【 論文 】

# Japanese Pharmacy Students' Knowledge of EMP Vocabulary:
## An analysis of its breadth, characteristics, and difficulty order

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**ABSTRACT**

This study illustrates and analyzes the knowledge of general academic and specialized pharmaceutical vocabulary that Japanese pharmacy students have. The authors used the pharmaceutical word lists developed by two previous studies by Grabowski (2015) and Heidari et al. (2020) as the database and developed a pharmaceutical vocabulary test. As the target words, 100 words appearing in pharmaceutical journals and textbooks that are essential for understanding content, were selected. A total of 232 Japanese university students (111 pharmacy major and 121 non-pharmacy major students) were tested on their recognition of pharmaceutical words with the use of 100 multiple-choice questions with 6 option responses each. The results of the test were analyzed by using the *t*-test and Pearson's and Spearman's correlation coefficient (Cohen, 1988) to examine the relationship between the test scores of the pharmacy and non-pharmacy students. The results showed that pharmacy students had acquired a significantly larger number of words than non-pharmacy students. There was a high degree of similarity between the difficulty order in the vocabulary among the pharmacy students and the non-pharmacy students, suggesting that pharmacy students acquire vocabulary in a similar order to non-pharmacy students. Highly specialized pharmaceutical words, especially those which are used in clinical trial protocols, seem difficult for students to learn.

**Keywords**

EMP, Japanese pharmacy students, pharmaceutical vocabulary, difficulty order

## 1. INTRODUCTION

In a School of Pharmacy and Pharmaceutical Sciences in Tokyo, its English program is highly geared towards EMP (English for medical purposes) in order to prepare the students for their medical studies. Pharmacists need to utilize basic academic and pharmaceutical terms as they 'provide patient care, describe medication-related mechanisms of action, recommend pharmacological treatments, and discuss monitoring and follow up parameters' (International Pharmaceutical Federation, 2020). Japanese pharmacy students are, therefore, required to acquire practical English skills in order to read basic medical articles and research papers to gain necessary information, and to communicate in the pharmaceutical setting with patients who do not speak Japanese.

Learning a language is essentially a matter of learning new words (Read, 2000), and vocabulary is closely connected to comprehension. A good understanding of English vocabulary used in pharmaceutical science is thus considered very important to improve the skills which pharmacy students need. However, researchers and teachers do not seem to have properly investigated pharmacy students' knowledge of vocabulary despite its importance. Smith et al. (2020) report on a study on Japanese pharmacy students' acquisition of specialist vocabulary focusing on meaning and pronunciation and conclude that pronunciation should be taught together with meaning and grammatical functions to increase the acquisition of both reception and production vocabulary. However, they admit their study did not take the difficulty levels and acquisition order of vocabulary into consideration.

Naruhashi (2021) investigated the relationship between general English proficiency and the degree of acquisition of specialized English terms of pharmacy students in Japan and found that the correlation between the score of the general English proficiency test and the acquisition rate of specialized pharmacy vocabulary was relatively low. Somewhat contradicting results have been obtained elsewhere. Boschmans and Webb (2014) in South Africa contend that achievement in pharmacology is related to students' general health vocabulary knowledge. In the United States, Diaz-Gilbert (2004) studied the word knowledge of pharmacy students whose first or best language is not English and identified problematic health and pharmacy-related vocabulary and language obstacles.

All these aspects constitute the rationale of this study, which aims at examining Japanese pharmacy students' second language knowledge of basic academic and pharmaceutical vocabulary. The study also investigates which words are more difficult and easier than others to acquire, and why these difficulty rankings occur, by comparing the data between pharmacy students and non-pharmacy students. The authors were interested in exploring how knowledge of words develops. To teach pharmaceutical vocabulary effectively and efficiently in a very limited time in an already busy pharmaceutical studies curriculum, it would be especially worthwhile for teachers to learn in advance about their students' vocabulary knowledge, and then choose which words to focus on, and in what order.

## 2. BACKGROUND

Pharmacy students are expected to develop a large breadth of knowledge about medical vocabulary terms because this will make it easier for them to understand texts which contain the words in context. The breadth of vocabulary knowledge refers to the size of the vocabulary or the number of words, and the meaning of which one has at least some superficial knowledge (Qian, 2002). Although there are other dimensions of vocabulary knowledge including depth of vocabulary knowledge, which includes word characteristics such as phonemic, collocational, and phraseological properties; lexical organization, which refers to the storage, connection, and representation of words in the mental lexicon; and automaticity of receptive knowledge (Qian, 2002), this study focuses on the breadth of vocabulary knowledge. Vocabulary breadth is linked to the acquisition of reading competence, so the authors believe that such basic information should provide the essential building blocks for language instruction.

Traditionally, words targeted for the explicit study were supplied to learners in the form of lists with appropriate translations and concise explanations for difficult vocabulary used in medical texts. There are numerous academic, field-specific, and technical word lists available for English study. Among them, the Academic Word List (AWL) which was developed by Coxhead (2000) is the most well-known general academic word list. It was developed by analyzing a corpus or body of academic written texts to find out which words occurred most commonly across a range of 28 subject areas in the four academic disciplines of Arts, Commerce, Law, and Science. Corpus linguistics helps us compile vocabulary lists (Read, 2000), so advances in technology have helped us collect and analyze current and specialized corpora such as EMP. *The New JACET List of 8,000 Basic Words* (Japan Association of College English Teachers, 2016) (hereinafter, referred to as New JACET8000), the updated version of JACET8000 (Ishikawa et al., 2003), serves as an educational word list for Japanese learners of English, especially university students and teachers. Based on the British National Corpus and the Corpus of Contemporary American English, the list has 8,000 words, and for each 1,000 words, a level from 1 to 8 is provided according to their frequency.

