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Assessments of vocabulary level and readability of academic articles used in a third-year ESP reading program

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Abstract

This paper analyzes vocabulary level and readability of the reading materials used in a "Medical and Dental English" for third-year Nihon University School of Dentistry students. The vocabulary of seven articles was computed with software called Range. Readability was confirmed with Readability Statistics function of Microsoft Word using Flesch Reading Ease and Flesch-Kincaid Grade Level. Results of the Range indicated that 22.88% to 40.84% of the total words in the texts were not in the three word base lists. The Flesch Reading Ease index indicated that one article was at college level and the other six were at college graduate level. Both results confirmed that a highly-advanced level of English in both vocabulary and sentence structure should be acquired.

Key words: academic articles, English for specific purposes, Medical and Dental English, readability, vocabulary

Introduction

Difficulty of classroom management can be one problem in teaching. Sakui (2007) writes that the school curriculum consists of not only academic curriculum, but also classroom management, and the more communicative an approach a teacher takes in the lessons, the more difficult classroom management can be. All the teachers who took part in her study experienced classroom management difficulties or knew others who had experienced them.

Closely related to classroom management problems, the selection of appropriate textbooks or teaching materials is a major issue for language instructors. Even though no empirical evidence is available to them, they are intuitively aware of the influence that a textbook can make on classroom management. However, as the choices are limited due to the fact that a course has a specific goal, which in this case is "learning how to read academic articles in the field of dentistry," it is necessary to make learners read them whether or not their reading ability matches the materials. In foreign language education, it is important to take readability into a consideration when selecting textbooks. It is difficult to expect effective and efficient learning, where learner ability in the target language has been ignored and when they feel the textbooks are too easy or difficult, compared to a situation where the materials chosen are at

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an appropriate level. Things, thus, tend to be rather more goal oriented than process oriented learning and knowing what can be expected of the selected text linguistically is also a key to giving proper instruction.

In this paper, two things will be considered, 1) vocabulary levels and 2) readability of seven reading materials used for a course, entitled "Medical and Dental English" at Nihon University School of Dentistry in the first semester of the 2007 school year. This will help establish what standard of English language skills are needed to comprehensively read the academic articles used in the classroom.

Background

There are three aspects to readability, 1) affective aspects of readers, such as motivation, attitude, and intention, 2) legibility of text, or the visual aspect of text, like the size of letters, design, or layout of pages, paper brightness, and lastly 3) reading difficulty of the text (Endo, 2005., Johnson, 1998). This paper looks into the last aspect of readability.

Readability usually measures how clear or easy a text is to read and comprehend by analyzing textual aspects, with readability formula, such as the number of words per sentence, the number of syllables per word, the number of sentences, and so forth. How one reader can or can not comprehend text, of course, largely depends on how one is familiar with form and content. Form here means linguistic elements including the structure of sentences and text, and logical development. Concerning content, culture, social background knowledge, and/or special and technical knowledge of a specific field are all important. Also, concreteness and abstractness can influence the reader's comprehension. Readability, thus, becomes something rather linguistic and that can be subject to mechanical measurement.

"Medical and Dental English" for third year students at Nihon University School of Dentistry is divided into two 50-minute lessons per week over a 14-week period. The students are assigned one academic article to read every two weeks. A native speaker of English teaches the articles in English for the one 50-minute lesson and another Japanese teacher who specializes in the target subject provides a deeper explanation in Japanese for another 50-minute lesson in a week. This way, each case study has four classes, two lessons by the native speaker of English and another two by Japanese to finish one article. The course purposes are mainly 1) to promote more English language learning and 2) to have students read academic articles in dentistry field. In other words, this is a typical course for "English for Specific Purposes" (ESP). What is expected in this course is learning efficient reading skills, as well as gaining knowledge in the dentistry field, since more and more academic journals are published in English throughout the world in dentistry and more Japanese researchers go abroad to attend conferences. Even if students do not become researchers, they are likely to refer to some international journals to gain related information and specialized knowledge in the future. Acquiring English can be considered as being closely related to their future occupation.

