The Lexical Profile of Laboratory Animal Science Review Articles: The Uses of Collocations and Purposive Writing Patterns

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Abstract

The corpus studies of words and concordance lines in various fields were widely investigated, but there were few studies examined on the collocations and purposive sentences in the field of laboratory science. Such rare studies can make ESP learners, science and technology students in particular, more aware of the significance of learning collocations and language patterns for effective academic writing. Thus, the current study aims 1) to investigate the grammatical and lexical collocations occurring in the content words of the Outside Word List (OWL) and 2) to analyze the patterns used to state the purposes of the study in laboratory animal science review articles. There were 555,526 running words in the 100 research articles of the *Institute of Laboratory Animal Research (ILAR)* journal between 2010 and 2014. AntConc (3.4.4) was used to count word frequency and create a laboratory animal science wordlist. Then the concordance lines for the highest-frequency words were analyzed to find grammatical and lexical collocations and the purposive function. The data were analyzed and displayed as percentages and frequencies. The results showed that most lexical collocations appeared in the following four patterns: noun + noun (55.81%), noun + verb (17.83%), adjective + noun (14.15%), and verb + noun (7%). Grammatical collocations were found only in the pattern of noun + noun (4.26%). The results demonstrated that purposive sentences used a main verb with to-infinitive to express the objectives of the study. The implications of the study are beneficial for students and novice researchers in writing development and more contribute to teaching and learning pedagogy in ESP course design. The results are advisable for ESP teachers, especially teachers in English for Science and Technology and Academic Writing classes, to integrate a lesson concerning collocations and language patterns into their

courses in order to teach students how to write professionally in scholarly contexts.

Keywords: collocation, corpus-based study, laboratory animal, Outside Words List (OWL), purposive function,

1. Introduction

With the development of science and technology, English is accepted internationally as the medium language for publication in the majority of science and technology research journals (Belcher, Johns & Paltridge, 2011; Cosby, 1987; Ulrich, 1996; Wood, 2001). Also, the arrival of the information age and advances in science and technology have led to a greater demand for learning English for Specific Purposes (ESP), especially English for Science and Technology (EST) (Montgomery & Crystal, 2013; Trimble, 1985). For college students who want to read and write scientific papers or keep up on developments in scientific knowledge and other professional areas, EST is a vital key to achieve such goals. For this reason, it is undeniable that English for Science and Technology is a major driver in enhancing the language education at a tertiary level (Bhatia & Bremner, 2012).

1.1 Characteristics of scientific articles

Linguistic researchers have conducted a number of studies and found that a genre demonstrates that one scientific paper can be distinguished from others in light of organization (Swales, 2005; Trimble, 1985), rhetorical structures (Paltridge & Starfield, 2011; Soranastaporn, 2013; Swales & Feak, 2012), and vocabulary (Coxhead, 2000).

Organization

Swales (2005) proposed a model for experimental research articles that includes four main sections: introduction (I), methodology (M), results (R), and discussion (D). The introduction is the section that states writer's purposes or the objectives of the research and pays initially important role to the readers. He further explained the purposes of each section as in Table 1.1.

Table 1.1: IMRD sections and purposes

Sections	Purposes
Introduction:	to present the problems, significance, and purposes of the study.
Methodology:	to explain instruments and procedures used to conduct the study.
Results:	to present what was discovered.
Discussion:	to analyze the importance of results and implications.

Rhetorical structures

In a scientific writing genre, unique linguistic features such as rhetorical structures are used to achieve the communicative purpose. The sentence stating the purpose of the study, for example, is found in articles in all standard journals and its use is accepted by researchers in all disciplines (Swales & Feak, 2012). According to Swales and Feak (2012), purposive statements are obligatory in all research articles. There are two variants: Purposive (P) and Descriptive (D).

Purposive (P): *The author or authors indicate their main purpose or purposes.*
e.g. The aim of the present paper is to give …

Descriptive (D): *The author or authors describe the main feature of their research.*
e.g. This paper reports on the results obtained …

(Swales & Feak, 2012: 355)

In addition, the words used in both patterns of purposive statements carry a purposive meaning. Three explicit patterns (Soranastaporn, 2013; Tampanich & Soranasataporn, 2018) have been described as the examples below illustrate.

