	3.9000	
Group discussion in English	Pre	55	3.3818	0.5848**
	Post	30	3.9667	
Presentation in English	Pre	54	3.3333	0.5667**
	Post	30	3.9000	
Average of all "Speaking" in subject 1	Pre		3.3606	0.5811
	Post		3.9417	
Subject 2				
Statement: I am confident in . . . [1]		**N**	**Mean**	**Difference (Post – Pre)**
Answering questions in English	Pre	210	3.2619	0.1885**
	Post	222	3.4505	
Asking questions in English	Pre	210	3.2762	0.2058**
	Post	222	3.4820	

Table 2.2. Self-evaluation of speaking (continued)

Subject 2				
Statement: I am confident in . . . [1]		**N**	**Mean**	**Difference (Post - Pre)**
Group discussion in English	Pre	210	3.1905	0.2465**
	Post	222	3.4369	
Presentation in English	Pre	210	3.2381	0.2214**
	Post	222	3.4595	
Average of all "Speaking" in subject 2	Pre		3.2417	0.2155
	Post		3.4572	

1. All responses were given on a five–point Likert scale (1 = strongly disagree; 5 = strongly agree).
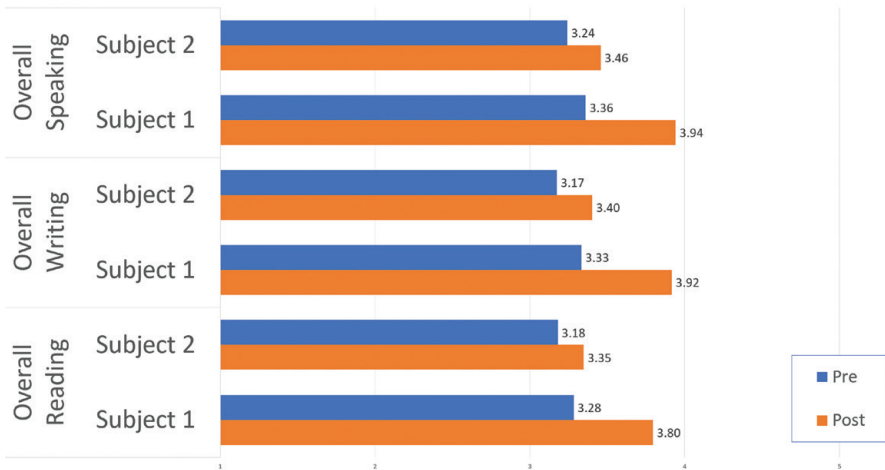* Results significant at level of significance; ** results significant at level of significance.

Figure 2.1. Overall ratings for reading, writing and speaking.

Difference Between Student Groups

Junior undergraduate students (subject one) showed higher levels of self-confidence in English and a larger improvement in self-confidence in the post-course survey than their final-year counterparts (subject two). This was possibly because half of the final-year class was made up of students who matriculated from higher diploma or associate degree programmes (alternative pathways to degree programmes) and thus had weaker English backgrounds. That group of students tended to strongly focus on achieving high GPAs in the technical subjects in order to matriculate to the degree programme and thus may have paid less attention to improving their English.

Awareness of the Importance of English

The second section of the survey examined students' awareness of the importance of English language skills. The results are summarised in Table 2.4.

Students were well aware of the importance of English for instrumental purposes, such as learning, handling assessment tasks, and getting jobs, as was evident from the high mean scores of close to or above 4 (*agree*). Final-year students (subject two) were highly aware of the importance of good English from the start of the semester, and this remained unchanged considering normal statistical variations. Junior undergraduate students (subject one), on the other hand, showed a statistically significant increase in their awareness of the importance of English in the post-survey.

The reported motivations for good English skills were all instrumental in nature and related to extrinsic pragmatic benefits; for example, achieving a better GPA to graduate with a good honours degree and thus getting professional recognition. These instrumental motivations were stronger among final-year students, for which "getting a job" appeared to be the most important consideration, based on the highest mean scores.