Reading formulae

Many reading formulae were thought up in the 20th century, though the Talmudists, scholars of the Talmud, a collection of Jewish laws and traditions, analyzed the difficulty of writing sometime around the 10th century as a function of the number of words that could be counted in a sentence (Endo, 2005). In the 20th century, some researchers made word lists according to field-dependent word frequency usage. Then, cloze procedure was invented, which takes into account the percentage of correct answers when filling in the blanks in a text to make it logically comprehensible. Reading formulae started with word and sentence length, and then proceeded to incorporate logic and text sense.

One of the most popular reading formulae is probably one based on a calculation of the length of words, sentences, and number of syllables. For example, Flesch also started by making word lists and tried to check text difficulty by analyzing what words it consisted of. However, realizing this did not go anywhere, he designed a reading formula using the mean number of words per sentence and the mean number of syllables per word (Flesch, 1981).

As Greenfield (2004) explains, readability can be seen through vocabulary difficulty and grammatical difficulty. Considering commonly used readability formula, difficulty in this case means the length of words and sentences in a text. The longer words and sentences are, the more difficult they are thought to become for processing and comprehension. He says that when grammatically complicated sentence structures exist, their calculation and appraisal will be more problematical. The author assumes such structures would include things like compound sentences, embedded-clause constructions, subordinate clauses, participial constructions and so forth, but is not categorical about this. He also introduces some empirical evidence that there was no significant difference in readability analysis between texts with and without complex sentence structures. However, it is also true that, thanks to computers, it is easier than before to do these calculations. This makes it possible to choose one of various methods to produce a more complicated analysis. One can carry out meta analysis, comparing conventional readability formulae to see if there is any statistical difference and, in this way, make a more accurate formula, or establish new ones tailored to specific fields, like readability of ESP for the medicine and dentistry field.

There are many different kinds of readability formulae. Flesch reading ease and Flesch-Kincaid Grade Level are built-in with Microsoft Word. There are also Fog index, Fry readability graph, and Smog (Endo, 2005). Johnson (1998) mentions FORCAST Formula and Powers-Summer-Kearl Formula as well as others. Kiyokawa (1992) introduces Dale-Chall formula and spache formula, too, and he writes that there are more than 50 readability formulae that have been designed. Among those, Flesch Reading Ease and Flesch-Kincaid Grade Level will be used in this paper after vocabulary checking with Range.

Flesch writes (1981) the readability formula as thus : “multiply the average sentence length

by 1.015. Multiply the average word length by 84.6. Add the two numbers. Subtract this sum from 206.835. The balance is your readability score."

Flesch Reading Ease = 206.835 − (84.6 × ASW) − (1.015 × ASL)

Abbreviations of Flesch Reading Ease Fomula (Endo, 2005)

ASW : average number of syllables per word

ASL : average sentence length

Method and Procedure

Firstly, all the articles are respectively computed with Range to check loadings of vocabulary in three groups, base word lists 1, 2, and 3, and "not in the list." The first base word list includes the most frequent 1000 words of English. Likewise, the second includes the second 1000 most frequent words, and the third includes words not in the first 2000 most frequent words of English but which are still frequent in upper secondary school and university texts from a wide range of subjects (Paul Nation, n.d). Words in "not in the list" are not included any of the three base lists above.

The sources of these lists are *A General Service List of English Words* by Michael West (Longman, 1953) for the first 2000 words, and *The Academic Word List* by Coxhead (1998, 2000) containing 570 word families. The first thousand words of *A General Service List of English Words* are usually those in the list with a frequency higher than 332 occurrences per 5 million words, plus months, days of the week, numbers, titles (Mr, Mrs, Miss, Ms, Mister), and frequent greetings (Hello, Hi, etc).

Secondly, all texts are again computed to detect the readability of each with Flesch Reading Ease and Flesch-Kincaid Grade Level which translates the 0-100 of score of Flesch Reading Ease to a U.S. grade level. Microsoft Word has "Readability Statistics" function which check the grammar and style of writing in English. Summaries or abstracts, lists of works cited or references, notes, note numbers, and figures in texts were eliminated from this study because its purpose was to examine the readability of the main body of each of the articles. The reason why summaries are excluded is because they must briefly describe what the articles are about and, consequently, their writing style can be considered unique when compared with the texts of which they are abstracts.