Pattern I: Presenting the purposes with the main verb in the active voice

DET.	Impersonal subjects		Main verb (V1 / will + V. inf.)			Phrase/ Clause
This The A	(present) review review article overview report	article essay text paper	provide(s) highlight(s) concentrate(s) on summarize(s) focus(es) on (briefly) discuss(es)	allow(s) purpose(s) review(s) present(s) address(es) outline(s)	explore(s) detail(s) illustrate(s) show(s) identify(ies) end(s)	Noun phrase / Noun clause
	study of … review of …					

Pattern II: Presenting the purpose by using words signaling the purposes and the to-infinitive

DET.	Subject (Words Signaling purposes)				Verb to be	to-infinitive (to + V1)				Noun phrase
The	objective (s) goal (s) (main) aim (s) purpose (s)	of	this the	article research review workshop (present) study	is (are) was (were)	to	describe present provide introduce give gain	use review identify design modify optimize	extend report investigate summarize discuss	Noun details of objective(s)
	objective (s) goal (s) purpose (s)									

Pattern III: Presenting the purposes with the main verb in the passive voice and to-infinitive

Subject	Main Verb (Passive voice)		To-infinitive (to + V1)	
	be	Past participle (V3)		
The (brief) overview of … This review / article A variety of procedure Several methods	is (are) was (were) will be can be	intended focused on meant	to	aid (briefly) describe provide

Vocabulary

To improve one's use of English in a specific discipline, vocabulary knowledge, especially the use of specialized words, is necessary for communication (Bromley, 2007) and the production of language output (Qian, 2005). A corpus is a collection of words that allows a researcher to find specific words and usages in a particular field (Nation, 2001). According to Nation (2001), there are three main groups of vocabulary in a text: high-frequency words, academic words, technical words. As West (1953) notes, high frequency words refer to the General Service List (GSL), which contains the 2,000 most frequent words. The academic word List (AWL) consists of the words that occur in a number of different academic disciplines. Technical words are the words used in one particular discipline, or the words that do not occur in the GSL or AWL. That is to say, technical words make up the outside words list (OWL). To illustrate more, the General Service List (GSL), the Academic Word List (AWL), and Outside Word List (OWL) are explained in detail below.

General Service List (GSL)

In order to find which English words were most frequently used, West (1953) created a list of the 2,000 most frequent words, and he called this list the GSL. The GSL includes both content words and function words and cover around 80% of running words in a text (Nation, 2001). Content words are words that contain lexical meaning. Content words include four parts of speech: nouns, verbs, adjectives, and adverbs (Nation, 2001). Fries (1952) claims that learning content words increases students' lexical knowledge, because content words contain the core meaning of a message. Consequently, this present study aims to study only content words.

Academic Word List (AWL)

The Academic Word List (AWL) was created and developed by Coxhead (2000). The AWL consists of academic words which do not generally occur except in a wide range of academic texts in different disciplines (Nation, 2001). Coxhead's AWL contains frequently appeared 570 words families and provides approximately 8 to 10% of text coverage in academic texts.

Outside Word List (OWL)

The Outside Word List (OWL) is a list of technical or specialized words that occur in particular disciplines (Nation, 2001). In other words, the OWL is the list of words that does not belong to the GSL or the AWL. The classification of OWL is based on the assumption on the boundary of GSL and AWL; therefore, the specialized vocabulary which occurs outside the GSL and the AWL is assumed to be technical words. For instance, Panjanon and Soranastaporn (2016) found specialized words used in a laboratory animal science corpus by separating words into three groups: GSL, AWL, and OWL. The results showed that the GSL accounted for 27.4% of coverage, and the AWL accounted for 6.73%. The remaining words made up the OWL (65.87%) which covered more than half of the corpus. Thus, most of the words in the laboratory animal science corpus were specialized words because they contain specialized meanings found particularly in the laboratory animal science field.

The word in the OWL with the highest occurrence was the word "zebrafish", and the second most frequent word was "methylation". The word "zebrafish" occurred 675 times in the corpus, while "methylation" occurred 533 times, accordingly making the word "zebrafish" the most frequently used in articles in laboratory animal science field. (Figure 1.1).

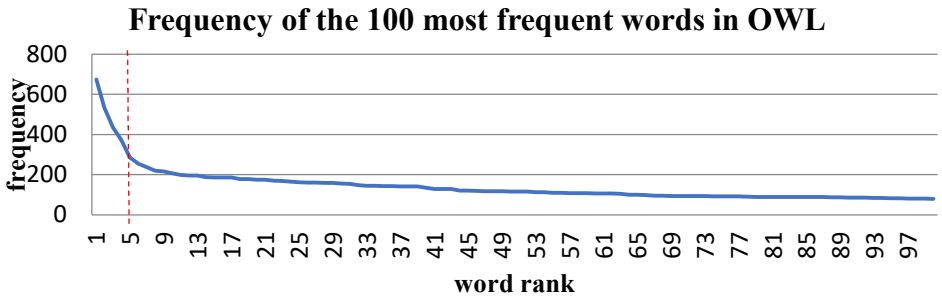


Figure 1.1 Frequency of the 100 most frequent words in the OWL (Panjanon & Soranastaporn, 2016)

The graph shows the five most frequently used words in the OWL including the word "zebrafish"; after that, frequency decreases dramatically. Unlike other words, the word frequency is slightly decreasing continually. It means that these five words were most frequently used in the laboratory animal science corpus. The highest frequency word seemed to be worthwhile studying as a launch pad to build an initial corpus of specialized terms in the field of laboratory animal science; and it would be more practically beneficial to address the functional uses of such word in respect of its collocations and actual applications within scientific papers and research. Therefore, the highest-frequency word or "zebrafish" was selected as the target word in this present study.