Table 2.4. English awareness

Subject 1				
Statement: I think good English is important for . . . [1]		N	Mean	Difference (Post - Pre)
Reading course materials	Pre	54	3.7037	0.4963**
	Post	30	4.2000	
Writing technical reports	Pre	54	3.8148	0.4185*
	Post	30	4.2333	
Presenting my ideas	Pre	54	3.7778	0.4556*
	Post	30	4.2333	
Getting a job	Pre	54	3.8148	0.4519*
	Post	30	4.2667	
Subject 2				
Statement: I think good English is important for . . . [1]		N	Mean	Difference (Post - Pre)
Reading course materials	Pre	208	4.0192	0.0170
	Post	221	4.0362	
Writing technical reports	Pre	208	4.0865	-0.0367
	Post	221	4.0498	

Table 2.4. English awareness (continued)

Subject 2				
Statement: I am confident in . . . [1]		**N**	**Mean**	**Difference (Post - Pre)**
Presenting my ideas	Pre	207	4.0773	-0.0592
	Post	221	4.0181	
Getting a job	Pre	208	4.1154	-0.0336
	Post	220	4.0818	

1. All responses were given on a five-point Likert scale (1 = strongly disagree; 5 = strongly agree).
* Results significant at level of significance; ** results significant at level of significance.

Difficulties with English and Self-Help Solutions

The final section of the survey consisted of open-ended questions about difficulties in learning or using English, and what students do if they encounter difficulties.

Difficulties in Learning or Using English

Table 2.5 summarises students' self-reported difficulties in learning and using English. Although students displayed higher self-confidence in speaking, followed by writing and reading (as discussed above), when they were asked open-ended questions about the specific difficulties they have, most replies concerned speaking, followed by vocabulary, grammar, and writing. Few replies focused on reading, and none were related to listening. It can be concluded that students acknowledged more difficulties in productive skills (speaking and writing) than in receptive skills (reading and listening).

In addition to reporting difficulties concerning their abilities, some students added comments about the learning environment, such as "(a lack of speaking) opportunities" or the "English atmosphere." Subject lecturers saw passive learning, or students' shyness to express their opinions, as the major reason for the students' perceptions of a poor English atmosphere.

Table 2.5. Students' self-reported English difficulties

Category	Subject 1	Subject 2
Reading	Comprehension	Reading speed Comprehension (e.g., understanding questions) Legal language
Writing	Essay writing	Academic writing (e.g., essay) Professional writing Technical writing

Table 2.5. Students' self-reported English difficulties (continued)

Category	Subject 1	Subject 2
Speaking	Opportunities Accent	Pronunciation Presentation skills Casual conversation Complete utterance Confidence Group discussion Speaking opportunities
Listening	-	-
Grammar	Sentence structures Grammar	Sentence structures Grammar Complete sentence Tenses
Vocabulary	Terminology Meanings Word choice	Word meanings Legal vocabulary Spelling Jargons Situation use
Others	Professional English English is not their first language	English atmosphere English is not their first language Organisation Expression of ideas Logic Reliance on translation sites

Self-Help Strategies

When students first learnt English, they were taught to consult a dictionary when they encountered words that they did not know. Their knowledge of specific words and phrases is largely sufficient for learning and understanding, but students need more than words and phrases to express themselves in extended paragraphs or in oral presentations, and dictionaries are not so helpful in this regard. As internet services become increasingly popular and convenient, it is interesting to see whether students' strategies have changed.

Students' habits in using dictionaries and translation sites (such as Google Translate) to assist in writing are summarised in Table 2.6, and the self-help strategies provided in response to the open-ended question are summarised in Table 2.7.