Thirdly, syllable count and mean syllables per word, sentence, and paragraph were checked with a website service "wordcalc.com," because Flesch Reading Ease Formula requires the number of syllables, but Microsoft Word does not reveal them in its results. Another purpose was to see if there are any differences in results between these two calculations.

Materials

The seven articles studied are as follows, as they appear in the syllabus.

Article 1 : Matis BA, Cochran MA, Wang G, Franco M, Eckert GJ, Carlotti RJ, Bryan C. A clinical evaluation of bleaching using whitening wraps and strips. Oper Dent 2005 ; 30 : 588-592.

Article 2 : Bolan M, Ferreira MC, Almeida ICS, Derech CD, Ribeiro CLU. Palatal expansion and the Klippel-Trenaunay-Weber syndrome, Am J Orthod Dentofacial Orthop 2005 ; 128 : 385-387.

Article 3 : Santos A., Goumenos G, Pascual A. Management of gingival recession by the use of an acellular dermal graft material : a 12-case series. J Periodontol 2005 ; 76 : 1982 -1990.

Article 4 : Matsumura H, Atsuta M. Repair of an eight-unit fixed partial denture with a resin -bonded overcastting : A clinical report. J Prosthet Dent 1996 ; 75 : 594-596.

Article 5 : Gozneli R, Ozkan YK, Kazazoglu E, Akalin ZF. Effects of Bartter's syndrome on dentition and dental treatment : A clinical report. J Prosthet Dent 2005 ; 93 : 522-525.

Article 6 : Ohki H, Matsumoto M, Hasegawa M, Shimizu O, Mukae S, Amano Y, Komiyama K. Unusal cyst-like lesions in the parapharyngeal space associated with recurrence of tongue carcinoma. J Oral Sci 2005 ; 47 : 219-222.

Article 7 : Chen I-P, Karabucak B. Conventional and surgical endodontic retreatment of a maxillary first molar : unusual anatomy. J Endod 2006 ; 32 : 228-230.

Findings and Synthesis

Range shows number and percentage with "Tokens," "Types," and "Families." "Token" means the total numbers of words in the text. "Types" means the number of unique words in the text and unique in this case indicates that each word is only counted the first time it appears and not counted at any subsequent appearance in the same text. "Family" tells the total number of times the word and its family members occur in all the texts. For example, able and abler are counted as one family (Paul Nation. n.d.).

The first list received loadings of words ranging from 148 and 301 words, 38.14% and 52.17% (Article 4 and 1). The second list contains many fewer words compared with the first list of

Table 1 : Range printouts for the articles (Types/%)

Word list	Article 1	Article 2	Article 3	Article 4	Article 5	Article 6	Article 7	mean	s/d
First list	301/52.17	230/45.63	266/48.10	148/38.14	224/42.75	213/44.38	212/42.83	227.71/44.86	47.74/4.44
Second list	60/10.40	57/11.31	114/20.61	66/17.01	57/10.88	60/12.50	77/15.5	70.14/14.03	20.57/3.81
Third list	84/14.50	28/5.56	34/6.15	28/7.22	29/5.53	32/6.67	41/8.28	39.43/7.70	20.18/3.15
Not in the lists	132/22.88	189/37.50	139/25.14	146/37.63	214/40.84	175/36.46	165/33.33	165.71/33.40	29.44/6.81
Total	577	504	553	388	524	480	495	503	60.88

between 57 (Article 2 and 5) and 114 words (Article 3), and 10.40% (Article 1) and 20.61% (Article 3) of the whole text. The numbers of words belonging to the third list drop to between 28 (Article 2) and 84 (Article 1) and the range of percentage of the third list are from 5.53% (Article 5) to 14.50% (Article 1). Both the first and second lists cover only a little more than 50% of each text, or Article 1 covers 62.57% and the third list proportions do not even account for 10%, but again, Article 1 shows 14.50%. This apparently indicates that Article 1 has more frequently and commonly used words and Article 5 is more challenging to read than the others are, just considering its vocabulary level. What is surprising is that average of the percentage of the words "not in the list" is 33.40%. In particular, the Range revealed over 40% of the words in Article 5 is not in the three word lists.

