



Japanese industrial technical terms: Word formation, word type and word pedagogical applications

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Abstract

In Thailand, Japanese learners need to attend trainings or internships at respectable Japanese companies. Previous research has found problems with comprehension of technical terms, but there are no studies on how technical terms can confuse learners or pose difficulties for them. Therefore, this study aimed to analyze word formation and word types of Japanese technical terms in industries, simplifying what makes technical terms difficult for learners in terms of their morphological knowledge, and offering a way to teach these terms and also enhance learners' understanding of them based upon morphological knowledge. The results have shown that regarding Japanese technical terms, Sino-Japanese or Kango were found most often when compared to other word types, such as hybrids, loanwords, or native words. In regards to word formation, compounding is the most common. The difficulties of technical terms could be divided into four types: unfamiliarity with Kango, changing forms into hybrids, the different meanings of loanwords, and a lack of knowledge of the intra-structure of compounds, affixes, and clippings. The test of morphological knowledge by the University of Washington was adapted into learning drills to enhance the knowledge of word types and word formation.

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Introduction

Why Study About Technical Terms?

In Thailand, job training or internship at the workplace is one requirement for final-year students. Many Japanese as foreign language learners (JFL) decide to take their job training at plants in industrial estates located around Thailand. One problem with language usage is the use of

technical terms in the workplace (Juntaro & Sontirak, 2020). In general, many educational institutions focus on general Japanese communication, so the vocabulary offered tends to be made up of general words rather than technical terms. Furthermore, some vocabulary and grammatical patterns found in basic Japanese learning tend to be different from the real-world usage and tend not to be updated because textbooks are published once, and a long time is needed for revision (Suzuki, 2010), whereas nowadays vocabulary and grammatical patterns in authentic situations tend to be chosen for responding to learner's needs (Kano, 2000).

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Even though there are problems with a lack of knowledge of technical terms used in an authentic situation, such as in Japanese industry, there are very few previous studies that systematically investigate Japanese technical terms. According to Sano (2021) most of the research on Japanese for Occupational Purposes (JOP) focusses on three fields, tourism, elderly care, and business, while research in other fields has not progressed substantially. There is some research on Japanese industrial technical terms. Sano (2020; 2021) studied the efficiency of Kanji vocabulary learning and which Kanji words should be given priority to learn in the field of auto mechanics. In another study, Shimizu (2018) extracted affixes and derived words from the written test for second-class automobile mechanics, studying the amount and classifying the meanings and functions of affixes. These works tried to specify what technical terms and which of their affixes should be studied, while the present study tries to study the type, formation, and difficulty of technical terms.

The Importance of Morphological Knowledge

According to studies on vocabulary knowledge that learners should comprehend, morphological knowledge including word formation and word types is one crucial part of vocabulary learning. However, word formation teaching is often avoided in language course books and there is little research conducted about the pedagogical status of word-building processes (Enesi, 2017). Nevertheless, many pieces of research strongly identify the significance of word formation knowledge as an integral part of language fluency (Haastруп & Hemriksen, 2000; Nagy, 1997; Nassaji, 2004). Qian (2002) indicates that the morphological features relate to word formation such as affixes. Kieffer and Lesaux (2008) offer evidence that morphological awareness might have some influence over reading comprehension among native English speakers, so it becomes significant to examine reading comprehension difficulties. According to Muse (2005), readers can predict 60 percent of new words' meanings by using the basic component morphemes as a clue.

Morphological knowledge, especially in aspects of bases and affixes is a significant part of vocabulary knowledge. When English learners encounter new words formed from known word parts, they can comprehend all or some meanings of the words (Li & Kirby, 2015). Ma and Lin (2015) surveyed the relationships of four subcomponents of the depth of vocabulary knowledge including morphological knowledge and summarized that morphological knowledge is significantly related to reading comprehension. Nation (2001) states about

morphological knowledge, that knowledge of affixes and roots has two advantages for English learners. One is that it helps with learning unfamiliar words by relating them to known prefixes and suffixes, and the other is the confirmation of whether unfamiliar words can be guessed from contexts.