- Use of dictionaries: When students did not know a word, most either agreed or strongly agreed that they would look it up in a dictionary. The level of agreement with regard to using a dictionary was higher

among more senior students (subject two), whilst around 30 percent of junior undergraduates (subject one) had a neutral view.

• Use of translation sites: When students did not know how to express themselves in written English, most reported that they would use a translation site. Nonetheless, the level of agreement was lower than that for the use of a dictionary, which demonstrates that students were more sceptical about the value of translation sites.

• The most popular self-help solution reported by students was the use of dictionaries, followed by the internet, but the combined results of "Internet" and "Google" surpassed that of "Dictionary." A small number of students reported they would seek help from the subject teachers, ask their friends, or contact the English Language Centre.

Table 2.6. Students' use of dictionaries and translation sites

When I do not know a word, I will look up dictionaries	Subject 1		Subject 2	
	Frequency	Percent	Frequency	Percent
5 - Strongly agree	8	14.5%	54	25.7%
4 - Agree	25	45.5%	97	46.2%
3 - Neutral	17	30.9%	42	20%
2 - Disagree	2	3.6%	13	6.2%
1 - Strongly disagree	2	3.6%	2	1%
Missing	1	1.8%	2	1%
Total	55	100%	210	100%
	Mean = 3.65 Std. deviation = 0.914		Mean = 3.90 Std. deviation = 0.890	
When I do not know how to write, I will use translation sites	Subject 1		Subject 2	
	Frequency	Percent	Frequency	Percent
5 - Strongly agree	10	18.2%	43	20.5%
4 - Agree	19	34.5%	82	39%
3 - Neutral	16	29.1%	48	22.9%
2 - Disagree	7	12.7%	26	12.4%
1 - Strongly disagree	2	3.6%	7	3.3%
Missing	1	1.8%	4	1.9%
Total	55	100%	210	100%
	Mean = 3.52 Std. deviation = 1.059		Mean = 3.62 Std. deviation = 1.056	

Table 2.7. Students' self-reported strategies

Subject 1		Subject 2	
Students' solutions	**Votes**	**Students' solutions**	**Votes**
Dictionary	8	Dictionary	44
Internet	3	Internet	43
Google	8	Google	24
Ask friends	5	Ask friends	23
Translation sites	4	Translation sites	14
Ask teachers	3	Ask teachers	11
		Consultation	5
		Read articles	4
		Ask native speakers	3
		Ask teaching assistants	3
English Language Centre (ELC)	1	ELC tutors	2
Centre for Independent Language Learning (CILL)	1	CILL	1
		Read reference books	1
		Revision	1
		Siri	1
		Wild guess	1
		Write down vocabularies	1
YouTube	1		
Wikipedia	1		

Discussion and Conclusions

Despite the importance of language and communication skills for students in the fields of science and engineering, a compartmentalisation of language learning and content learning has been observed in technical disciplines. The teaching, learning, and assessment of technical content habitually use symbols (calculations) and drawings much more often than words. Writing and speaking practice activities are therefore marginalised. This chapter has reported results from a student survey conducted as part of a project that aims to devise content-based language enhancement strategies for the science and engineering disciplines.

The student survey was conducted to understand students' self-evaluation of their abilities in English and their attitudes, major difficulties, and self-help strategies. Generally, students were fairly confident in their use of English in the academic/disciplinary context. They felt most confident in speaking, followed by writing, and then reading. However, when they were asked in open-ended questions to identify the most difficult issues in learning or using English, most replies were related to speaking, followed by writing, vocabulary, and grammar. This is not a contradiction but rather serves as indirect evidence that the current teaching practice does not demand much productive language use. As a result, students have high confidence in handling the (minimal) kind of speaking required. Apart from the difficulties concerning their English language ability, students also reported that the (classroom) atmosphere did not facilitate the use of English or improvement in its use. The subject lecturers commented that students' passive learning attitudes and/or shyness in expressing their views could be attributed to the "poor English atmosphere."