The Readability Statistics of Microsoft Word can elicit numbers and means of words, sentences, paragraphs, and the readability of text, and so forth. Moreover, Microsoft Excel can help with the checking of basic statistics such as means and standard deviations of each of the categories. For example, the mean number of words of the seven articles is 1459 words and that of sentences is 73.29. They are rather short articles in general. As the number of words varies depending on the length of articles, it may not be worthwhile for the purpose of comparing the reading difficulties of those articles. However, it is also probably true that the longer reading materials are, the more information there is to process, which would make it seemingly more difficult to comprehend as a textual whole.

The number of sentences per paragraph ranges from 2.4 to 8.5 and the mean is 4.84, which

Table 2 : Microsoft Word printouts of readability statistics

	Article 1	Article 2	Article 3	Article 4	Article 5	Article 6	Article 7	mean	s/d
(Counts)									
Words	2095	1351	1866	928	1265	1453	1255	1459.00	396.45
Characters	11138	7449	10162	5159	7109	8276	7096	8055.57	2023.27
Paragraphs	61(33)	20(17)	29(22)	19(14)	14(11)	10(8)	13(11)	(16.57)	(8.58)
Sentences	106	63	101	48	59	68	68	73.29	21.77
(Averages)									
Sentences per paragraph	2.4	3.7	4.3	3.6	5.3	8.5	6.1	4.84	2.01
Words per sentence	19.1	21.3	18.3	18.6	21.3	21.3	18.4	19.76	1.46
Characters per word	5.0	5.3	5.3	5.3	5.4	5.5	5.5	5.33	0.17
(Readability)									
Passive sentences %	25	47	41	52	25	38	41	38.43	10.26
Flesch Reading Ease	36.5	24.6	28.9	24	18.9	24.5	18.5	25.13	6.17
Flesch-Kincaid Grade level	12	12	12	12	12	12	12	12.00	0.00

is again not so high. Yet, the number of words per sentence ranges from 18.3 to 21.3 and the mean number of words per sentence is 19.76 and standard deviation is 1.46. Technically, half of the sentences in those articles are longer than 19.76 words. Considering the possibility that somewhere from 25 to 40% of these words are not in the 3000 word base list, and that most of them are likely to be technical terms, learners of the target language would be expected find it quite difficult to comprehend such texts.

As for Readability, the lowest proportion of the use of the passive among the articles studied is 25% and the highest 52%. The mean is 38.43%. Endo (2005) writes that the percentage of the passive voice should be under 5 to 10% of total text, though the validity of this assertion has not been confirmed. Myers (1994) says that many passive voice sentences are changed into the active voice in popular magazines when they rewrite scientific articles for non-specialists, since it is considered easier to read. It maybe a good idea to teach rephrasing of the passive into the active as well.

Flesch Reading Ease shows readability to range from 18.5 to 36.5. According to Flesch Reading Ease index table (Table 3), while Article 1 is more easily readable than the others and yet at a "difficult" level, all the other articles are "very confusing." The Flesch-Kincaid Grade Level reveals all the articles are grade 12 or higher. A score of between 30 and 49 is college level and 0 and 29 is college graduate level (Flesch, 1981).

Table 3 : Flesch Reading Ease index table (Endo 2005, Flesch 1981)

Score	Style Description	Estimated reading grade
90-100	Very easy	5th grade
80-89	Easy	6th grade
70-79	Fairly easy	7th grade
60-69	Standard	8th and 9th grade
50-59	Fairly difficult	10th to 12th grade
30-49	Difficult	College
0-29	Very confusing	College graduate

Discussion

Range shows outstanding percentages of words "not in the list" in all the articles, especially Article 5 which includes 214 words out of 524 types of words used, loading more than 40% of the total words. The plausible reasons for this are that the article requires many words which 1) have extremely low frequency of use in other cases, 2) are highly complex, 3) are purely technical terms for dentistry, and/or 4) are all of the above.