1.2 Collocations

Collocations refer to a group of word that often occurs together (Benson, 1985). The *Oxford Advanced Learner's Dictionary* defines collocation as the word that "happens very often and more frequently than would happen by chance" (Hornby& Wehmeier, 2005, p.293). Benson (1985) says that collocations are divided into two principal types: grammatical or syntactic collocations and semantic or lexical collocations. See Table 1.2.

Table 1.2: Grammatical and Lexical Collocations (Benson, 1985)

Types of collocations	Collocation patterns	Examples
Grammatical collocations	noun + preposition	abstinence from, access to, accusation against, acquiescence in (to), admiration for
	adjective + preposition	absent from, accountable to, acquainted with, adept at (in), adequate for (to)

Types of collocations	Collocation patterns	Examples
	verb + preposition	abide by, abstain from, account for, approve of
Lexical collocations	verb + noun	set an alarm, roll a hoop, fly a kite, launch a missile
	noun + verb	adjectives modify, bells ring
	adjective + noun	a confirmed bachelor, a pitched battle, pure chance, a responsive chord

Grammatical collocations consist of two or more words that often go together. This refers to a noun, verb, or adjective followed by a particle such as a preposition (Benson, 1985). In contrast, lexical collocations are a combination of two equal words such as verb + noun, noun + verb, adjective + noun. Each word in a lexical collocation has corresponding meaning that can co-occur properly in a given context (Benson, 1985).

Different frameworks for grammatical and lexical collocation have been used to find grammatical and lexical collocations in different fields (Table 1.3).

Table 1.3: Previous collocation studies

Author	Field of investigation	Collocations found
Ackermann and Chen (2013)	Pearson International Corpus of Academic English (PICAE)	adjective + noun (71.8%) verb + noun (12.6%) adverb + past participle (5.0%) adverb + adjective (5.0%) noun + noun (2.5%) verb + adjective (1.2 %) verb + adverb (1.2%) adverb + verb (0.6%)
Buakaew (2015)	Food and beverage advertisements	adjective + noun (45.90%) verb + preposition (44.06%) noun + noun (15.85%) preposition + noun (15.25%)

Author	Field of investigation	Collocations found
		noun + preposition (13.56%) verb + noun (6.01%) verb + adverb (5.46%) adjective + preposition (5.08%) verb + noun / pronoun (4.37%) adjective + to infinitive (1.69%) adverb + adjective (1.09%)
Panjanon and Soranastaporn (2016)	Laboratory animal science	noun + noun (55.81%)

Ackermann and Chen (2013) collected academic words in order to find academic collocations used in research articles. The results showed that the 2,468 most frequent collocations were relevant to the teaching of English for Academic Purpose. Moreover, Buakaew (2015) conducted a corpus-based study to categorize the types of collocation and their characteristics in food and beverage advertisements. The results indicated that collocations with verb combinations such as phrasal verbs were mostly used in the corpus. In addition, Soranastaporn and Panjanon (2016) investigated lexical collocations in laboratory animal science research and found that the pattern of noun collocated with noun occurred most frequently in the corpus. To provide more insight into the use of collocations in scientific field of study, this present study further investigated other lexical collocations and grammatical collocations in laboratory animal science research.

In conclusion, to design an effective curriculum for an EST course, a corpus, which is a thorough collection of the most frequent words, phrases, and sentences in a particular field of study, has become a common resource utilized as a basis to customize course contents to meet the students' needs. From an exhaustive search in the two primary databases ScienceDirect and Scopus (June 1, 2015), many corpus-based studies in many fields were found, such as medicine (Staples, 2015), agriculture (Martinez, Beck, & Panza, 2009), chemistry (Valipouri, & Nassaji, 2013), and environmental science (Liu & Han, 2015). Still, so far, very few corpus-based studies in the field of laboratory animal science have been conducted; and there was only one corpus-based study, a lexical profile, in the laboratory animal science field undertaken in Thai context (Panjanon & Soranastaporn, 2016). Collocations and purposive functions in the field of laboratory animal science have never been investigated. This may be the reason why there are no ESP courses in the field of laboratory

animal science taught in any university. Such fact is in line with the information from the interview with the director of the National Laboratory Animal Center at Mahidol University in 2015, who stated that the studies produced by Thai researchers in the field of laboratory animal science have not been accepted worldwide due to the improper use of language and academic writing styles. That is why English presents a big obstacle for Thais and novice researchers. To fill the gap, this present corpus-based study was conducted by focusing on the uses of collocations and purposive writing patterns used in laboratory animal science articles.

