Teaching Materials for Scientific English

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This paper describes some of the issues that might be faced by a teacheror author who is creating materials for students learning scientific English. In particular, it focuses on materials designed for students at Japanese universities and is based on the author's experiences in writing course books. After a discussion of the background to teaching scientific English in Japan, the paper examines criteria for deciding methodology, vocabulary, and texts.

この論文は、著者の経験に基づき、科学技術英語教材について記述しています。日本で科学技術英語を教えることへの背景の議論の後に、方法論、語彙及びテキストを決定する基準を検査しています。

This paper describes some of the issues that might be faced by a teacher or author who is creating materials for students learning scientific English. In particular, it focuses on materials designed for students at Japanese universities and is based on my own experiences in writing course books and other materials which can meet the needs of students, teachers, employers, and other involved parties. As such, it is rather anecdotal and in preference to using the standard academic paper format, I have chosen to write it as an interview. I hope that it will be useful in showing some of the constraints and options involved in writing or using materials for scientific English.

Can you explain a little about the background to teaching scientific English in Japan?

From the Meiji Era, Japan changed very quickly from an agricultural to an industrial economy. This was achieved by first copying translated technology and later by innovating it. Since the main purpose of a knowledge of English was an understanding of imported foreign texts, English education in Japanese universities focused on translation and generally employed the grammar-translation method. However, as Japan became a major exporter of technology from the 1960s, English was increasingly needed for international business communication and technology exchange. Oral communication and writing skills became as important for many engineers as reading skills. English has become increasingly important as an international language in recent years, and this trend has accelerated. Today, it is as

likely that a Japanese will speak English with a Chinese as with an American .

In general, the need for English can be divided into two areas: the workplace and research. In the workplace, many Japanese engineers and technicians now need good English to communicate with non-Japanese workers, often while onsite in locations such as China, or other South-East Asian nations. The required English is what I call Type A scientific English: mostly general English with a certain amount of specifiable language functions and structures. For research, most technical and scientific research today is published in English, so ability to produce and understand high-quality presentations and scientific papers is necessary. This English can be specified more clearly and is closer to the usually meaning of ESP. I call this type B scientific English.

Table 1. Type A and Type B scientific English

	Situations Used	Specifics
Type A	Workplace, social situations	Mostly general English; ability to use simple rhetorical structures such as classification and definition; ability to describe problems, explain solutions etc.
Type B	Conferences, research papers	ESP; Language structures and vocabulary for scientific discourse etc.

What is your own teaching situation?

Currently, I teach two types of courses at Japanese universities. First, I teach undergraduate engineering students in their first and second years of university. Second, I teach courses in scientific writing and presentation to graduate engineering students.

Can you talk about the undergraduate courses?

The undergraduate course is titled “English for Science and Engineering”. It is a two-year course that students take in their first and second years at university. Despite the title, the needs of the students are so diverse that they cannot be truly defined as ESP. This corresponds to what I have called Type A above. This diversity is explained at length in an earlier paper (Robins & Cullen, 2002). Let me summarize briefly.

First, students in any particular class are not all studying the same major. Some major in civil engineering, some in electronic engineering, and so on. At my university, we have made efforts to divide students according to major in their second year, but the different number of students in each major makes this difficult to achieve completely. It is therefore not possible to specify the target specialization accurately. Instead, I find that is more useful to focus on general language patterns that occur in scientific English.

Second, although students choose their specialization before they enter university, most of the courses in the first two years are general subjects such as mathematics, physics, and chemistry. They do not really get into their specialization until the third year, after the two years of compulsory English are already finished.

Third, many classes are taught by teachers who do not have a background in scientific English. Whereas full-time teachers can be expected to learn the basics of the specialized subject, it is an unreasonable burden to place upon the part-time teachers who teach the majority of the courses.

Fourth, student future needs are not clearly defined. Up to 50% of students will go onto graduate courses and some of them will require English for presentations and research papers. The other students will go directly into the workplace where they are much more likely to need general English.

Finally, student ability in English ranges from false beginner up to near-native level. Many lower level students need to work on basic vocabulary and sentence structure before they can seriously consider using English for work or research.

If student needs are so diverse, what kind of materials can you write for them?

For our first year and second year courses, I have taken different approaches. Glendinning (1997) makes a useful distinction between language-led approaches and subject-led approaches. The first year course book at our university is titled *Humanity and Technology* (Cullen, 2002, 2004). This textbook is a subject-led approach. In other words, it is organized according to content, or topics. Table 2 shows the topics chosen. Because the students have still not really entered their specialization, the content is closer to popular science than to genuine scientific discourse.

Table 2. Topics chosen for inclusion in subject-led textbook.

1. History of Science and Technology	7. Climate
2. Communication	8. Building Technology
3. Population	9. The Media
4. Energy	10. Pollution
5. Food Technology	11. Robots and Artificial Intelligence
6. The Internet	12. The Future

The materials had to be usable by students of a range of English ability and motivation, so many learning activities of varying difficulty were included to provide different challenges to students of different levels. Table 3 shows the activities in each unit. The teacher is encouraged to choose suitable activities to match student abilities and interests.

The textbook has very little explicit language support. It is an integrated skills textbook that aims to cultivate critical thinking skills in the area of science of technology. In Japanese high schools, students spend most of their time in grammar translation tasks and word-by-word decoding tasks. The textbook encourages students to *use* the knowledge that they have from high school in a wide range of input and output tasks.

Table 3. Activities in each unit.