The results of Range clearly demonstrate the usefulness of vocabulary building activities. Third base word list words already approach an academic word level. Although the percentages of third base word list words are from 5.53% to 14.50%, less than 10% except Article 1, the percentages of "not in the list" words are very high. In fact, "not in the list" reaches the second largest proportions among the four lists in all the articles. The importance of the role of ESP stands out here. It would certainly be a good idea to make a word list specifically for this course. It is time consuming for students to consult their dictionary for every word which they encounter for the first time. Although Flesch writes that he started by making a word list and got nowhere (Flesch, 1981), without enough specific knowledge of vocabulary, it would be next to impossible to comprehend this type of text.

However, the problem does not lie only in vocabulary. Cohen *et. al.* (1998) discuss problems of classifying vocabulary as technical or non-technical. Compound words made of words in the first two word lists seem easy enough, but some are used in specific ways requiring a specialized terminology in Japanese. For instance, the word "chief" is in the first 1000 words, and "complaint" in the second 1000 words, but "chief complaint" is translated as "shuso" and that is basically a medical (including dentistry) term in Japanese and is hardly used elsewhere.

In this study, the Flesch-Kincaid Grade Level shows level 12, but considering the nature of the texts, they are realistically much higher than the 12th grade of the U.S. education system. Johnson (1998) writes in his website that readability is decided on for 50 percent of correct answers with regard to text comprehension. It is rather doubtful whether readers really understand the text in such a case. Because of this, a more accurate measure of readability would be, in this case, to add two grades to the Flesch-Kincaid Grade Level (Johnson, 1998). The conclusion is that the texts under consideration are, realistically, even more difficult to read than they might appear.

Taking into consideration the nature of all academic articles, the two study results showing that the dentistry field texts used this time required a high educational background are understandable. The articles, being mostly case reports, need a large number of technical terms. One Japanese teacher told the students in his lecture that academic articles should be written so that anyone can understand them and, assuming one has enough vocabulary, they should not be difficult to read. However, the results of readability studies indicate that vocabulary is not the only obstacle. It is true that academic articles are usually written in a certain format so that anyone with enough knowledge of the field should be able to comprehend them. The problem is that readers should have knowledge of the certain textual rules as well as vocabulary.

One thing Microsoft Word does not show is the number of syllables per word, sentence, and paragraph. The number of syllables is needed in order to reveal Flesch Reading Ease. At least, the author is not aware of how to check it with Microsoft Word. However, the website, wordcalc.com can check number of syllables in a text. Other software should exist, which has the same function as well.

Table 4 : wordcalc.com printouts of statistics of the articles

	Article 1	Article 2	Article 3	Article 4	Article 5	Article 6	Article 7
Paragraph Count	33	15	18	10	7	10	9
Sentence Count	103	62	94	44	67	60	68
Word Count	2100	1382	1924	927	1464	1310	1258
Syllable Count	3093	2222	3066	1623	2474	2199	2187
Character Count (alphanumeric)	10485	7201	9861	4988	8011	7083	6874
Mean sentences per paragraph	3	4	5	4	10	6	8
Mean words per paragraph	68	92	107	93	209	131	140
Mean syllables per paragraph	99.77	148.13	170.33	162.30	353.43	219.90	243.00
Mean characters per paragraph	67.74	92.13	106.89	92.70	209.14	131.00	139.78
Mean words per sentence	20	22	20	21	22	22	19
Mean syllables per sentence	30.03	35.84	32.62	36.89	36.93	36.65	32.16
Mean characters per sentence	20.39	22.29	20.47	21.07	21.85	21.83	18.50
Mean syllables per word	1.47	1.61	1.59	1.75	1.69	1.68	1.74
Mean characters per word	4.99	5.21	5.13	5.38	5.47	5.41	5.46

The major problem is that each software and similar website services extract different results. For example, Microsoft Word counted 2095 words in Article 1, while wordcalc.com counted 2100 words. They may count differently some words with shortened forms such as “He’s” as one word or two, and hyphenated words as being one or more. Also, Microsoft Word elicits the number of paragraphs quite differently from the actual number of paragraphs in the articles. The actual number which the author manually counted was shown in brackets in the same column (Table 2). For example, there are many itemized points in Article 1. Apparently, Microsoft word counts changing line functions as one paragraph. It is not advisable to rely on these results. This is one problem which needs to be clarified in studies.