Research Questions

1. What are the grammatical and lexical collocations of the highest-frequency content word in the OWL used in laboratory animal science review articles?
2. What patterns are used to state the purposes in laboratory animal science review articles?

2. Research Methodology

A corpus-based research approach was adopted to investigate collocations and the purposive function using words from the OWL. The emphasis was on the highest-frequency content words in the OWL, which are specialized words or technical terms used in the field of laboratory animal science. The following description of the research methodology includes the source of the corpus, the size of the corpus, research instruments, data analysis, and the steps used to carry out the study.

2.1 Source of the corpus

The source of this corpus was from the *Institute of Laboratory Animal Research Articles (ILAR)*, and it was selected based on the following six criteria.

First, the source for the corpus was review articles because they are a kind of authentic material that could enrich students' language learning experiences and can sensitize students to the target language use in real-world situations (Breen, 1995; Otte, 2006; Wong, 1995).

Second, the source of a corpus should be well-known and acceptable in the specialized field, and the source of the present corpus was suggested by an expert in the related field. To select a renowned journal in the field of laboratory animal science, the researcher interviewed the director of the Laboratory Animal Center at Mahidol University, Thailand. In the interview, the director of the Laboratory Animal Center suggested that the *ILAR* journal was internationally well known and reliable.

Third, the reliability of a journal was assessed through Beall's list. It should not appear on Beall's list, because Beall's list is a list containing the names of suspicious journals or predatory journals which do not meet the normal standards for a journal. Therefore, Beall's list was searched for *ILAR*. The results showed that *ILAR* was not on the list.

Fourth, the journal also was validated by via the peer-review process. In academia, the peer review process is often used to vet academic papers; therefore, one can be sure that the methodology, the content, and the language are correct before publication. The official *ILAR* website says that this journal is peer-reviewed by professional reviewers who are specialized in the laboratory animal science field.

Fifth, the journal was validated by the impact factor which was calculated by adopting *Journal Citation Reports* (JCR). ILAR's five-year impact factor in the fields of Animal Science and Zoology, Biochemistry, Genetics, and Molecular Biology was acceptable at the level of 2.393. Based upon the five criteria mentioned above, the journal of *ILAR* was affirmed to be sufficiently credible and was acceptable for use as the data source for this current study.

Finally, the quartile ranking of the ILAR journal was also checked upon *Scimago Journal & Country Rank.* The qualities of journals were categorized into four equal categories: Q1, Q2, Q3, and Q4. Q1 is the highest rank, while Q4 represents the lowest rank. This conducted journal, ILAR (2010-2014) ranked in the higher categories (Q1 and Q2) (Scimago, n.d.).

Overall, the data source for the present corpus was evaluated by six criteria including authenticity material, recommendation by a specialist, non-appearance on Beall's list, use of the peer review process, impact factor, and quartile. The *ILAR* journal met all the criteria; therefore, this journal was chosen for use as the data source for the current corpus-based study.

2.2 Size of the corpus

The sample size used for the present research was based on the lexical profile of the laboratory animal science corpus collected by Panjanon & Soranastaporn (2016). The laboratory animal science corpus included 555,526 running words from 100 articles. As the number of the publications each year was not equal, stratified random sampling was implemented to determine the number of articles to be selected from each year. Then the articles in each year were selected by simple random sampling. In the laboratory animal science corpus, the words from the Outside Word List (OWL), which consisted of the specialized words used in the field of laboratory animal science, accounted for 12,220 words out of the whole corpus. Among all the words from the OWL, the word "zebrafish" was the highest

frequency word, occurring 675 times. Consequently, the 675 sentences in which "zebrafish" collocated with other words were analyzed for collocations and for the purpose function.

2.3 Research instruments

AntConc (3.4.4) was used to compile a wordlist and find the concordance lines for the target word. AntConc (3.4.4) is a concordance program developed by Anthony (2014). Linguists use AntConc to analyze data such as words and sentences because the program is reliable and easy to use (Diniz, 2005). Froehlich (2015) claimed that AntConc can show the frequency, structure, and collocation of the target word or the concordance lines for sentences which need to be analyzed. Furthermore, Tribble (2012) compared computer programs used to analyze corpora. The result indicated that AntConc was widely used by almost 20% of researchers because it is a fast, nonprofitable and multi-purpose freeware. For these reasons, AntConc was suitable for use in this corpus-based study to collect the data for the researcher to analyze the collocations and the purposive functions.

2.4 Data analysis

Two frameworks were used for data analysis:1) grammatical and lexical collocations and 2) purposive functions.