Although there are fewer word lists featuring pharmaceutical terminology, Grabowski (2013, 2015) focused on keywords and lexical bundles used in pharmaceutical texts and compiled pharmaceutical vocabulary lists. Grabowski (2015) analyzed the corpora that include patient information leaflets, summaries of product characteristics, clinical trial protocols, and chapters in academic pharmacology textbooks. Heidari et al. (2020) established a pharmaceutical academic word list (PAWL) that functions as a reference for pharmacy students and researchers. Heidari et al's PAWL is a list of the most frequent words from a corpus devised from the most recent pharmaceutical texts including research articles, review articles, and short communications in pharmacies.

Many vocabulary tests are available to English language teachers. However, most of them are tests of general terms, so the current study utilized the pharmaceutical word lists developed by both

Grabowski (2013, 2015) and Heidari et al. (2020) and created a pharmaceutical vocabulary test to measure students' English vocabulary knowledge of pharmaceutical terms. Despite the importance of English proficiency to Japanese pharmacy students, few studies have examined the vocabulary knowledge of pharmacy students in the Japanese context. This study investigated the vocabulary knowledge of Japanese pharmacy students and proposes difficulty rankings of English vocabulary for facilitating the teaching of vocabulary. It might be assumed that pharmacy students know more pharmaceutical words than non-pharmacy students. However, you can never be sure of anything until you have examined it closely. Therefore, it is important to measure the knowledge of students' vocabulary in the field of pharmacy in order to know their vocabulary learning.

## 3. EXPERIMENT

### 3.1 Research Questions

The following research questions were investigated in this study.

(1) Is there any statistical difference between the average scores for a pharmaceutical frequency vocabulary test of a group of pharmacy students and a group of non-pharmacy students?

(2) Is there any similarity in the order of difficulty of the target words between pharmacy students and non-pharmacy students?

(3) What are the characteristics of the words that pharmacy and non-pharmacy students have not acquired?

Regarding research question 1, the average score of the pharmacy students is expected to be higher than that of the non-pharmacy students because many of the target words are pharmaceutical and the pharmacy students might have already encountered some of these words. The responses to research question 2 may lead us to better understand the order of vocabulary difficulty for Japanese learners of English. By seeking answers to research question 3, the factors that make specific words difficult to learn might be revealed.

### 3.2 Participants

A total of 232 Japanese university students (111 pharmacy and 121 non-pharmacy students) participated in this study. All the participants had studied English for at least six years.

The authors took careful steps to adhere to guidelines for ethical classroom research.

### 3.3 Materials and Procedures

One main consideration was how to measure knowledge of vocabulary. This study used the same test format that has been used in our previously published article (Shimazaki & Shirahata, 2022) and was compatible with the purposes of the current study. This test utilized a format that was perhaps the most-widely used in research involving assessing meaning recognition knowledge: a meaning recognition multiple-choice test (Webb, 2005). Recognition in this study was understood as a type of knowledge when the learner is able to recognize and select a correct translation of a target item from six given options. To lower the probability of students correctly guessing answers, multiple-choice questions with 6 options were adopted. See the Appendix for a complete description of the target words. Based on the following criteria, 100 words were selected:

a. The 'Top 50 Word Families in PAWL' (Heidari et al., 2020) were chosen on a preferential basis because of their highest frequency in the pharmaceutical field, and 48 words from the 50 words were selected from the list.

b. Four different text types from Grabowski (2015) were included: six words from patient information leaflets (PILs), 11 words from summaries of product characteristics (SPCs), 22 words from clinical trial protocols (CTPs), and 13 words from chapters in academic textbooks in pharmacology (ATs).

c. Various words from the different parts of the speech were selected: 61 nouns, 21 adjectives, and 18 verbs.

Some words on the frequency lists were excluded based on the following criteria:

d. Very easy words on the frequency lists such as *doctor* that all the students should know.

e. The same words in a different form on the lists, for example, *patients* and *patient*, *interact* and *interaction* were considered as one word family.

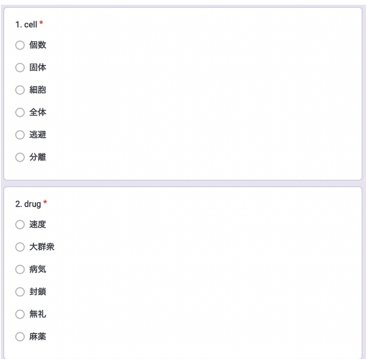
f. Very easily-guessable words in the form of English loanwords in Japanese such as *insulin* – '*insurin'* in Japanese.

g. Abbreviations and acronyms such as EudraCT

(European Union Drug Regulating Authorities Clinical Trials Database) and DNA (deoxyribonucleic acid) were also excluded because those are often very easy to guess the meaning from knowledge of Japanese vocabulary.

The test was prepared both on Google Forms and in pen-and-paper format. Among the 232 participants, 150 participants completed the test online, and 82 used the pen-and-paper format for their convenience. All the participants took the test in July 2022. Participants received one point for a correct answer and zero points for a wrong answer. The highest possible score on the vocabulary test was 100. Each test started with specific instructions on how to complete it. Figure 1 shows examples of the test questions.

Figure 1: Examples of the vocabulary test on Google Forms




Participants took approximately 15 minutes to complete their responses, either by accessing the Google Forms on their own devices such as a smartphone, a PC, or a tablet, or in paper format by using a pen and paper. All the participants sat in the classroom in real-time with the instructors invigilating to prevent cheating. The genre of the vocabulary was not announced in advance, to avoid unnecessary speculation, so the participants did not know the test was about pharmaceutical vocabulary.