As seen above, the relevance of morphological knowledge on language learning, especially on reading comprehension, has been discussed in many studies as mentioned by Kieffer and Lesaux (2008); Li and Kirby (2015); Nagy et al. (2006); and Ma and Lin (2015), all whom reported a reasonable relationship between morphological knowledge and reading comprehension. It is believed that knowledge of morphology can contribute to learners' ability to parse the intra-structure of words and to comprehend words' meanings. The importance of morphological knowledge in Japanese can be seen in Sagara et al. (2020), who synthesized compounds in medical records into word construction elements for application to medical education and language research. In Uchiyama et al. (2018) also emphasized that if word constituents are determined and their meanings are understood, then this connects to the comprehension of technical terms, such as compounds and nonce words. Therefore, the implication of morphological knowledge, including word formation and word types for technical term analysis could be useful for enhancing technical term learning and also reading comprehension.

How to Teach Technical Words?

Regarding technical term education, Nation (2001) offered two ways for how teachers can teach about technical terms. Technical terms should be treated as high-frequency vocabulary if technical vocabulary is also high-frequency vocabulary. The connections and the differences between the high-frequency meanings and technical uses should be given to distinguish these two-word types. Another is teaching technical vocabulary with specialist knowledge of the field because many technical terms will only make sense in the context of the specialized subject matter. Mori (2014) also offered context-based strategies for learning new words in a meaningful context that were more effective than learning words in isolation. Furthermore, Quackenbush (1977) remarked that devising more systematic methods was needed to present loanwords, one of the word types, to students. Some basic understanding of the nature of borrowing should be given to students and exercises in rewriting English. Therefore, technical term teaching should be designed with real-world usage contexts, and

morphological knowledge should be applied to technical term explanation to enhance learners' deep understanding of words.

Word Formation

In Japanese, according to Ootsu et al. (2002), the process of word formation is divided into compounding (e.g., *senmongakkō* (vocational school)) and derivation (e.g., *omosa* (weight)). Besides compounding and derivation, clipping and borrowing are also key processes for forming new words (Kenworthy, 1991). Clipping is when an existing word that is clipped becomes a new, shorter word, typically by discarding some parts of the existing words without losing its meanings. According to Kubosono (2010), clipping in compounds tends to have two styles: the latter word is removed such as *keitaidenwa* (mobile phone) that is shortened to *keitai* or the first syllable of each word is preserved, such as *Tokyodaigaku* (Tokyo University) is shortened to *Tōdai*. Borrowing is one of the word formation processes found in every language. Loanwords are the output of the borrowing process, and include words such as *rokkudaun* (lockdown), *konpyūtā* (computer).

Japanese Lexical Categories

In Japanese, there are four sub-groupings of lexical categories or word types: native Japanese such as *neko* (cat), Sino-Japanese or Kango borrowed from Chinese such as *gengo* (language), loanwords (not including Sino-Japanese) such as *shisutemu* (system), and hybrid words (*konshugo*) which combine more than two types of lexical categories, such as *kōhī-mame* (Coffee bean). Kango is found mostly in Japanese dictionaries, lexical surveys, and modern Japanese magazines (Nomura, 1999, Yamasaki & Konuma, 2004) and is used in more than 70 percent of technical terms (Matsushita, 2018). Kango education, including word formation and word types, has become more extremely essential because it decreases the lexical gap between school education and authentic situations. Matsushita (2018) and Yamashita (2014) also indicate the

importance of Kango functioning as an affix that can decrease the burden on learners of remembering words.

The objectives of this study are to explore word formation and word types of Japanese technical terms in industries, to clarify what makes technical terms difficult for learners in the aspect of morphological knowledge and to offer a way to teach technical terms and enhance learners' understanding of Japanese technical terms based on morphological knowledge.

Research Questions

1. What is the proportion of word formation and word types between native Japanese words, Sino-Japanese words, loanwords, and combinations of them or hybrids?
2. From the aspect of morphological knowledges, what makes learning technical terms more difficult for learners?
3. What are the drills of a technical term can be applied for the preparation course of internship students?

