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Exploring English Lexical Bundles in the Methodology Chapter of Education Doctoral Theses

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Abstract: Lexical bundles (LB) refer to sequences of words that frequently co-occur in texts. While numerous studies on LB have been conducted in various sections of theses, such as abstracts, acknowledgements, introductions, findings, and conclusions, the Methodology chapter has received comparatively less attention, despite its crucial role in outlining the research process. To address this gap, the present study aims to analyse the use of English LB in the Methodology sections of 50 PhD theses from the Education domain. The results reveal that commonly used bundles in the corpus often serve to frame and situate the studies, as evidenced by bundles such as *in this study*, *for the purpose of*, and *in the context of*. Furthermore, analysis of the structures discovers noun phrase bundles occur most frequently, followed by prepositional and verb phrases. In terms of the LB functions, Research-oriented bundles are predominant, followed by text- and participant-oriented bundles. These findings are valuable not only for PhD candidates in Education but also for postgraduate students, as they provide insight into common academic phrases used in the Methodology sections of theses.

Keywords: Corpus-based analysis, lexical bundles, methodology chapter, PhD theses

Introduction

The English language has been dominating the world of academia for ages. This can be proven through the widely distributed English-written academic publications (Hyland, 2008b; Swales, 2004). The practice has led to the use of English in writing theses at postgraduate levels despite the fact that the writers are non-native (L2) English speakers. One of the linguistic elements that requires mastery by L2 learners is lexical bundles (henceforth, LB). LB refer to word sequences that are commonly found to co-occur in texts and consequently form a cohesive unit that conveys meaning (Biber et al., 1999). The range of LB starts from two words and may continue up to several words in length. As Hyland (2008b) noted, LB help shape fluent discourse by assisting coherence and cohesion, particularly in academic texts.

Previous studies found that L2 learners often struggle in using LB (Bychkovska & Lee, 2017; Cortes, 2006). This issue could be attributed to a few factors. Firstly, lack of awareness of "collocational appropriateness" (Chi et al., 1994). The problem has become apparent even among advanced L2 learners since they lack exposure to the use of correct bundles. This could be caused by limited sources of academic texts that utilise a wide range of LB (Hyland, 2008b). Therefore, they should be exposed to LB from a young age as this gives them sufficient knowledge. Furthermore, understanding the proper use of LB contributes to its effectiveness in applications and achieving native-like language competency (Hyland, 2012; Pérez -Llantada 2014). Furthermore, L2 learners

find LB to be challenging due to the differences between the structure of English and their first language (L1) (Bychkovska & Lee, 2017). Pang (2010) argued that structural differences hinder learners from acquiring the correct use of LB. This may be caused by the absence of similar multi-word sequences in their L1. As a result, L2 learners are struggling to recognise and generate common LB used in English academic writing (Römer, 2009; Wachida, 2020). This issue will lead to errors in the formation and application of LB (Cortes, 2004; Ozturk & Taşçı, 2023).

In writing a thesis, the Methodology section is often written as the third chapter or a chapter that appears after the literature review. Thesis writers must fulfil six functions of the chapter (Bitchener, 2009). They include describing the methodological approach, justifying research design, choosing specific methods, discussing validity and reliability, documenting data collection procedures and reporting data analysis. In addition, the section is crucial in explaining how the methodology influences the findings and beneficial to those interested in replicating or extending the study (Weissberg & Buker, 1990). However, writing this section has been reported to be one of the main challenges in completing a thesis since the writers have problems in forming the chapter (Kikula & Quorro, 2007; Manchishi et al., 2015). The problems can be linked to the lack of awareness in using LB in their writing. Wei and Lei (2011) pointed out that ESL students often use direct translation from their first language, leading them to not conforming to the expected academic style in English. Hyland (2012) claimed that LB work as building blocks to guide readers through complex arguments and processes. Failure to utilise LB effectively in writing will result in fragmented writing which discourages readers from understanding the train of thoughts of the writers.