First, the results of the vocabulary tests of the two cohorts, pharmacy students and non-pharmacy students, were analyzed statistically using *t*-test. Second, Pearson's correlations and Spearman's correlations were computed to obtain an overall view of the degree of interrelatedness between the vocabulary test scores of the two groups. Third, the characteristics of the words which were the most difficult for the participants to answer correctly were closely examined according to their text types, genres, and parts of speech.

## 4. RESULTS AND DISCUSSION

### 4.1 The breadth of vocabulary

The results from the *t*-test as shown in Table 2 indicate that there is a statistically significant difference between the average scores of the vocabulary test of pharmacy students and non-pharmacy students, $t(215)=15.40$, $p < .001$, $d = 9.47$, 95%CI[16.46,21.30].

Table 1: Descriptive statistics of participants' test scores

| | *M* | *SD* | Skewness | Kurtosis | Minimum | Maximum |
|---|---|---|---|---|---|---|
| Pharmacy students (N=111) | 79.7 | 7.63 | 0.724 | -0.574 | 62 | 94 |
| Non-pharmacy students (N=121) | 60.9 | 10.88 | 0.989 | -0.212 | 31 | 82 |

The average score of the pharmacy students was 79.7, whereas that of the non-pharmacy students was 60.9, which means that the pharmacy students have acquired approximately 80 words out of the 100 most important pharmaceutical words, while 20 of the words have not been learned yet. Compared to the non-pharmacy students, the pharmacy students have a significantly wider breadth of pharmaceutical vocabulary. The period of pharmaceutical study both within and beyond the English language classes at the School of Pharmacy is a possible factor associated with their existing knowledge of basic pharmaceutical terms.

The pharmacy students begin the English for medical and pharmaceutical purposes course in the first term of the first year and continue the course until the second term in the third year. In addition, they begin the pharmacotherapy courses from the second term in the second study year, and their associated pharmacy practice laboratories in the second term in the third study year. On the other hand, non-pharmacy students would not have an opportunity to focus on learning medical terms. Simply, students' encounters with the terms would matter most in terms of their scores, and possibly, motivational factors would also affect students' study time and attitudes. Pharmacy students are highly motivated to pursue their careers, so that might also influence academic performance in general.

### 4.2 The difficulty orders

Pearson's correlations were subsequently applied to ascertain the statistical dependence of ranking between the pharmacy student and non-pharmacy student cohorts. Pearson's ranking correlation coefficients between the pharmacy students' and non-pharmacy students' 100-question test scores are presented in Table 2.

Table 2: Correlations between participants' test scores

| | | Pharmacy students | Non-pharmacy students |
|---|---|---|---|
| Pharmacy students | Pearson's coefficient of correlation | 1 | .835** |
| | p-value (one-tailed) | | 0 |
| | n | 100 | 100 |
| Non-pharmacy students | Pearson's coefficient of correlation | .835** | 1 |
| | p-value (one-tailed) | 0 | |
| | n | 100 | 100 |

**. $p$ < .01 (one-sided)

The $p$-value computed for the test (0.835) is significantly higher than the significance level we have chosen (0.01) as shown in Table 2. This suggests that both groups' overall test scores are highly correlated. The descriptive statistics of correlations between participants' test scores are shown in Table 3.

Table 3: Descriptive statistics of correlations between participants' test scores

| | n | mean | sd | median | trimmed | mad | min | max | range | skew | kurtosis | se |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pharmacy students | 100 | 0.80 | 0.25 | 0.94 | 0.84 | 0.1 | 0.04 | 1 | 0.96 -1.28 | 0.63 | 0.02 | |
| Non-pharmacy students | 100 | 0.61 | 0.3 | 0.64 | 0.63 | 0.42 | 0.03 | 1 | 0.97 -0.27 | -1.24 | 0.03 | |

95% CI [lower, upper] = 0.764 0.886

Figure 2: Correlations between participants' test scores

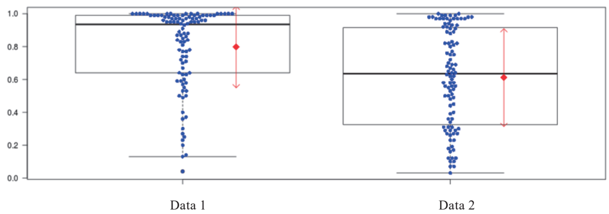



Figure 2 graphically illustrates the correlations and the independent $t$-test results obtained. These are $t$ = 4.7964, $df$ = 198, $p$-value = 3.172e-06 $d$ [95 %CI] = 0.68 [0.39, 0.97]. In the box and whisker plot, Data 1 represents the overall test scores of the pharmacy students, and Data 2 represents that of the non-pharmacy students. Although average scores are significantly different, the distribution of the data looks similar, suggesting that both groups' difficulty orders in terms of general academic and specialized pharmaceutical vocabulary are almost identical.

Spearman's rank-order correlation coefficient is a nonparametric measure of rank correlation. Table 4 shows Spearman's ranking correlation coefficients between the two groups' scores with regard to the 28 pharmaceutical words on the vocabulary test. These 28 words such as 'inhaler' and 'hypoglycaemia' are not included in the New JACET 8000 Word List (JACET, 2016). The authors considered these 28 words as highly specialized pharmaceutical terms because they are not included in the New JACET 8000 Word List, but they appear frequently in pharmaceutical texts.