Students clearly recognised the importance of English for instrumental purposes, such as learning, handling assessment tasks, and getting jobs. Therefore, if "good English" is not aligned with these instrumental purposes, most students would not devote time and effort to them. The low usage of project materials and low engagement rates in voluntary language enhancement activities provided clear evidence for this.

Self-Regulation in Language Enhancement

Content-based language enhancement strategies are not about promoting language to serve as a core learning objective in science and engineering subjects; essentially, they are about technical subject teachers playing a role in fostering self-regulated language learning. Rebecca Oxford and Carol Griffiths (2016) consolidated the definitions of L2 learning strategies and identified self-regulation as one of the key learning "strength factors." Barry Zimmerman (1990) defined students' self-regulated learning as involving three features: (i) their use of self-regulated learning strategies, (ii) their responsiveness to self-oriented feedback about learning effectiveness, and (iii) their interdependent motivational processes. Empirical evidence presented by Zimmerman (1990) also suggested that self-regulation leads to higher academic achievement. Self-regulated learning requires more than cognitive skills; it also requires a motivational component, and the motivation is domain specific. Ulrich Schiefele (1991) echoed the view that "interest" is a content-specific motivational characteristic that has an important bearing on the quality of

learning results and the learning experience, and stimulates the use of deep learning strategies. Furthermore, Zimmerman (1990) noted that self-regulated learners have the option not to self-regulate if they are not sufficiently eager to achieve a particular learning outcome. Problems in self-regulation typically arise when discrepancies occur between short-term and long-term outcomes.

The above discussion about self-regulated language learning leads to two conclusions that are relevant to this chapter. First, if interest or motivation is domain specific, it is almost certain that the status quo of diminished importance of language in technical subjects is undermining students' motivations for language improvement, and is thus not conducive to language enhancement. Second, when students' academic success in subjects is predominately dependent on their ability to demonstrate their knowledge via calculation and drawing rather than via writing or oral presentation, conflicts arise between short-term and long-term outcomes, as described in the preceding paragraph. Although effective communication skills may lead to the eventual reward of better career opportunities, most students choose to spend their time focusing on technical content for more immediate rewards, which causes problems with self-regulation in language learning.

The Way Forward for Language Enhancement in Science and Engineering

In an effort to help science and engineering students enhance their English via a content-based approach, the following four actions are considered essential:

- devising useful language enhancement materials that target students' specific areas of weakness,
- integrating these materials into respective technical subjects,
- soliciting cooperation from subject teachers, and
- stimulating students' motivation and engagement.

Of these, stimulating students' motivation and engagement is the most difficult to achieve but the most crucial element of success. The findings reported in this chapter suggest that the current subject and curriculum design cannot provide motivation for students to deploy self-regulated language learning or to sustain their self-regulation.

Lacking opportunities for more extensive use of English in teaching and assessment, and students' low levels of motivation are systemic issues that cannot be solved with piecemeal efforts. In the future development of this

project, in addition to devising other types of content-specific language-enhancement materials, efforts are required to create more opportunities for students to practise English at the subject and curriculum levels. A long-term plan should be developed to consistently incorporate sufficient writing and speaking tasks throughout a programme, and students should be required to complete more challenging language tasks as they progress.

Acknowledgement

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Appendix

Pre-course Questionnaire

Think about your learning experience in the first two lessons. Please circle the suitable number for Question 1 to 23 and answer Question 24 to 25 below.