Hitherto, studies on LB have been conducted on entire theses (or dissertations) (e.g: Dontcheva-Navratilova, 2012; Narkprom & Phoocharoensil, 2022; Sugiarti et al., 2018), and other thesis chapters including abstracts (Bao & Liu, 2022, 2023; Samodra & Pratiwi, 2018), acknowledgements (Bao & Liu, 2024) introduction (Gil & Caro, 2019; Niu, 2015) and findings (Wachidah et al., 2020). Surprisingly, the LB used in the methodology chapter of theses is still understudied compared to other sections of theses. On top of that, previous studies have also exhaustively researched LB in applied linguistics (e.g: Bao & Liu, 2022; Li et al., 2022; Öztürk & Taşçi, 2023). The current study, however, aims to examine the LB used in a different domain which is Education since it is composed of different sub-domains such as English language, Science, and Management. Further, examining LB in the Methodology chapter is paramount understating how these bundles help in expressing clear and effective research procedures (Cortes, 2013). Besides that, the field of Education also has received scant attention from previous scholars studying LB. Hence, to shed light on the issues above, the present study intends to answer the following research questions:

1. What are the most frequent four-word lexical bundles in the Methodology sections of Education doctoral theses?
2. What are the structures of the lexical bundles in the Methodology sections of Education doctoral theses?
3. What are the functions of the lexical bundles in the Methodology sections of Education doctoral theses?

Literature Review

Lexical Bundles

Biber et al. (1999) defined LB as recurring sequences of three or more words that commonly occur in texts. The concept similarly reflects what Byrd and Coxhead (2010) explained, with the addition of the lexical bundles being used frequently over a specified period. As a prevalent feature of academic discourse, LB refer to recurrent multi-word sequences or word combinations that appear more frequently in a given corpus than would be expected by chance (Ang & Tan, 2018). LB also refer to entities with incomplete structures since they usually belong to phrases or sentences with incorporated fragments (Biber et al., 1999; Narkprom & Phoocharoensil, 2022). In an academic context, these word combinations are used to cater to certain functions like conveying meaning, organising discourse, or expressing relationships between ideas. They are not necessarily idiomatic but are common enough to

be recognised as standard word groupings. To qualify as LB, a word sequence must occur at least 10 times per million words and appear in at least five different texts (Biber et al., 1999). These characteristics can be automatically identified using concordance software, which is typically used to locate words, word groups, and other kinds of structure in texts. The concordance results will be further analysed, such as identifying LB and parts of speech in product reviews (Altun, 2019) or detecting hedging in spoken discourse (Nuraniwati & Permatasari, 2021).

The study of LB has gathered interest in recent years, driven by the increasing globalisation of academia and the concomitant need to understand the linguistic conventions that characterise successful academic writing. In general, people study LB because they reveal important patterns in language use and thus help to understand how language functions in specific contexts. Hyland (2008a) argued that LB reveals the natural patterns and structures of a language, leading to insights into how the language is used in various contexts. This will give a clearer idea of how LB impact the purpose of a written text. Biber and Barbieri (2007) on the other hand, looked at how LB may help in understanding how a language is processed and stored in the human mind. Another study by Coxhead and Byrd (2007) affirmed that by studying LB, researchers would have a good chance in understanding their effects on accuracy and fluency. They also believed that LB could help in retrieving information systematically to collect only relevant information in large datasets. Additionally, studying LB aids in understanding second language acquisition and supports the development of more effective language learning materials.

A growing body of research has explored the use of LB in various academic genres (e.g: Budiwiyanto & Suhardijanto, 2020; Byrd & Coxhead, 2010; Cao, 2021; Hyland, 2008b; Kwary et al., 2017). These studies found distinct usage of LB across various fields of study. Notably, stance bundles were commonly used in social science academic writing. Social science authors tend to use stance bundles more frequently to express their opinions rather than present verified information. There are also studies that explore the variations of LB usage between first and second language writers. L2 writers tend to use LB more frequently than L1 writers as discourse organisers and signals to structure their texts (Chen & Baker, 2010; Güngör & Uysal, 2016). Nevertheless, L1 writers demonstrate greater variation in the structure of the LB they use. Besides that, some other studies investigated the LB in academic theses. For instance, Wachidah et al. (2020) discovered that text-oriented LB were the most commonly used in the Findings and Discussion sections of ten graduate students' theses. Guiling (2015) on the other hand, analysed the introduction sections of research theses by international and Chinese students and discovered that Chinese students used more LB with primarily noun-based structures to organise discourse and provide referential expressions. Similarly, Samodra and Pratiwi (2018) studied undergraduate thesis abstracts in both Indonesian and English, and discovered that research-oriented LB were the most prevalent.