1. Starting Out	8. Debate
2. Conversation	9. Listening to Conversations
3. Reading 1	10. Writing
4. Lecture	11. Reading Exchange
5. Talking Point	12. Research and Presentation
6. Sound Bytes	13. Work it Out
7. Reading 2	

The second year course book is titled SciTech Discovery (Cullen, 2004). It is a language-led textbook organized around functions, or notions. Some examples are given in Table 4. These functions and notions are important language structures in all kinds of scientific and technical writing. There are still many speaking and listening activities, but the emphasis of the second year course is towards the fundamentals of scientific discourse.

As can be seen, the approach in the two textbooks is quite different. This was a decision based on local factors, always an important part of ESP material design. There are links to sample units of the two textbooks at the end of this paper.

Table 4. Examples of functions or notions.

Function/Notion	Example
Classification	Computer displays can be divided into three types: CRT, plasma, and LCD.
Definition	A hard disc is a computer peripheral that stores data.
Cause and Effect	An earthquake can produce a large tsunami.
Instructions and Reports	First, press the green button. Next, turn the lever until the dial reaches 7.5.
Comparison and Contrast	The M450 is not as expensive as the M500.
Location	The screws should be aligned with the top of the cabinet.
Function	FTP is used to transfer files over the Internet.
Modality and Hedging	There is a slight possibility that the engine could fail.

Do you try to build methodology into your materials?

To a large degree, all textbooks have an inherent methodology, but I do like to give teachers a degree of freedom in using activities in their own way. Even when activity instructions are clearly specified, experienced teachers may sometimes be able to use it in a more useful way. However, because of the nature of the learners, I do try to impose certain methodology. First, every learning activity should have a clear objective. Students of science or engineering like to solve problems. They want to see that the activity has a clear answer. Related to this, I rarely ask

for much reflection. Reflection on one's learning processes is quite popular in EFL circles at the moment, but I have not found it to be successful with the engineering students that I work with. Second, I like to repeat activity types between units to build up a pattern. Learners of science and engineering naturally look for patterns and I believe that this helps them to learn more effectively. So each unit has the same activities in the same order.

Can you talk about the graduate courses?

The graduate courses which I teach are entitled *Writing a Scientific Paper* and *Presentation of Research*. This corresponds to what I have called Type B scientific English above. The graduate students are more motivated and focused as they can often see the immediate goal of a conference presentation. For these students, a more learner-centered approach as advocated by Hutchinson & Waters (1987) is advisable.

An important distinction that arose in the JALT presentation was between bottom-up and top-down approaches in material design. In a bottom-up approach, discrete language elements such as grammar and vocabulary are taught as steps towards a final goal. In a top-down approach, a model of the final target language structure is presented and learners grasp the elements that constitute it through analysis. In logical terms, bottom-up corresponds to a deductive approach (moving from a particular example to a general idea) and top-down corresponds to an inductive approach (moving from a general idea to a particular example).

In the undergraduate courses, I tend to produce materials with a bottom-up approach. In other words, the learners progress from individual language structures or skills towards greater competency. In the postgraduate courses, I tend to take a top-down approach. I do not use a course book. As Type B has more specific needs, I take authentic target language texts such as a scientific paper or a presentation into the classroom and ask the students to analyze it to recognize the underlying features. For example, when teaching scientific writing, I begin by asking students to identify the different sections in a scientific paper using standard labels such as abstract, introduction, procedure, results, discussion, and conclusion. Then students practice writing simple versions of each section. Finally, they write their own scientific paper based on their own research.

How do you choose vocabulary load?

Vocabulary is a difficult area to deal with in materials for English for science and technology. If learners end up using English of type B, they will definitely need to learn certain specialized vocabulary. Some of this vocabulary can be explicitly taught, but my general feeling is that in postgraduate courses, students generally discover this vocabulary as they need it. If it is used incorrectly in papers or presentations, it is the responsibility of the teacher to correct it. For the undergraduate course books, I have used two commonly used word frequency lists: the General Service List and the Academic Word list. The General Service List is a list of 2,000 words. The Academic Word List is 570 words and provides good coverage of academic texts. I try to keep within the GSL and the lower levels of

the AWL. See Bauman (<jbauman.com/index.html>) for more information on word lists. Occasionally, I will also use corpus analysis software to check usage of vocabulary items.

How do you choose your texts?

This is a contentious area for many writers and teachers. There is a long-running debate in EFL as to whether students should be exposed to authentic or simplified texts. Personally, for the undergraduate textbooks, I generally write my own texts to match the skill or topic. This is as much a matter of practicality as principle. It takes considerable time and resources to find suitable texts to exemplify language points. Even after finding the texts, it is necessary to get copyright clearance, a very time-consuming process.

For postgraduate classes, I use authentic texts from the students' own discipline. This also relates back to what I said earlier about bottom-up and top-down approaches. For undergraduate students, I take a bottom-up approach and for this the text should provide lots of examples of the chosen language points. For postgraduate students, I take a top-down approach, and authentic texts provide a natural starting point.

Any final comments?

Well, this really only touches the surface of a very complicated process. In writing materials, I try to make the best compromise between the needs of teachers, learners, institutions, and employers. The materials attempt to maintain the short-term interest of the students while supporting their long-term learning objectives. It is a complicated task, but one which can be very rewarding for the teacher and beneficial to the learners.

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Links to Sample Units

Humanity and Technology

<ftp://ftp.intercompress.com/pub/htsample.pdf/>

SciTech Discovery

<www.edsys.center.nitech.ac.jp/lang/a07edc04/Research/Publications/SciTechSample.pdf>