The collocation frameworks for this study are divided into two types: grammatical collocations and lexical collocations (Benson, 1985)

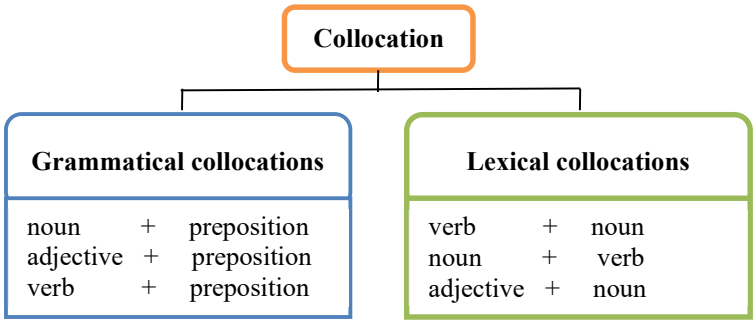


Figure 2.1 Grammatical and lexical collocations

According to Benson (1985), grammatical collocations consist of a noun, verb, or adjective followed by a preposition. On the other hand, lexical collocations consist of two equal words such as a noun collocated with a verb, a verb collocated with a noun, or an adjective collocated with a noun. Moreover, Benson (1985) identifies the patterns of grammatical and lexical collocations by part of speech, which can be of benefit in analyzing written texts.

Researchers can use the patterns for grammatical and lexical collocations to analyze grammatical structures, such as the semantics of prepositions, compound nouns, voice, and descriptive adjectives. For this reason, Benson's collocation framework was utilized to analyze grammatical and lexical collocations in the present study, because this study focused on the words and language used in laboratory animal science research.

In addition, the frameworks of Swales and Feak's (2012) and Soranastaporn's (2013) were adopted to analyze the use of high frequency words to express the purposive function. The present study investigated the purposive function or the statement that shows the objective of the study, which is a requirement in all research articles. The purposive statement contains a keyword or words that tell the reader the central idea of the study. Moreover, purposive statements make use of specific words and patterns to present purpose of the study. Consequently, words and patterns that match with the framework (Soranastaporn, 2013; Swales & Feak, 2012) were to be considered a key component in forming a purposive statement.

In summary, to achieve the objectives of the study, a specific research methodology was designed. The 12,220 words in the OWL from 100 articles published in *ILAR* between 2010 and 2014 were collected. Then the content words were entered into AntConc (3.4.4) for collocation and purposive function analysis. Finally, the results were presented as percentages for word frequency.

3. Results

This section presents the results of the analysis of the collocations and the purpose function which are related to the content words listed in the OWL used in laboratory animal science review articles. The results are presented according to the research questions.

Research question 1: What are the grammatical and lexical collocations of the highest-frequency content word in the OWL used in laboratory animal science review articles?

According to Panjanon and Soranastaporn (2016), the OWL in the laboratory animal science corpus consisted of 12,220 content words. The highest-frequency word was "zebrafish". The concordance program showed that there were 675 sentences with the word "zebrafish", and the word "zebrafish" occurred most often in issue 53 (2012) of the *ILAR* journal. Consequently, all 675 sentences were analyzed for collocations. The collocations were categorized into grammatical collocations and lexical collocations. The previous research showed noun collocated with noun occurred most frequently in the corpus. In the present study, the other patterns for lexical collocations were found including noun + verb (17.83%), adjective + noun (14.15%), and verb + noun (7%). In addition, the analysis showed that the least used type of grammatical collocation was noun + preposition (4.26%).

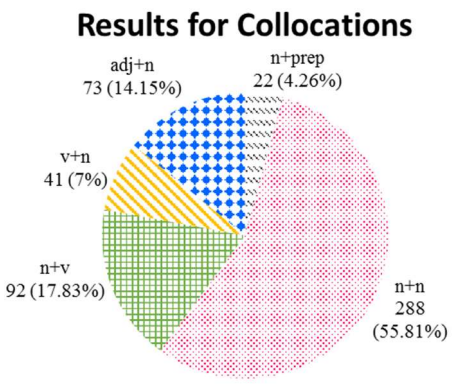


Figure 3.1 The results for collocations

Grammatical collocations

The results showed that grammatical collocations accounted for only 4.26% of the corpus. The results show that 22 sentences used grammatical collocation. The most frequent pattern of grammatical collocation was *noun + preposition*. The word "zebrafish" collocated the most frequently with the preposition "in", followed by "with', and "from".