Methodology

1. Technical terms were collected from authentic materials, as shown [Table 1](#).

All data from all authentic materials which could be collected were used as analysis data. The reasons for selection of authentic materials are based on Kano (2000) and Suzuki (2010), who explain that there are gaps between textbooks and real-world usages. In addition, some language usage phenomena, such as clipping, are seen less frequently in textbooks or books.

2. Word types and word formation were analyzed and grouped into categories. Including native Japanese, Sino-Japanese, loanwords, hybrids, single words, compound words, derived words, and clippings. In the case of word types, the menu "goshu (word types)" in the online data retrieval engine *Chūnagon* (which can search various corpora) was used as a tool for judgement. In the case of word formation, Kenworthy (1991), Kubosono (2010), and Ootsu et al. (2002) were used as main criteria for analysis.

Table 1 Detail of Sources and Number of Token Words

Anonymous Name of Factory : Produce	No. of Token words
A : Production of motorcycles (from 10 groups of work: mole, press, problem, monetary account, ISO, environment, tool&equipment, accident, product innovation, PC (production control))	3,600
B : Electronic and mechatronic products	52
C : Automotive critical safety parts	93
D : Chain of motorcycle manufacturing and the chain of the automotive industry	947
Total	4,692

Results and Discussion

To answer the first research question, Figure 1 shows the proportion of word formation and word types.

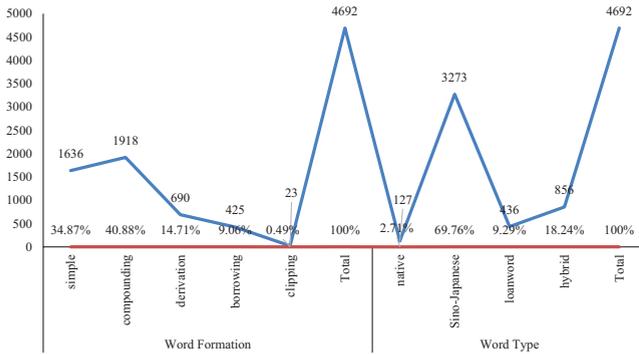


Figure 1 The Proportion of Word Formation and Word Type

As seen in Figure 1, technical terms found from various industries totaled 4,692 words as the word tokens. In the case of word formation, compounding is the most frequent at 40.88 percent. The second is simple words (or *Tanjungo*, which are the outcome of the process of word formation that has only one free word as cited in Kokuritsukokugokenkyūsho (1985, p. 8) at 34.87 percent. The third is derivation at 14.71 percent, and fourth is borrowing at 9.06 percent, and finally, clippings at 0.49 percent. For the aspect of word types, Sino-Japanese or *Kango* is the most at 69.76 percent hybrids (18.24%), loanwords (9.29%), and native words (2.71%), respectively.

To answer the second research question, the discussion provided is based on the morphological aspects and the gap between school education and real-world usage.

Unfamiliarity with Sino-Japanese Words or *Kango*

The proportion of lexical category is not different from previous studies (Matsushita, 2018; Nomura, 1999; Yamasaki & Konuma, 2004), which indicated a high frequency in the use of *Kango* in general and specific Japanese, including intermediate and advanced Japanese. In this study, *Kango* was the most common, and some were rarely found in everyday learning, for example, *chinden* (precipitation), *rōden* (electrical fault), and *kakuhan* (mixing).

Most of the words found in the industry are technical terms that learners are unfamiliar with, for example, *muda* (wasteful), *mura* (nonuniformity), and *muri* (impossible). Though learners have the opportunity to

learn and use *muda* for meaning wasteful, and *muri* for meaning impossible, they have little or no chance to encounter *mura* in their study. Some words can have more than one meaning; for example, *bakaana* means unloaded hole when the word *baka* in *bakaana* does not mean stupid or dull. *Baka* in the word *bakaana* comes from the sentence *ana ga baka ni naru*, which workers use daily at work in the shortened form. This case is also found in the word *bakaneji* with the meaning stripped screw condition that comes from the sentence *neji ga baka ni niru*.