Reading comprehension

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1. I can fully understand the English vocabulary in textbook.	1	2	3	4	5
2. I can fully understand the English sentences in textbook.	1	2	3	4	5
3. I can fully understand the English lecture notes (e.g. lecture notes and Powerpoint slides)	1	2	3	4	5
4. I can fully understand the English tutorial notes (e.g. worksheet)	1	2	3	4	5
5. I can fully understand the English assignment questions.	1	2	3	4	5
6. I can fully understand the quiz and exam questions.	1	2	3	4	5
7. I can fully understand the English laboratory instruction.	1	2	3	4	5

Technical writing

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
8. I am confident in writing assignments in English.	1	2	3	4	5
9. I can summarise major ideas in a paragraph in English.	1	2	3	4	5
10. I can use different English vocabulary in my writing.	1	2	3	4	5
11. I usually start writing with a topic sentence.	1	2	3	4	5
12. I have no difficulties reporting on figures/findings in English.	1	2	3	4	5
13. I am confident in writing laboratory reports in English.	1	2	3	4	5

Presentation skills

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
14. I am confident in answering questions in English.	1	2	3	4	5
15. I am confident in asking questions in English.	1	2	3	4	5
16. I am confident in group discussion in English.	1	2	3	4	5
17. I am confident in presentation in English.	1	2	3	4	5

English awareness

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
18. I think good English is important for <u>reading course materials</u>.	1	2	3	4	5
19. I think good English is important for <u>writing technical reports</u>.	1	2	3	4	5
20. I think good English is important for <u>presenting my ideas</u>.	1	2	3	4	5
21. I think good English is important for <u>getting a job</u>.	1	2	3	4	5
22. When I do not know a word, I will look up <u>dictionaries</u>.	1	2	3	4	5
23. When I do not know how to write, I will use <u>translation sites</u> (e.g. Google Translate).	1	2	3	4	5

24. What are your major difficulties in English?

25. When you have English problems, what will you do?

Post-course Questionnaire

Think about your learning experience in the first two lessons. Please circle the suitable number for Question 1 to 25 and answer Question 26 below.

Reading comprehension

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1. I fully understand the English <u>vocabulary</u> in textbook.	5	4	3	2	1
2. I fully understand the English <u>sentences</u> in textbook.	5	4	3	2	1
3. I fully understand the English <u>lecture notes</u> (e.g. lecture notes and Powerpoint slides)	5	4	3	2	1
4. I fully understand the English <u>tutorial notes</u> (e.g. worksheet)	5	4	3	2	1
5. I fully understand the English <u>assignment questions</u>.	5	4	3	2	1
6. I fully understand the <u>quiz and exam questions</u>.	5	4	3	2	1
7. I fully understand the English <u>laboratory instruction</u>.	5	4	3	2	1

Technical writing

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
8. I am confident in writing <u>assignments</u> in English.	5	4	3	2	1
9. I can <u>summarise major ideas</u> in a paragraph in English.	5	4	3	2	1

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10. I can use different English <u>vocabulary</u> in my writing.	5	4	3	2	1
11. I usually start writing with a <u>topic sentence</u>.	5	4	3	2	1
12. I have no difficulties reporting on <u>figures/findings</u> in English.	5	4	3	2	1
13. I am confident in writing <u>laboratory reports</u> in English.	5	4	3	2	1

Presentation skills

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
14. I am confident in <u>answering questions</u> in English.	5	4	3	2	1
15. I am confident in <u>asking questions</u> in English.	5	4	3	2	1
16. I am confident in <u>group discussion</u> in English.	5	4	3	2	1
17. I am confident in <u>presentation</u> in English.	5	4	3	2	1

English awareness

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
18. I think good English is important for <u>reading course materials</u>.	5	4	3	2	1
19. I think good English is important for <u>writing technical reports</u>.	5	4	3	2	1
20. I think good English is important for <u>presenting my ideas</u>.	5	4	3	2	1
21. I think good English is important for <u>getting a job</u>.	5	4	3	2	1
22. I find the English Hub (i.e. the website shared in class email) useful.	5	4	3	2	1
23. I find the 'wordcloud' of vocabulary useful.	5	4	3	2	1
24. I find the reading tips useful for understanding assignment questions.	5	4	3	2	1
25. I find the writing tips useful for writing a case study report.	5	4	3	2	1

26. What other resources and/or services do you want to get from the English Hub website?