1. "zebrafish" collocated with "in" (50%)

e.g. *(1) The dramatic increase in the use of* ***zebrafish*** *(*Daniorerio*) in biomedical research has led to a corresponding increased interest in the diseases affecting this important biological model.*

(Sanders, Watral & Kent, 2012)

e.g. *(2) Severe hepatic megalocytosis was found in* ***zebrafish*** *in a new facility and was presumed to be associated with a toxicant from new plastics, glues, and the like.*

(Kent, Harper & Wolf, 2012)

The results showed that the preposition "in" was used to indicate the utilization of the zebrafish as a laboratory animal in the experiment.

2. "zebrafish" collocated with "with" (45.45%)

e.g.(3) ***Zebrafish*** *with clinical microsporidiosis are emaciated and may exhibit skeletal deformities, but many infected fish are asymptomatic and the infection is often seen in sentinel fish.*

(Kent, Harper & Wolf, 2012)

e.g.(4) We are anxious to obtain live ***zebrafish*** *with skin or fin papillomas because we believe that these papillomas are the best neoplasm candidates for harboring a tumorigenic virus of zebrafish.*

(Spitsbergen, Buhler & Peterson, 2012)

The results indicated that the preposition "with" was used to indicate the physical and internal features of "zebrafish" as a laboratory animal. Example 3 used the preposition "with" to indicate being involved. In addition, example 4 showed that the preposition "with" can be used to indicate "having".

3. "zebrafish" collocated with "from: (4.55%)

e.g.(5) Watral and Kent added M. marinum *to this growing list, isolating the bacterium from* ***zebrafish*** *from a facility supplying fish to the research community and experiencing low to moderate levels of mortality.*

(Whipps, Lieggi & Wagner, 2012)

This finding demonstrated that the preposition "from" was used to show the origin of "zebrafish". Moreover, the example showed that using "from" together with "to" can show the distance between two places from the start to the end.

Lexical collocations

Most of the collocations found in the present corpus were lexical collocations (95%) (Figure 3.1). The results showed that the word "zebrafish" co-occurred with nouns, verbs, and adjectives in three main patterns, including: *noun + verb*, *adjective + noun*, and *verb + noun*.

1. The pattern of noun collocated with verb (17.83%)

The collocation of the word "zebrafish" with a verb accounted for 19% of occurrences. The verbs that collocated with "'zebrafish" were *used, raised, treated, maintained, exhibit, emerged, spawn, obtained, survive,* and *infected*. More than half of the word "zebrafish"

that collocated with verbs were in the active voice (63.54%), and 36.46% were in the passive voice.

1.1 "zebrafish" collocated with verbs in the active voice (63.54%)

*e.g.(9) Sexually mature **zebrafish** can spawn in the laboratory continuously all year at a frequency of two or three times a week.*

(Nasiadka & Clark, 2012)

*e.g. (10) **Zebrafish** and other fish larvae use cutaneous gas exchange for their oxygen demands while their gills are still developing.*

(Matthews & Varga, 2012)

1.2 "zebrafish" collocated with verbs in the passive voice (36.46%)

*e.g.(11) Such nonexperimental variation magnifies the importance of evaluating the influences these infections may have when **zebrafish** are used as models for studies on disease, immunology, ecotoxicology, and so on.*

(Whipps, Lieggi & Wagner, 2012)

*e.g.(12) In contrast to purpose bred research mice, ornamental **zebrafish** are often raised together with other species that harbor numerous pathogens.*

(Crim & Riley, 2012)

The results showed the patterns of noun collocated with verb in both active and passive voices. The lexical collocations in the active voice exhibited the nature and body mechanism in zebrafish; whereas the lexical collocations in the passive voice were used to emphasize "zebrafish" as the subject laboratory animal in the scientific experiment.

2. The pattern of adjective collocated with noun (14.15%)

Another type of lexical collocation found in the present study was an adjective collated with a noun (15%). The examples were *adult zebrafish, infected zebrafish, larval zebrafish, immunocompromised zebrafish,* and *pathogen-free zebrafish.* Most of the descriptive adjectives used to modify the word "zebrafish" were subjective or evaluative adjectives and measurement adjectives.

2.1 "zebrafish" collocated with subjective or evaluative adjectives (88.63%)

*e.g.(13) A 2- to 5-g/ml dosage concentration is recommended to sedate adult **zebrafish**, and 60 to 100 ?g/ml is used for immersion anesthesia.*

(Crim & Riley, 2012)

*e.g.(14) Larval **zebrafish** are quite susceptible to P. neurophilia infections; hence, the infection could compromise developmental neurotoxicity testing and musculoskeletal development studies.*

(Kent, Harper & Wolf, 2012)

2.2 "zebrafish" collocated with measurement adjectives (1.37%)

*e.g.(15) This hypothesis that the colony at Pennsylvania State College of Medicine has some unique factor predisposing it to epithelial neoplasia is supported by the finding that papillomas have not been observed on the skin or fins in several large **zebrafish** including those at the University of Oregon, Cornell University, and Harvard University in which adult males have been mutagenized using ENU in protocols similar to that used by Beckwith and colleagues.*

(Spitsbergen, Buhler & Peterson, 2012)

The results indicated that many descriptive adjectives such as subjective or evaluative adjectives and measurement adjectives were used to modify the word "zebrafish". While subjective or evaluative adjectives such as "adult" and "larval" were used to represent the age of the "zebrafish", measurement adjectives such as "large" were used to describe the size of the "zebrafish".