Some Kanji have different pronunciations and different meanings, though they have the same structure. For example, Kanji 縁 can be read as *en* (meaning fate) or *fuchi* (meaning edge). In general, the collocation *en o kiru* (break off the relationship) or the compound *enkiri* is the word with which learners are acquainted, but in the industry, the same collocation has a different pronunciation *fuchi o kiru* or the same compound *fuchigiri*, which has a different pronunciation and meaning, which is cutting edge. Some words are used to refer to concrete objects or machines such as *kata*, which means die (a tool in metal-making). In basic Japanese, learners learn only the abstract meanings of *kata*, *type*, and *model*. *Kata* is shortened from *kanagata* (die) and has the potential for making new words in the industry such as *anaakegata* (hole piercing die), *uchinukigata* (blinking die), and *oshidashikata* (pushing outside die). This fact is related to Matsushita (2017), who states that in the case of technical terms, the meanings as defined in a dictionary are not enough for complete understanding and background knowledge in the fields is also required.

Furthermore, a common word such as *furyō*, meanings bad, inferior, or wicked, can be found in textbooks like *furyōgakusei* (a bad student), and also has the potential to create new words in the industry such as *sunpōfuryō* (dimension NG), *seikeifuryō* (injection NG), *sōsafuryō* (control NG), and *tosōfuryō* (spray NG). Many words have the same meanings which can increase the burden on learners to remember. For example, the words *mating part*, *counterpart component*, and *common part* refer to the same things which are *aitebuhin*, *kyōtsūbuhin*, and *kyōyōbuhin*.

In conclusion, the irregularity of Kanji and words, the variety of word meanings, and the potential of words may contribute to increased difficulty for learners' comprehension.

The Changing Form in Hybrid Words

Hybrid words are forms structured with a mixture of native Japanese, Sino-Japanese and loanwords. The difficulty of hybrid words is that their forms tend to be shorter than the former. Some hybrid words are Japanese

words (waseigo: a foreign lexeme invented in Japanese (Miller, 1998)), especially in the case of the compound form of loanwords with native Japanese or Sino-Japanese forming. Some examples are given below.

Fukaōbā (overload) is a hybrid of Sino-Japanese, fuka and a shortened loanword, ōbā deriving from ōbārōdo (overload). This word in Japanese is kafuka, which has the same meaning: overload.

Sukimagēji (feeler gauge), is a hybrid of native Japanese, sukima and a loanword, geiji (gauge). This word is a Japanized compound because the original word in English is feeler gauge.

Learners who are majoring in technological fields may learn the word feeler gauge or overload in its original English form, but when it is used in Japanese, it has a transformation of form as Japanized words. The amount of Japanized words that are found in hybrid forms between Japanese and loanwords is quite high, and include daburushigoto (double work), kūkiponpu (air pump), āsu-suru (or setchisuru-earth), kyūmeibui (rescue buoy), kensetsusaito (construction site), jokyoburashi (eliminating brush), bōjinmasuku (dust protective mask), and bakkuappudengen (back-up power supply).

The shortened forms, Japanese style usage, and Japanized words as seen above are also obstacles to learning and usage. Many loanwords have morphed into Japanese words such as the word double work changing into daburushigoto, or air pump changing into kūkiponpu. This complexity makes technical term comprehension more difficult to remember and increasingly burdensome to use.

The Different Meanings of Loanwords used in Industry

Loanwords are words borrowed from English or other languages, except for Chinese. Normally they should retain most of their original forms and meanings, even after they have become part of the Japanese lexicon written in the Katakana syllabary. Writing in Katakana syllabary often causes a change of pronunciation and sometimes a change in semantic and grammatical features (Quackenbush, 1977). Takashi (1990) identified five functional types of loanwords: (1) lexical-gap fillers; (2) technical terms; (3) euphemisms; (4) special-effects-givers; and (5) trade names. The reasons for using technical terms are usually the shortage of native equivalents, and technical terms are more specialized than lexical-gap fillers.