Table 4: Spearman's ρ between the two groups' scores with regard to highly specialized pharmaceutical terms

| | | Pharmacy students | Non-pharmacy students |
|---|---|---|---|
| Pharmacy students | correlation coefficient | 1 | .839** |
| | p-value (one-tailed) | . | 0 |
| | n | 28 | 28 |
| Non-pharmacy students | Pearson's coefficient of correlation | .839** | 1 |
| | p-value (one-tailed) | 0 | . |
| | n | 28 | 28 |

**. $p$ < .01 (one-sided)

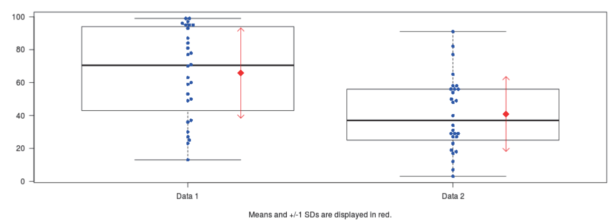
As Table 4 shows, the scores of the two groups are statistically highly correlated as Spearman's ρ was .00 (p<.001). This suggests that both groups of students learned the highly specialized pharmaceutical terms in similar orders. The descriptive statistics are shown in Table 5. It should be noted, however, that the number of items is only 28, and this small number might have led to a statistical analysis quirk.

Table 5: Descriptive statistics of participants' test scores with regard to highly specialized pharmaceutical terms

| | n | mean | sd | median | trimmed | mad | min | max | range | skew | kurtosis | se |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pharmacy students | 28 | 65.79 | 27.4 | 70.5 | 67 | 34.84 | 13 | 99 | 86 -0.36 | -1.31 | 5.18 | |
| Non-pharmacy students | 28 | 40.89 | 22.8 | 37 | 40.08 | 27.43 | 3 | 91 | 88 -0.33 | -0.78 | 4.3 | |

Figure 3 graphically illustrates that the correlations and the independent $t$-test results obtained are $t$ = 3.6963, $df$ = 54, $p$-value = 0.0005125 d [95 %CI] = 0.99 [0.42, 1.56]. In the box and whisker plot, Data 1 represents the scores of the pharmacy students, and Data 2 represents that of the non-pharmacy students. Although average scores are significantly different, the distribution of the data looks similar, suggesting that both groups' difficulty orders in terms of highly specialized pharmaceutical vocabulary are also almost identical.

Figure 3: Correlations between participants' test scores with regard to highly specialized pharmaceutical terms




Next, the items that were scored very differently between the two groups were extracted. The authors assumed that these words were also highly specialized vocabulary because, in most cases, the group of pharmacy students scored very highly with regard to some words, while the non-pharmacy students scored very low. For example, with regards to the target word ‘enzyme’, the pharmacy students’ correct percentage was 87%, whereas that of the non-pharmacy students’ was 27%. With regards to ‘membrane’, it was 72% and 12% respectively. Both enzyme and membrane are considered to be highly specialized pharmaceutical terms. The scores of the two groups with regard to more general target words were computed. Table 6 shows that the two groups’ scores with regard to general academic words are highly correlated, suggesting again that both groups of students learned the words in approximately a similar order.

Table 6: Spearman’s **ρ** between the two groups’ scores with regard to general academic words

| | | Pharmacy students | Non-pharmacy students |
|---|---|---|---|
| Pharmacy students | correlation coefficient | 1 | .795** |
| | p-value (one-tailed) | . | 0 |
| | n | 47 | 47 |
| Non-pharmacy students | Pearson’s coefficient of correlation | .795** | 1 |
| | p-value (one-tailed) | 0 | . |
| | n | 47 | 47 |

**. *p* < .01 (one-sided)

Table 7 shows the descriptive statistics of the participants’ test scores with regard to general academic words that are not very pharmaceutical-field-specific. For example, ‘potential’ and ‘factor’ are included in this category. Both groups were 100% correct for the word ‘potential’, while for ‘factor’ it was 99% and 91% respectively. The results show that both groups have acquired general academic words in a similar order.

Table 7: Descriptive statistics of participants’ test scores with regard to general academic words

| | n | mean | sd | median | trimmed | mad | min | max | range | skew | kurtosis | se |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pharmacy students | 47 | 80.66 | 30.32 | 99 | 85.64 | 1.48 | 4 | 100 | 96 -1.27 | 0 | 4.42 | |
| Non-pharmacy students | 47 | 76.19 | 30.6 | 92 | 80.41 | 8.9 | 7 | 100 | 93 -1.15 | -0.78 | 4.46 | |

The correlation analyses revealed that the ranking correlation coefficients are high in all three cases: the 100 target words altogether, the 28 pharmaceutical words, and the 47 general academic words. We found significant correlations between the test scores of pharmacy students and non-pharmacy students, indicating that there is clearly a strong similarity in the order of difficulty.

Intuitively, some pharmaceutical words would clearly seem easier or more difficult to learn than others, but there has been little evidence indicating the order of difficulty of pharmaceutical vocabulary. Although the period of pharmaceutical study both within and beyond English language classes is a possible factor associated with the pharmacy students’ greater knowledge of basic pharmaceutical terms, the results of the current study suggest that pharmacy students have acquired vocabulary in a similar order as non-pharmacy students have.

### 4.3 The characteristics of difficult words

In this section, we will look closely at some of the target words that were found to be very difficult for students to acquire. Since it became clear that both groups of students would acquire English vocabulary in a similar order, there does not seem to be any differences in the difficulty ranking of words among students of any major. Therefore, the most difficult words were extracted from the synthesized data of the two groups. Table 8 shows the top 30 most difficult target words, their text types according to Heidari et al. (2020) and Grabowski (2015), the frequency levels according to the New JACET 8000 Word List (JACET, 2016), and the parts of speech.