Schema Theory for more efficient comprehension

If background knowledge is essential to understand any text, then, schema theory should be put into consideration. Schema consists of structured and/or stratified background knowledge about a particular object (Kanatani, 1995). In other words, schema is a whole group of related points of knowledge needed to comprehend a certain matter. He says that when it comes to reading comprehension schema consists of two elements 1) content schema and 2) formal schema. The former is related to the text content with regard to background knowledge level, encompassing such matters as the cultural, social, and political background on which the text

depends. To understand a new idea or information, one compares and/or applies some relevant knowledge gained in the past to new information. Without this knowledge, it is impossible to comprehend something totally new. Relating irrelevant knowledge, comprehension level will go lower. Most Japanese specialists in the "Medical and Dental English" course showed many pictures of teeth, the mouth, etc., in the dental treatment with presentation software in the classroom. Students could be expected to have a deeper understanding of what they read by means of the presentation software imagery.

As for the latter, formal schema are affected in understanding by text structure. There are many studies about the syntax of scientific articles as Myers points out (1994). Not only vocabulary, but also a knowledge of sentence structures, coherences and cohesions, topic sentence and supporting sentences in paragraph reading, the introduction-body-conclusion structure, to name a few, would be very helpful to dissect the text, especially if there are specific characteristics one should pay attention to in a particular type of writing. One understands a reading passage more easily when the text structure is familiar to him/her.

Carrell (1987) compared these two components of schema to find which was more affective on L2 reading. The more familiar the form and contents are, the easier reading becomes, but unfamiliar content has a greater effect than unfamiliar form. She concludes that a reading teacher should provide related information and reading skills for L1 reading, whereas L2 reading teachers should teach the rhetorical organization of texts as well as provide background knowledge of its content. While Yorio (1971) finds vocabulary is one of the main problems in ESL reading, it is not always easier for L2 readers to understand the simple sentences in terms of syntax (Blau, 1982). As L2 readers already have reading skills in their own native language, they comprehend somewhat complex texts better than overly simplified ones.

Considering these points, the teaching methods used in "Medical and Dental English" which are a combination of two approaches, one taken by a native speaker of English and the other by Japanese teachers with a certain level of expertise in the dentistry field, are very promising.

Conclusions

Academic articles justly require specific knowledge to understand them, but it is meaningful to evaluate and recognize these texts' vocabulary and readability level numerically. Comprehension difficulties of the texts in terms of linguistic aspects come from both vocabulary level and text structures. In this study, Range elicited the fact that 22.88% to 40.84% of the total words appearing in the texts were "not in the list." According to Flesch Reading Ease index table (Table 3), Article 1 is at a "difficult" level and the rest are at a "very difficult" level, which, in this case, is college graduate level in the U.S. These texts are used with individuals having educational levels. This is understandable and may be presumed, as they are academic articles in the field of dentistry. As such, learners need a large amount of technical words and linguistic reading skills to comprehend them.

Further studies are needed to consider 1) establishing ways to teach technical terms more efficiently and effectively, 2) distinguishing commonly used words in general and specifically used words in the first and second lists, 3) analyzing characteristic sentence structures like the passive voice and determining whether or not these should be specifically instructed to enhance reading comprehension ability, and 4) exploring further differences of results among different software and web-based services.

If a reader is well acquainted with either content or form, it helps to understand the writing, but when neither of these aspects is familiar, it will be even harder for learners to read these articles. After all, in order to help Japanese university students to learn how to read academic articles of this particular field in English, it is necessary for them to acquire not only language skills, but also knowledge of content and how that content is presented academically.

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