The difficulty of learning loanwords has been explored in many aspects. Quackenbush (1977) indicated the reason loanwords are difficult for English-speaking

students include the non-uniformity of adaptation to Japanese, phonological changes of loanwords, production in deduction form, and recognition from the original English form. Sometimes loanwords' pronunciation is distorted or shortened (Yano, 2001), and they change or lack original meanings (Tanaka & Tanaka, 1995).

Loanwords in industry are more difficult than those in other fields because of the unfamiliarity as mentioned above. Most of them in original English forms are not found in the daily life lexicon, such as The New General Service List (NGSL) (Browne et al., 2013). There are only 20 words found in NGSL from the overall 436 loanwords based on Figure 1: *alcohol, hook, tank, coin, service, dust, paint, oil, pan, gear, brake, supple, wrap, motor, chip, error, size, budget, gap, and staff*. These words should not create any problems for learners because they are often found in general learning and daily usage, while the remaining (loanwords (416)) are not found in the NGSL.

Furthermore, there are 21 words categorized as being part of the Academic Word Lists or AWL (Coxhead, 1998): *design, conduct, commission, credit, computer, initial, cycle, error, job, project, capacity, tape, transform, aid, convert, couple, equip, infrastructure, offset, random, and manual*. Some loanwords tend to make problems for learners, for example, the word capacity can be translated as nōryoku. Then, it confuses learners as to when the loanword capacity needs to be used or when the Japanese word nōryoku should be used. The remaining 395 words are all technical terms that learners may have never seen before because they are outside of the scope of the NGSL and the AWL.

Moreover, industry vocabulary words can have more than one meaning. This affects learners' understanding though the words have been learned before, for example, couple. It means coupler or coupling (two or a few things that are similar or the same, or two or a few people who are in some way connected). This meaning was learned by learners before. In some industry fields, it is used to indicate equipment like renketsuki (coupler). Polysemous words are also problematic. For example, earth which means setchi, or ground in English, and also ground wire as in a piece of equipment. However, in industry, the word earth or the Japanese pronunciation āsu indicates earth wire or ground wire that differ from ground. A belt means a strip of leather or other material worn around the waist or across the chest, but it has another meaning which is a continuous band of material used in machinery for transferring motion from one wheel to another. The latter is used in industry, and it is hardly found in daily life. It could be concluded that,

unlike other types of loanwords, those used as technical terms may cause various problems. It is not only pronunciation and uncertain transliteration but also complicated meanings that are found in specific industrial contexts.

Lack of Knowledges

Knowledge of the intra-structure of compounds

According to Hisamitsu and Nitta (2003), Japanese compound nouns are especially useful because they convey a lot of information in a compact expression, especially in a newspaper. The capacity of expressing a lot of information in a compact expression is a ubiquitous characteristic that could be implied to compounds in industry, as well.

Several compound nouns in industry often form two nouns, for example, gasuseikei (gas injection), kisoboruto (lockbolt), and sagyōtejun (operational procedure). According to Kageyama (2001) compound nouns can be divided into eight groups (NN, AdvN, AN, VN, NV, NA, AdvV, and AA). Most of the compound nouns found in the present study are of the NN structure. 1,496 words have the structure of NN compounds. This contributes to 78 percent of 1,918 words, especially compound nouns such as two nouns forming together (e.g., aitebuhin (mating part) and gasuseikei (gas injection)). Other groups have much fewer; therefore, discussion about them may not be as necessary. The main difficulty lies in the intra-structures of the NN compounds, which Sano (2021) also indicated automobile mechanic students lacked knowledge on how to divide compounds to the bases and affixes for meaning understanding. The intra-structures have four main types as referred to in Kobayashi et al. (1995). The examples of each type were given by the author.

1. A complement relation, such as seihintenji (showing the product). The initial noun is a complement (an objective) of a latter verbal noun, as in the sentence *seihin o tenji suru*.

2. An adverbial relation, such as rinjihatchū (urgent/special order). The initial noun is an adverb of a latter verbal noun, as in the sentence *rinji ni hatchū suru*.

3. An adjectival relation, such as seikeijōken (injection condition). The initial noun is a modifier of a latter noun, as in the phrase *seikei no jōken*.