Table 8: The 30 most difficult pharmaceutical words

| Vocabulary | Text type | JACET8000 | Part of speech |
|---|---|---|---|
| inhaler | PILs | None | n |
| excretion | ATs | None | n |
| designated | CTPs | Lev 4 | v |
| criteria | CTPs | None | n |
| subcutaneous | SPCs | None | adj |
| synthesis | ATs | Lev 7 | n |
| anaemia | SPCs | None | n |
| secretion | ATs | Lev 7 | n |
| protocol | CTPs | Lev 5 | n |
| incidence | SPCs | Lev 5 | n |
| administer | Heidari | Lev 4 | v |
| pediatric | CTPs | None | adj |
| membrane | ATs | Lev 7 | n |
| excipients | SPCs | None | n |
| hypoglycaemia | SPCs | None | n |
| expiry | PILs | None | n |
| adverse | SPCs | Lev 5 | adj |
| formula | Heidari | Lev 4 | n |
| impairment | SPCs | Lev 6 | n |
| ventricular | ATs | None | adj |
| renal | SPCs | Lev 8 | adj |
| assay | Heidari | None | v |
| anesthetic | ATs | None | adj |
| childbearing | CTPs | None | n |
| investigator | CTPs | Lev 4 | n |
| contraception | CTPs | None | n |
| scope | CTPs | Lev 4 | n |
| homeopathic | CTPs | None | adj |
| somatic | CTPs | None | adj |
| bearing | CTPs | Lev 6 | n |

Table 9 focuses on the pharmaceutical text types of the most difficult words to acquire. It shows that CTPs (clinical trial protocols) are the most difficult text type to acquire, SPCs (summaries of product characteristics) the second most difficult, and ATs (academic textbooks in pharmacology) the third. PILs (patient information leaflets) and the PAWL (pharmacy academic word list) which consists of the 50 most frequently used words in pharmaceutical texts are less difficult to acquire. CTPs are documents that describe the objectives, design, methodology, statistical considerations, and aspects related to the organization of clinical trials (Cipriani & Barbui, 2010). Students would not normally encounter such clinical trial protocols until they start preparing themselves for clinical trials. This would also be true of SPCs until they prepare for pharmacy practices.

On the other hand, the purpose of PILs is 'to inform patients about the administration, precautions and potential side effects of their prescribed medication' (Herber et al., 2014). PIL is written in an easy language so that patients can make informed decisions about the prescribed medication. Students should also be able to read and understand PILs easily without specialist vocabulary.

Table 9: The most difficult text types

| Text type | Number of items |
|---|---|
| CTPs | 11 |
| SPCs | 8 |
| ATs | 6 |
| PAWL | 3 |
| PILs | 2 |

Table 10 compares the 30 most difficult words with the levels in the New JACET 8000 (JACET, 2016). Sixteen target words are not included in the New JACET 8000, which indicates that those are not particularly frequent and tend to be highly specialized pharmaceutical vocabulary. Other words are located at higher levels in the JACET List. Levels 6 to 8 are the highest levels in the list and are for college liberal arts students to English majors. Levels 4 to 5 are for university entrance exam levels to non-English major university level. It seems natural that both the pharmacy and non-pharmacy students find those high levels of English vocabulary difficult.

Table 10: The JACET 8000 levels of the most difficult words

| Levels | Number of items |
|---|---|
| Out-rank | 16 |
| Level 6-8 | 6 |
| Level 4-5 | 8 |

Among the 100 target words in the pharmaceutical vocabulary test, there were 61 nouns, 21 adjectives, and 18 verbs. Table 11 indicates that the participants find the adjectives in the vocabulary test the most difficult, the nouns the next most difficult, and the verbs the least difficult to acquire.

Table 11: The incorrect answer rates for words in different parts of speech

| Part of speech | Incorrect answer rate |
|---|---|
| Adjective | 38% |
| Noun | 31% |
| Verb | 17% |

English teachers at pharmacy schools may utilize the difficulty-ranking information provided in this study to determine when and how each target word should be taught. This study also revealed that Japanese pharmacy students still have somewhat limited knowledge of frequently-occurring basic academic and pharmaceutical vocabulary, and that learning the rest of the words should take priority.

## 5. CONCLUSION

This study explored the overall nature of Japanese pharmacy students' vocabulary knowledge, using a multiple-choice pharmaceutical vocabulary test with a relatively large number of participants (N= 232). The findings have helped us to paint a larger picture of the factors involved in vocabulary learning. Three conclusions can be drawn: Firstly, a statistical analysis revealed that pharmacy students scored significantly higher than non-pharmacy students, indicating that pharmacy students have acquired a significantly larger number of pharmaceutical words than non-pharmacy students.

Secondly, there is a statistically high degree of similarity between the difficulty order in the acquisition of English basic academic and pharmaceutical English words between pharmacy students and non-pharmacy students, indicating that pharmacy students acquire vocabulary in a similar order as non-pharmacy students do. Thirdly, both pharmacy and non-pharmacy students acquired more general words earlier than more pharmaceutical words, indicating the acquisition of basic-level terms prior to advanced-level terms. Highly difficult words for non-pharmacy students to learn also seem highly difficult for pharmacy students to learn as well.