The key findings from this body of research suggest that LB are crucial in academic discourse, with their use varying across disciplines, genres, and text sections. These insights have clear pedagogical implications, emphasising the need to incorporate the systematic instruction of LB into second-language writing curricula (Chen & Baker, 2010; Güngör & Uysal, 2016).

Previous Studies on Lexical Bundles in Theses

LB serves multiple functions in academic writing, particularly doctorate and master theses. They contribute to the overall coherence, argumentation, and stylistic features of the texts. Further, LB may also enhance learners in their academic writing, or writing in general. Hyland (2008b) asserted studying LB can help students obtain certain rhetorical practices of their communities. This can be accomplished through learning more frequent fixed phrases of a discipline. As Niu (2015) claimed, analysis of LB is beneficial in developing the second language learners' genre consciousness. It also promotes fluency in the English language. Biber et al. (2004) mentioned that LB are not just repetitive phrases but are also significant for constructing meaning in academic discourse. Studies by Chen and Baker (2010) and Hyland (2012) pointed out that the fluency and coherence of students' academic writing can be improved with clear instructions in the use of LB. Furthermore, the studies of LB are also beneficial for educators when teaching their students. Findings on LB in academic writing can assist language instructors in developing learning materials for teaching writing (Faqih & Harjanto, 2022).

Some key findings have shown the prevalence of LB in academic writing. Hyland (2008b) conducted a comparative study on the use of LB in PhD and Master theses. In this study, Master theses were found to include more bundles in contrast with other genres. It also highlighted that PhD theses had a higher frequency of text-oriented bundles, likely due to the greater experience and proficiency of their writers compared to those of master's theses, reflecting a proficiency gap. Additionally, Faqih and Harjanto (2022) revealed that graduate students in Teaching English as a Foreign Language (TEFL) used more research-oriented bundles, which suggested that the students focused on the structure of their research. Ahmed and Ariannejad (2024) also conducted a study which involved native writers and non-native writers. In the study, the non-native writers used more bundles than the native writers. They also applied more research-oriented bundles than their native counterparts.

The studies of LB have gained traction, especially in analysing academic texts such as journal articles as well as theses and dissertations. In studies involving theses, different chapters or sections were chosen as part of the analysis. Bao and Liu (2024) investigated the acknowledgement part of theses. Comparisons were made between completed dissertations of Chinese and American linguistics doctorate students. It was discovered that the Chinese students used more gratitude LB than the American students. Besides, the forms of gratitude LB used by both groups were substantially different. Another section of theses that had been analysed was the abstract. Samodra and Pratiwi (2018) examined the abstract sections in undergraduate theses to identify three and four-word combinations. The result obtained suggested that the differences of frequencies between English and Indonesian LB were not highly significant. Research-oriented bundles had the highest number of frequencies while participant-oriented bundles had the lowest. Apart from that, the bundles in the introduction section also had been scrutinised. Niu (2015) compared LB in the section written by Chinese and international students. It was found that LB in the English introductions of the Chinese students' theses were structurally incomplete compared to those in the theses of the international students.

Moreover, research in English-speaking countries like the United States and the United Kingdom has generally focused on identifying the role of LB in academic writing and comparing their use in different academic disciplines. Biber et al. (2004) provided a comprehensive analysis of LB in a corpus of research articles. Their findings highlighted the frequent use of bundles in various academic fields, with significant differences between the humanity and science fields. In the study, it was found that bundles that are common in the humanities often differ from those prevalent in the sciences. The difference was identified by looking at the frequency and function as well as the structural patterns of the LB. Hyland (2008b) conducted a significant study in the UK, analysing LB in undergraduate and postgraduate theses. The research highlighted the importance of LB in achieving academic writing proficiency, particularly among novice writers. In the study, a comparative study between the use of LB in PhD and Master theses. It was mentioned that PhD theses had more text-oriented bundles than Master theses since the writers of the PhD theses had more experience and proficiency.

In non-English-speaking countries, research on LB has primarily focused on how non-native English speakers use these bundles in their academic writing. Studies from countries like China and Iran have provided valuable insights into the challenges faced by non-native speakers in mastering LB. Pan et al. (2016) examined the use of LB in Chinese students' academic writing. Their studies discovered that Chinese students usually struggle with using appropriate LB, leading to issues with coherence and fluency in their writing. In Iran, studies have shown that Iranian EFL learners often overuse certain types of LB, particularly those that are more common in conversational English rather than academic genres. Jalali and Moini (2014) analysed the use of LB in Iranian students' theses and found that many students were too reliant on a limited range of bundles, which negatively impacted the sophistication of their writing.