4. A parallel relation; two independent constituents can be connected by *to* in Japanese such as *jiyūjizai* (free), which can be separated by *to* as in, *jiyū to jizai*. They can stand together equally.

In general, Japanese structures, especially intra-

structures of compounds are not deeply taught because of their complexity and are not essential. Therefore, when learners encounter compounds, they tend to guess the meaning of each word without the knowledge of intra-structure relations that affect meaning translation.

Knowledge of affixes

Affixes are a significant part of derived words. They function to decide the part of speech of words and add meanings to the bases. According to Mori (2014), knowledge of semantic components enables students to make educated guesses when they encounter unfamiliar words. In this section, the types of prefixes and suffixes found in industrial technical terms and their coverage rate found in Japanese textbooks are discussed as *the degree of intimacy (the closeness between learners and affixes)*. All derived words shown in Figure 1 includes 690 words or 14.71 percent of the target words. There are 37 derived words made up of 24 prefixes and 653 derived words made up of 88 suffixes. Derived words with suffixes are used more than those with prefixes.

The degree of intimacy is shown in the coverage ratio of affixes in textbooks per affixes found in industry. Six Japanese textbooks of the Minna no Nihongo series (4 upper-beginner levels, one intermediate level, and one upper intermediate level) were selected as sources for studying the degree of intimacy of affixes as seen in Figure 2.

Figure 2 shows that the coverage ratio of prefixes in textbooks is 33.3 percent or 8 of 24 prefixes in industrial technical terms. It means that learners have the experience to study derived words with only 8 prefixes even though in real-world usage 24 prefixes are used in industry vocabulary. The coverage ratio of suffixes in textbooks is 45.5 percent or 40 of 88 suffixes. This means that learners

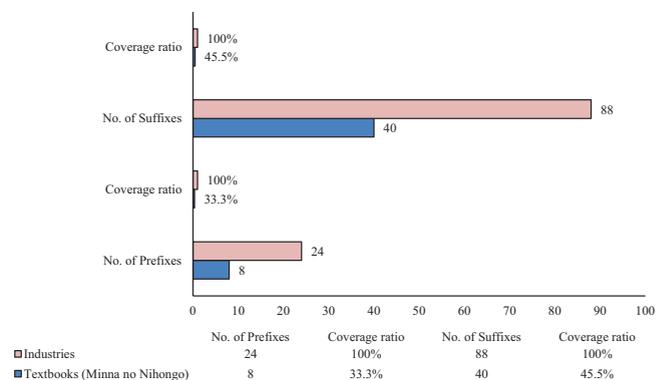


Figure 2 The Degree of Intimacy showing by Coverage Ratio of Prefixes and Suffixes

only get to experience 40 prefixes for derived words when studying, while in the industry 88 suffixes are used for derived words. Some prefixes and suffixes that are not found in textbooks are shown below.

Prefixes: jun-(pure), kei-(light), ta-(much), chō-(super)

Suffixes: -zai (material, wood), -butsu (thing, object), -zu (diagram, figure), -kan (tube, pipe), -yu (grease; oil), -ten (spot, dot, point), -ro (oven, furnace)

As seen above, the coverage ratio of affixes is not high when compared to what is used in the industry. Certainly, the essential affixes especially suffixes, were not fully covered. Learners had little chance to experience and absorb only some affix knowledge unintentionally. The knowledge gap for affixes is wide, so it could be concluded that learners may not understand the meanings of derived words found in industry field.

Knowledge of clipping

Clipping is the process of word formation that makes words shorter by discarding some parts of the word while still retaining its meaning. Clipped words such as paasokon (personal computer) and pokemon (pocket monster) are known by learners, but in textbooks such as Minna no Nihongo series, there is no explanation of how these words form. In industrial technical terms, only 23 clipped words or 0.49 percent, are found. They are found in both single words and compound words. The following examples are taken from industrial technical terms.