Although this may be one of the first studies to assess and compare pharmacy and non-pharmacy students' knowledge of basic academic and pharmaceutical English terms in Japan, several limitations must be acknowledged. Firstly, the participants were part of a convenience sample, and the results may not be generalizable to the entire cohort of pharmacy students in Japan. Secondly, although this study focused on the investigation of pharmacy students' vocabulary knowledge, more research on the effectiveness of methods of vocabulary instruction methods is necessary. The importance of specialized medical vocabulary instruction will continue to interest English teachers in the field, and medical terminology instruction should be incorporated into the EMP curriculum.

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**REFERENCES**

Boschmans, S., & Webb, P. (2014). Evaluating the relationship between general health vocabulary and student achievement in pharmacology. *American Journal of Pharmaceutical Education*, *78*(6), 122, 1-6.

Cipriani, A., & Barbui, C. (2010). What is a clinical trial protocol? *Epidemiol Psichiatr Soc, 19*(2), 116-117. https://pubmed.ncbi.nlm.nih.gov/20815294/

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences (2nd ed.).* Lawrence Erlbaum.

Coxhead, A. (2000). A new academic word list. *TESOL Quarterly, 34*, 213-238. https://doi.org/10.2307/3587951

Diaz-Gilbert, M. (2004). Vocabulary knowledge of pharmacy students whose first or best language is not English. *American Journal of Pharmaceutical Education, 68*(4), 91, 1-8.

Grabowski, L. (2013). Register variation across English pharmaceutical texts: A corpus-driven study of keywords, lexical bundles and phrase frames in patient information leaflets and summaries of product characteristics. *Procedia – Social and Behavioral Sciences, 95C*., 391-401. doi:10.1016/j.sbspro.2013.10.661

Grabowski, L. (2015). Keywords and lexical bundles within English pharmaceutical discourse: A corpus-driven description. *English for Specific Purposes, 38,* 23-33. doi: 10.1016/j.esp.2014.10.004

Heidari, F., Jalilifar, A., & Salimi, A. (2020). Developing a corpus-based word list in pharmacy research articles: A focus on academic culture. *International Journal of Society, Culture & Language, 8*(1), 1-15.

Herber, O. R., Gies, V., Schwappach, D., Thürmann, P., & Wilm, S. (2014). Patient information leaflets: informing or frightening? A focus group study exploring patients' emotional reactions and subsequent behavior towards package leaflets of commonly prescribed medications in family practices. *BMC Pham Pract, 2*, 15-163. doi: 10.1186/1471-2296-15-163.

International Pharmaceutical Federation. (2020). *Pharmacists' role in "Medication without harm".* https://www.fip.org/file/4757

Ishikawa, S., Uemura, T., Kaneda, M., Shimizu, S., Sugimori, N., & Tono, Y. (2003). *JACET8000: JACET List of 8000 Basic Words.*『大学英語教育学会基本語リスト: *JACET List of 8000 Basic Words*』. 桐原書店.

Japan Association of College English Teachers. (2016). *The New JACET List of 8,000 Basic Words.*『大学英語教育学会基本語リスト新 *JACET8000*』. 桐原書店.

Naruhashi, K. (2021). Relationship between general English language proficiency and specialized professional English acquisition ability: Investigating students at the Faculty of Pharmaceutical Sciences, DWCLA.『同志社女子大学総合文化研究所紀要 38』, 30-35.

Nation, I.S.P. (1995). Best practice in vocabulary teaching and learning. *English Australia Journal*, *13*(2), 7-15. https://search.informit.org/doi/10.3316/aeipt.113149.

Nation, I.S.P., & Waring, R. (1997). Vocabulary size, text coverage and word lists. In Schmitt, N. & McCarthy, M., Eds., *Vocabulary: description, acquisition, and pedagogy.* Cambridge University Press. 6-19.

Qian, D. D. (2002). Investigating the relationship between vocabulary knowledge and academic reading performance: An assessment perspective. *Language Learning*, *52*(3), 513-536. doi: 10.1111/1467-9922.00193

Read, J. (2000). *Assessing vocabulary.* Cambridge University Press.

Shimazaki, H., & Shirahata, T. (2022) 「薬学生の英語語彙知識の調査」『教科開発学研究会発表論文集 13』, 12-17.

Smith-Yamashita, T., Amagase, Y., Yamashita, N., & Noguchi, J. (2020). A pilot study on the acquisition of specialist terminology by pharmaceutical students: Focusing on meaning and pronunciation. 『大阪薬科大学紀要 14』, 77-80.

Webb, S. (2005). Receptive and productive vocabulary learning: The effects of reading and writing on word knowledge. *Studies in Second Language Acquisition, 27*, 33-52.