3. The pattern of verb collocated with noun (7%)

The lowest occurrence or lexical collocations found in the corpus was for verb collocated with noun. The total number of sentences found accounted for 8% of the corpus. Verbs that collocated with the word "zebrafish" were *use, infect, anesthetize,* and *sedate*.

*e.g.(17) Naturally occurring infections along with oncogenic viruses may also play a role in confounding experiments, including cancer studies using **zebrafish**, because viruses are associated with tumorigenesis in several other fish species.*

(Crim & Riley, 2012)

*e.g.(18) Therefore, the most widely used method to anesthetize or sedate **zebrafish** is immersion, which, in fish, is analogous to inhalant anesthesia in terrestrials.*

(Matthews & Varga, 2012)

The results showed that writers used action verbs to represent behavior or physical actions of "zebrafish". A verb that collocated with a noun was a transitive verb. A transitive verb was used when the action was directed toward "zebrafish", which was the object of the verb.

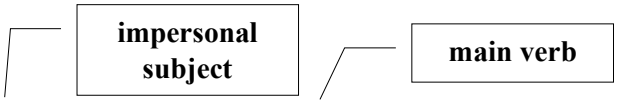
Research question 2: What patterns were used to state the purpose in the laboratory animal science review articles?

This corpus-based study also aimed to find the patterns used to state the purposive function in sentences with the word "zebrafish", which was the highest-frequency word in the OWL in the laboratory animal science corpus (Panjanon & Soranastaporn, 2016). The introductory section of 14 review articles in the *ILAR* journal was investigated in order to find purpose statements which contained the word "zebrafish". The results indicated that six forms of purposive sentences occurred with the word "zebrafish". These six forms of purposive sentences were grouped into two different patterns as follows.

Pattern1

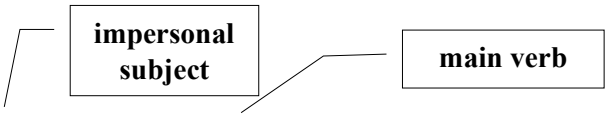
Impersonal subject	Main verb	Phrase/Clause
This (present) review This studies This article	highlights focuses on addresses outlines	noun phrase or noun clause

The findings showed that five sentences were found to use main verbs to state the purpose of the article. The main verbs were in the present simple tense as in the following sentences.



(1) *The present review focuses specifically on the transmission and control of microsporidia in* ***zebrafish*** *facilities.*

(Sanders, Watral & Kent, 2012)



(2) *These studies highlight the need for careful consideration of diet and husbandry in order to ensure valid and reproducible data in research using the **zebrafish** model.*

(Spitsbergen, Buhler & Peterson, 2012)

Pattern 2

Subject (words signaling purpose)			Verb to be	to + V.inf	Noun phrase
The goal (s)	of	this review	is	to provide	Noun details of objective(s)

The other pattern used to state a purpose of the studies was noun phrase with the to-infinitive as in the following example:

(3) *The goal of this review is to provide researchers, laboratory animal science professionals, architects, and others who may be involved in the planning of a new fish facility with a comprehensive overview of design concerns that should be considered when planning to purchase and install **zebrafish** housing and life-support equipment in biomedical research settings.*

(Lawrence & Mason, 2012)

In conclusion, the word "zebrafish", the highest-frequency word in the OWL, was found to most frequently occur with nouns, verbs, and adjectives to form lexical collocations (95%). Moreover, such main verbs as *highlight, focus on, addresses,* and *outlines* were found to co-occur with the word "zebrafish" to state the purpose of the studies.

4. Discussion

This section will discuss the results, the limitations and pedagogical implications of the study

4.1 Grammatical collocations

The results showed that grammatical collocations were rarely found in the laboratory animal review articles and accounted for only 4.26% of the corpus, and only one pattern of grammatical collocation, which noun + preposition, was discovered from the analysis. The results are in contrast to those found by Buakaew (2015). She investigated collocation usage in food and beverage advertisements and found that grammatical collocations occurred very frequently in such text and various patterns of collocations were reported. The combination of verb + preposition occurred the most frequently (44.06%), followed by preposition + noun (15.25%), and noun + preposition (13.56%). The reason that the pattern and frequency of grammatical collocations found in the present study differ from those reported Buakaew maybe because the sources for the corpora and the genres of writing used for analysis are different. As previously mentioned, grammatical collocations, especially phrasal verbs (verb + preposition) are generally used in spoken texts or informal language such as advertisements (Buakaew, 2015), so it is no surprise that phrasal verbs barely appears in the academic texts like in *ILAR*. Obviously, the data source of the corpus and the restriction on the target word investigated are the reasons behind the low frequency and little variety of the grammatical collocation patterns found in this study.