Single words (1) Terebi clipped from terebishon (television)

Compound words (2) Haizai clipped form haikizairyō (waste materials)

The clipped words in (1) and (2) exemplify the output of full words found in the industry, while most of the industrial clipped words, 21, are from compounds. In the form of compounds, the affixes retained in their outputs are outstanding as seen from (3) to (8).

(3) Chihōkōkyōdantai: The clipped form is chikōtai (local public entity).

(4) Shikyūbuhin: The clipped form is shikyūhin (supplied part).

(5) Gaichūbuhin: The clipped form is gaichūhin (subcontract goods).

(6) Genchichōtatsuka: The clipped form is genchika (increase local procurement).

(7) Saikeisan: The clipped form is saikei (recalculate).

(8) Yokotenkai: The clipped form is yokoten (horizontal expansion).

Suffixes, -tai, -hin, -ka, and prefixes, sai-, yoko- are part of the words retained for keeping morphemic

boundaries as mentioned in Daniel (2018). This type of clipping is hardly found in general Japanese, so being able to guess the meanings becomes more difficult. It can be said that the difficulty of clipped words is not only the phonological unpredictability of the original forms but also that various patterns of clipping include omitting the end of the word (back-clipping), the first part of the word (fore-clipping), the middle part of the word (mid-clipping), or the beginning and the end of the word (edge-clipping). Furthermore, the retention of affixes as seen from (3)–(8) makes it more difficult for learners who are inexperienced about word clipping and affixes.

Technical term education

Theoretical Implications: First, the finding of the present study showed that Kango accounted for the largest proportion (69.76%) of all word types. Next were hybrid words and loanwords. As a result, learners need to strive to remember Kango words, hybrids, and loanwords to succeed in comprehending in a technical context.

Among the five subtypes of word formation, compounding was found to have the highest proportion in industrial words. Next were simple words, which is not surprising because single words are the basic constituents of communication. The third highest proportion was derived words. This re-confirmed that affixes are important parts of words that learners should acquire as asserted by many researchers (Li & Kirby, 2015; Ma & Lin, 2015; Nation, 2001), who indicate that morphological knowledge, especially affixes and their roots, is an important contributor for language comprehension. Furthermore, the recognition of how these industrial words are formed may not always be very easy in a language such as Japanese, given the fact that by forming new words, several unknown and unpredictable changes might emerge during or after the new formation, regarding output forms in clipped words, meaning relation in compounds, meaning changes in loanwords, and unfamiliar words. All these factors increase the difficulty of comprehension for the learner.

Finally, the results of the current study also shed some light on vocabulary knowledge. It could be said that all types of words, general, academic, and technical words require knowledge of morphology as a theory to analyze and imply to class teachings.

Practical Implications: Some pedagogical implications can also be discussed from the results of the present study in terms of technical terms. As the current study shows, there are gaps between lexical knowledge in school education and real-world usage. The suggestion in this section is to design an overall curriculum based upon

technical terms systematically. According to Matthews (1974), the overall curriculum is lacking in vocabulary, and most ESL/EFL textbooks do not systematically deal with vocabulary.

Not only ESL/EFL textbooks, but many textbooks in Japanese education including *Minna no Nihongo*, also ignore vocabulary explanation by way of morphology or word-formation. No explanation is offered to learners to clarify for them that *shōene* (energy saving) found in *Minna no Nihongo Chūkyū* is formed by clipping the prefix *shō*, and the noun *ene* is the clipped form of the full noun *enerugii* (energy). As a result, learners usually come across all types of words such as derived words, *torihikisaki* (business partner), compounds, *shigotobeya* (workroom), or clipped words, *rimokon* (remote control) as single units without explanations or practice to enhance their awareness. Most words are derived or composed from words that can be broken down into smaller components that have their own functions and meanings and can create new words even though they will not appear in a dictionary.

For material design, vocabulary with special word formation needs to stand out to be seen easily and needs extra explanation about its word formation. If learners do understand well how words are formed by the process of word formation, they should be able to apply it to words they come across. Based on the result, the example of explanation on affixations with productivity found in the industry can be concretely given as follows:

First, we should offer general knowledge of morphology about the target words. Once we give the meaning of prefixes, *sō-* (total, whole) and their usage (to combine with nouns implying quantity, ratio, and percentage (not space or time)), then, we can display some combined words of *sō-* and its practices to learners. If this process is firmly established, the unfamiliar word that has *sō-* as a prefix could be guessed. This method is also offered by Nation (2001).