# APPENDIX

## The Pharmaceutical Vocabulary Test Items

| No. | Vocabulary | Answer | Distractor 1 | Distractor 2 | Distractor 3 | Distractor 4 | Distractor 5 |
|---|---|---|---|---|---|---|---|
| 1 | cell | 細胞 | 個数 | 固体 | 全体 | 逃避 | 分離 |
| 2 | drug | 麻薬 | 速度 | 大群衆 | 病気 | 封鎖 | 無礼 |
| 3 | analyze | 分析する | 意味を取り違える | 救助する | 結合して一体にする | 破壊する | 予防する |
| 4 | significant | 意味を持つ | 一定に保つ | 実効性のない | 小さな割合の | 恥ずかしい | めずらしい |
| 5 | protein | たんぱく質 | 脂肪 | 生物学的薬剤 | 繊維 | 炭水化物 | 切断 |
| 6 | data | 事実情報 | あいまいさ | 依頼 | 過失 | 感情 | 矛盾 |
| 7 | concentrate | 集中させる | 省略する | 手で軽く引く | 統制する | 回り道をする | 弱める |
| 8 | inhibit | 抑制する | 影響を与える | 運ぶ | 引き伸ばす | 勇気づける | 影響を与える |
| 9 | method | 方法 | 差異 | 現実 | 不変性 | 材料 | 浪費 |
| 10 | expose | さらす | 範囲に含む | 変化させる | 断る | 立案する | 高く上げる |
| 11 | induce | 誘発する | 散らばる | 引き止める | なだめる | 紹介する | 沈む |
| 12 | dose | 服用量 | 集積 | 防御 | 免疫付与 | 疾病 | 分泌 |
| 13 | patients | 病人，患者 | 内科医 | 実習 | 中庭 | 悲観論者 | 手術 |
| 14 | compound | 化合物 | 不可欠な構成要素 | 分析 | 分裂 | （受精卵の）卵割 | 打撲 |
| 15 | process | 過程 | 混乱状態 | 実体 | 自制 | 倦怠感 | 反転 |
| 16 | release | 解き放つ | 待たせる | しっかりと固定する | 集まる | 作業に使う | 浮遊させる |
| 17 | acid | 酸 | 不足 | 真正であること | 種類 | 合致 | 窒息 |
| 18 | molecule | 分子 | 完全な形 | 量 | 集合 | 体積 | 光 |
| 19 | function | 機能 | 非現実性 | 失敗 | 刺激 | 退院 | 余暇 |
| 20 | obtain | 獲得する | 犠牲にする | 一時的に停止する | 回復する | 奮闘する | 運ぶ |
| 21 | tissue | （細胞の）組織 | 安静 | 無能力 | 体の細さ | 境界 | 資源 |
| 22 | response | 反応 | 共感 | 質問 | 原因 | 無感覚 | 非生産性 |
| 23 | previous | 以前の | 続いて起こる | 最新の | 便利な | （成長などが）遅い | 不確実な |
| 24 | species | 種（しゅ） | 総計 | 出発 | 過度 | 個性 | 死ぬ運命 |
| 25 | formula | 化学式 | 移行 | 不規則性 | あいまいさ | 構成要素 | 外面 |
| 26 | interact | 相互に作用する | 断絶する | 凝縮する | 同意する | 縮む | 洗浄する |
| 27 | factor | 因子 | 例外 | 総額 | 心 | 混合物 | 顧客 |
| 28 | structure | 構造 | 少量 | 言語 | つじつまの合わないこと | 目的 | 本質 |
| 29 | potential | 潜在的な | 疑わしい | 不合理な | 無関心な | 熟した | 合法的な |
| 30 | similar | 似ている | 対照的な | 遠距離の | 独立した | 正確な | 反抗的な |
| 31 | receptor | 受容器官 | 抗原 | 濃度 | 神経伝達物質 | 実験 | 混合物 |
| 32 | assay | 検定する | 放棄する | 提出する | 合成して作る | 休息する | 鈍感になる |
| 33 | administer | 投与する | 従う | 撤回する | 加速する | 和らげる | 乱用する |
| 34 | gene | 遺伝子 | 排出 | 種子 | 腐敗 | 結果 | （炎症などの）消散 |
| 35 | react | 反応する | ためらう | 頼む | 免除する | 停滞する | 直面する |
| 36 | role | 役割 | 無知 | 楽しんでいる状態 | 一定の基準 | 熱心 | 概観 |
| 37 | activate | …を活性化する | 中和する | 停止する | 魅了する | 結論を出す | 排出する |
| 38 | range | 範囲 | 不幸 | 特異性 | 無限 | 安定 | 見積もり |
| 39 | tumor | 腫瘍 | 減少 | 優位 | 立方体 | 均衡 | 同種性 |
| 40 | involve | 巻き込む | 退屈させる | 賞賛する | すばやくかき混ぜる | 軽減する | （機能などを）高める |
| 41 | chemical | 化学薬品 | 臓器 | 上昇 | 反対 | 有利な立場 | 散乱物 |
| 42 | phase | 局面 | 集まり | ゼロ | 後部 | 継続 | 恩恵 |
| 43 | complex | 複雑な | 別々の | 期待どおりの | ～の傾向がある | 熱っぽい | 苦痛のない |
| 44 | parameter | 母数 | 羞恥心 | 傷跡 | 実態 | 愛着 | 絶対的原理 |
| 45 | demonstrate | 明確に示す | 隠す | 埋める | 観察する | 否定する | 持続させる |
| 46 | medium | 中間 | 底 | 記録 | 明るさ | 一般の人 | 補助装置 |
| 47 | inject | 注射する | 引き算をする | 侮辱する | 契約する | 縮小する | 感染する |
| 48 | stress | 重圧 | 回復 | 睡眠不足 | 周辺部 | 定数 | 軽減 |
| 49 | pharmacist | 薬剤師 | 薬理学 | 障害物 | 検査助手 | 構成 | 局面 |