4.2 Lexical collocations

Most of collocations found in the present corpus were lexical collocations (95.74%). The word "zebrafish" co-occurred with nouns, verbs, and adjectives. Three patterns for lexical collocations were found, which included *noun* + *verb*, *adjective* + *noun*, and *verb* + *noun*. These three patterns are consistent with the theoretical framework in lexical collocations proposed by Benson (1985) who stated that lexical collocations could be formed by combining two equal words such as verb + noun, noun + verb, adjective + noun. The variety of the lexical collocation patterns in this present study is also in line with the collocation patterns reported in the Pearson International Corpus of Academic English developed by Ackermann and Chen (2013). A wide range of collocation patterns were revealed in their corpus, such as adjective + noun, adverb + adjective, noun + noun or verb + adverb. Apparently, noun is the key component in most of lexical collocations as well as the basis to generate the variety of collocation patterns; thus, investigating the ways a particular noun combines with other words of different part of speech is possibly the best way to explore and realize how lexical collocations actually function in English.

Moreover, the word "zebrafish" can be both subject and object. If "zebrafish" functions as the subject of a sentence, it will be written in the pattern of noun collocated with verb. If

"zebrafish" functions as the object of a sentence, it will be written in the pattern of verb collocated with noun. In the pattern of adjective collocated with noun, subjective or evaluative adjectives especially adjectives telling the age were used to describe "zebrafish". In the experiments described in the articles, zebrafish were used in laboratory animal science as a subject. Researchers need to describe the age of the subject because the subject's growth rate or age is one of the factors that researchers are required to consider when conducting an experiment. Therefore, researchers need to use descriptive adjective to state the age of the subject.

4.3 The purpose function and the highest-frequency content words in the OWL

From the analysis of the patterns used in the purposive statements in the laboratory animal science review articles in the *ILAR* journal, two common patterns were found: The use of the main verb such as *focus (on), highlight, or address*; and the use of verb to be with the to-infinitive. The former pattern corresponds with what is suggested in textbooks on how to write research papers that a purposive sentence can be written using words signaling purpose and the to-infinitive (Swales & Feak, 2012; Soranastaporn, 2013). The nouns signaling purpose may encompass the words *purpose, goal, aim, objective,* and *reason*; while the examples of verbs or phrasal verbs expressing the purpose may include the words *study, investigate, explore, concentrate (on), focus (on).* The later pattern is consistent with the findings reported by Lawrence and Mason (2012). In their corpus-based study, it was found that verb to be "is" was frequently used with the verb "to provide" to state the purpose of the research. As seen from the theoretical and the empirical evidences, it could be inferred that the patterns or structures used to write the purpose in academic studies are just a simple or basic sentence; to provide a clear and straight-forward information, the key is to select a proper main verb or exploit verb to be with infinitive with to, so that the attention of the readers would be drawn to the messages conveyed or explanations after a verb.

Concluding Remarks

In conclusion, the present study presented a lexical profile of the OWL in terms of collocations, and purposive functions used in laboratory animal science review articles from the *ILAR* journal. This is an important contribution to the laboratory animal science, since no previous studies have attempted to compile the words and linguistic patterns used in this field.

Hence, this corpus-based study shed light on the use of word collocations and the purposive function in laboratory animal science review articles.

The findings of words in the OWL will contribute to the language pedagogy especially ESP courses. As the word lists were collected from the *ILAR* journal, they would be advantageous to scientific students. Therefore, teachers can select the words from the OWL to teach veterinary and scientific students because this OWL is the word list which commonly occurs in the zoology and biochemistry field and matches with veterinary and scientific students' study. Moreover, the teaching of the actual uses of such scientific words or vocabulary should be included in English for Science and Technology classes. To put it another way, the concordance lines of words should be used to exemplify the sentence writings for students because the concordance lines represent word collocations that can help students form sentences naturally. Furthermore, the findings in the present study revealed the keywords and common patterns, which are used to state the purpose or objective in academic texts; such findings, thus, can serve as useful guidelines for students and researchers on how to write purposive sentences professionally for academic articles. Obviously, the corpus not only acts as a collection of words in a particular field, but the corpus also holds the potential to be utilized as a didactic to facilitate language pedagogy especially in the English for Science and Technology classes.

Future studies can explore the features of the words in larger corpora of the same or similar fields.

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