In the case of compounding that produces compounds, with NN, a high-frequently found structure, it is strongly recommended to make a clear explanation on intra-structure relations to clarify its meanings. It is highly unlikely that NN compounds can be found in an ordinary dictionary. The reason why compound nouns are the most frequently found maybe because they convey a lot of information in a compact form. According to Kudo (2007), Japanese compounds, although there are some exceptions, follow the Right Head Rule of Williams (1981, cited in Kudo, 2007). As a result, the meaning translation of compounds can start from the rightmost constituent to the left one. As mentioned above, NN

compounds have four main intra-structure relations. Their meanings can be translated from the right following the intra-structure relations: a complement relation, an adverbial relation, an adjectival relation, and a parallel relation.

For the application of NN compound knowledge to teaching, the Right Head Rule or the translation from the rightmost one and NN intra-structure relations are contributors for grasping the meanings of NN compound knowledge. The explanation should be conducted with NN compound examples from industrial word lists to make a solid understanding of the intra-structure of NN compounds used in industrial work.

In the case of clipping producing clipped words, the output patterns should be taught through the words which learners are acquainted with such as *pasokon* (personal computer), and *rimokon* (remote control), which are the clipped forms of two compound nouns, by coining the first two moras of each word. To give the output patterns of clipped words by categorizing them as single words, compound words, or word types is a way to enhance knowledge about clipping.

Moreover, the morphological knowledge of each word type should be described with the context using context-based strategies (Mori, 2014; Nation, 2001). Therefore, all technical terms found in this study should appear with other words relating to the industry and should be offered repeatedly at least six times for enhancing long-term memory (Nation, 2001).

Finally, the practices to develop morphological knowledge about technical terms can be applied from the test of morphological knowledge by the University of Washington Morphological Awareness Battery (1999). First, the derivational suffix choice test can be adapted to the practice of derived words as follows:

(9) The requirement of production of a derived word to finish a sentence:

The word is *jinkenhi* (labor cost). *Jūgyōin no jinken_____o herashitai.*

I would like to decrease the labor cost.

(10) The requirement of selecting the fit one of the sentences. The three or four options of different derivational prefixes or suffixes are offered as parts of sentences.

Three options of words: *hoshōkin* (security money), *hoshōnin* (guarantor), and *hoshōjō* (letter of guarantee) *Hitsuyōshorui o goannai no ue, sumiyakani _____ hakkō no tetsuzuki o itashimasu.*

We will give information about the necessary documents and then promptly process the letter of guarantee.

Second, the bee grass test of the University of Washington Morphological Awareness Battery (1999) is adapted as a practice for enhancing learners' comprehension of infra-structure relationships of compounds and the Right Head Rule. Here is an example: *Which is a better name for a bee that lives in the grass? A grass bee or a bee grass?* The adapted example for practicing technical terms, *kōtaikinmu* (*shift work*), starts with the question, *jikantai o kugitte, kōtai de kinmusuru toiu kotoba wa dore desuka* (Which is the word meaning to work in shifts by dividing the time zone?) *Kinmukōtai or kōtaikinmu?*

Conclusion and Recommendation

The present study investigated the difficulties of technical terms used in Japanese industries in detail from the viewpoint of morphological knowledge. The most frequently used word types were Kango, hybrid, and loanwords in order of frequency. Compounding was the main process for organizing word forms regarding Japanese technical terms followed by derivation, borrowing, and clipping. The results also showed the gap between school education and real-world usage. The drills modified from the test of morphological knowledge by the University of Washington were proposed to enhance learners' knowledge of technical terms. All investigated results can act as guidelines, not only for learners who plan to undertake their internship in industries, but also for general learners in Japanese classes. Nevertheless, the amount and balance of data from each source are limitations of this study.

Conflict of Interest

The author declares that there is no conflict of interest.

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