| 50 | ingredients | 成分 | 災害 | 集合体 | 統治 | 研究課題 | 組織化 |
| 51 | inhaler | 吸入器 | 小室 | 過失 | 操縦者 | 粉薬 | 居住者 |
| 52 | prescribe | 処方する | 署名する | 換気する | 検算する | 隠す | 音を弱める |
| 53 | expiry | 呼気 | 開始 | 創造 | 真相 | 成果 | 非存在 |
| 54 | pregnant | 妊娠した | 率直な | 現代的な | 人工の | 多義の | 痛みを伴う |
| 55 | disorders | 不調 | 計画立案 | 了解事項 | 開花 | 機械設備 | 静穏 |
| 56 | anaemia | 貧血 | 激怒 | 細菌 | 用法指示 | 保存 | 集団 |
| 57 | renal | 腎臓の | 溶液の | 不活性の | 再生の | 中性の | 熱による |
| 58 | subcutaneous | 皮下の | 遮断された | 興奮気味の | シリンダー状の | 観測可能な | 危険を伴う |
| 59 | impairment | 機能障害 | 増進効果 | 浄化 | 潜在能力 | 慈善 | 経過 |
| 60 | excipients | 添加剤 | 交換 | 切除 | たっぷりあること | 沈殿物 | 付着 |
| 61 | hypoglycaemia | 低血糖 | 学究的環境 | 垂直面 | 検査員 | 生体構造 | 不規則性 |
| 62 | incidence | 発生 | 証拠 | 相談 | 参考資料 | 残留感覚 | 自制 |
| 63 | chemotherapy | 化学療法 | 隠蔽擬態 | 矛盾 | 補助 | 遺伝治療 | 依存症 |
| 64 | dialysis | 透析 | 性癖 | 結合 | 連動制御 | 合成 | 放出 |
| 65 | adverse | 有害な | 対応している | 意識のある | 眼科の | 激しい | 感染力のある |
| 66 | ethics | 倫理 | 破損 | 肉体的適応 | 横たわること | 画像 | 素材 |
| 67 | orphan | 孤児 | 作用 | 限度 | 許容 | 仮定 | 便通 |
| 68 | protocol | 実施要綱 | 不品行 | 論争 | 展開 | 変質 | 噴霧 |
| 69 | classification | 分類 | 測定 | 汚染 | よく考えること | 生気 | 解釈 |
| 70 | designated | 指定された | 高く評価された | 動機づけられた | 混合法の | 禁止された | 熱性の |
| 71 | criteria | 基準 | 内部 | 認可 | 封入物 | 数十年 | 大嫌いなもの |
| 72 | scope | 範囲 | 興奮剤 | 外被 | 顕微鏡 | 病原菌 | 無数 |
| 73 | bioequivalence | 生物学的同等性 | 信頼性 | 仮説 | 持続可能性 | 生分解性化合物 | 沈着 |
| 74 | contraception | 避妊 | 胎児 | 種子 | 生殖 | 推論 | 比較 |
| 75 | extractive | 抽出できる | 初歩の | 資本の | 飼育下の | 静観的な | 合法の |
| 76 | radiopharmaceutical | 放射性医薬品の | 仮想症例の | 向精神薬の | 栄養価のある薬の | 電解加工用の | 麻酔学の |
| 77 | investigator | 治験責任医師 | 防御 | 実験参加者 | 酔っていない人 | 被害者 | 騒々しい声 |
| 78 | homeopathic | 同毒療法の | 民主的な | 社交的な | 自動的な | 判読しづらい | 自然主義の |
| 79 | somatic | 身体の | 実用的な | 静的な | 気体の | 心的外傷の | 分類に基づいた |
| 80 | immunological | 免疫学的な | 理論に基づいた | 時代遅れの | アレルギーに関する | 心臓医の | 老年学の |
| 81 | ongoing | 進行中の | 慈善の | 電気の | 新生の | すすり泣くような | 窒息しそうな |
| 82 | bearing | 姿勢 | 的外れであること | 慎重 | 結合 | 欠如 | 空腹 |
| 83 | childbearing | 出産 | 家系などの断絶 | 力学 | 死産 | 一致点 | 小児用安全容器 |
| 84 | indication | 指示 | 申請 | 伝染 | 傾き | うまい思いつき | 専念 |
| 85 | pediatric | 小児科の | 動態の | 伸縮自在の | 具体的な | 神経過敏な | 自己中心の |
| 86 | placebo | 偽薬 | 治療法 | アミノ基 | 中性微子 | 禁止 | 過多 |
| 87 | organisms | 有機体 | 批評 | 精神的外傷 | 同性愛 | 声帯 | 尊厳死 |
| 88 | membrane | 薄膜 | 人道的配慮 | 極度 | 骨髄 | 捕捉剤 | 背骨 |
| 89 | synthesis | 統合 | 因果応報 | 適応 | 軽量 | 実習生 | 要約 |
| 90 | stimulation | 刺激 | 等量 | 推定 | 変更 | 診察 | 薬物治療 |
| 91 | sympathetic | 共感した | 電気の | 臓器の | 疑わしい | 慈善の | 鎮痛性の |
| 92 | anesthetic | 麻酔の | 多産の | 補償外の | 点滴の | 空気の作用による | 本来備わっている |
| 93 | neurons | 神経細胞 | 角 | 予期 | 中断 | ミリミクロン | 混乱 |
| 94 | secretion | 分泌 | 矯正具 | 固形体 | 成り行き | 抑制 | 合併 |
| 95 | enzyme | 酵素 | 落ち着き | 機械故障 | 付け足すこと | 糖複合体 | 塗布液 |
| 96 | excretion | 排泄物 | 付着 | 吸収作用 | 補修管理 | 投与 | 憂うつ |
| 97 | ventricular | 心室の | 循環性の | 分子の | 伝統医療の | 誤った | 習熟した |
| 98 | toxic | 毒性の | 透き通った | 伸縮自在の | 生命の | 解剖学の | 塞栓症の |
| 99 | metabolize | 新陳代謝させる | 形を与える | 中和させる | 批判する | 苦悩する | 視覚化する |
| 100 | blockade | 遮断 | 次々に起きる化学反応 | まん延 | 混合液 | 軽量 | くぼみ |