Methodology

In the present study, a specialised corpus comprising the Methodology chapters of theses from the Education domain was created. The collection of the corpus data was conducted following two

criteria: topic and text type (Salazar, 2011). Firstly, the texts were doctoral theses from Education disciplines. This domain has a wider scope, as it includes sub-disciplines such as languages, management, engineering, and sciences. Secondly, the texts were retrievable in full-text PDF format. The present study obtained the theses from a Malaysian public university database, and they were published between 2020 and 2022. The corpus, which is referred to as the Corpus of Methodology Chapters in Education Doctoral Theses (henceforth, COMCET), contained 50 methodology chapters, comprising 428,771 word tokens. Table 1 summarises the corpus data of this study.

Table 1. Summary of COMCET

Type of Texts	**Doctoral theses**
Domain	Education
Number of texts	50
Number of word tokens	428,771
Number of word types	16,598

The data were analysed using concordance software, AntConc (Anthony, 2019) due to its simple and friendly interface. It also has been designed to assist researchers to easily run concordance searches, analyse word frequency, and identify lexical bundles. Additionally, it offers a wide range of tools which are essential in investigating LB such as analyses of keywords, collocations, and clusters. Although the present study utilised previous version of the software, it was still capable of performing similar tasks of the latest version. However, AntConc is only capable of processing texts in Plain Text Format (*.txt). Therefore, to prepare the data, the identified theses were first downloaded from the university's database. Next, the methodology chapters were extracted from the theses. Since the original files were in Portable Document Format (PDF), they were converted to *.txt format using AntFileConverter software (Anthony, 2017). As a result of the conversion, some words or phrases originally located in tables and figures became scattered throughout the text files. This necessitated a data cleansing process, where all unnecessary parts such as information in tables, figures, and page numbers were excluded from the corpus data to ensure accuracy of the findings.

In identifying the lexical bundles, the present study followed three preconfigured settings namely, the length, the cut-off frequency and the distribution of the LB. In determining the length of the LB, this study follows Hyland (2008b) who defined it at 4-word bundles. This is because they are more common than 5-word bundles and have a more comprehensible range of structures and functions than 3-word bundles (Chen & Baker, 2010). As for the cut-off frequency, it was used to quantify the number of the target LB. Previous studies argued that the value should be set between 20 and 40 times per 1,000,000 words (Biber et al., 2004, Hyland, 2008b). The current study employed the cut-off frequency of 20, which was equivalent to 46 occurrences per 1,000,000 words, indicating a slightly higher point than the one set in the literature. The last setting involved the distribution of the LB since relying on cut-off points only could lead to false findings. For instance, one LB may have a high frequency but is only found in a single text. This circumstance could be caused by the writer's preference in using the bundle. Biber et al. (2004) recommended setting the range of texts in which the LB may appear to 3 to 5 texts. This study, however, set a higher value which is 10 since the LB may be derived from the same subdomain of Education.

The analysis of the corpus data involved identifying the most frequent four-word LB, the structures, and the functions of the LB. In examining bundles with the highest occurrences, a list of LB was first generated from AntConc software. The list was then ranked in terms of the raw frequency and distribution of range. 20 LB with the highest value in frequency and distribution were chosen to represent the most frequent four-word LB (see Table 4 in the following section). Moreover, the present study also attempts to categorise the LB into their structure following grammatical categories by Biber et al. (2021). The list of categories is the latest revision of Biber et al.'s (1999) lexical expressions. In the case of any doubt during the categorisation of LB, an English dictionary was used to determine the correct part of speech. Table 2 summarises the structural categorisation of LB.

Table 2. Structures of Lexical Bundles (Biber et al., 2021)

Category	Structure	Example of LB
Noun phrases	Noun phrase with of-phrase fragment	*the size of the, the structure of the, the surface of the, the top of the, both sides of the*
	Noun phrase with other post-modifier fragments	*the way in which, the ways in which, such a way that; the extent to which, extent to which the*
	Pronoun/noun phrase + be (+ ...)	*this is not the, this is not to, there was no significant, there are a number, there has been a*
Prepositional phrases	Prepositional phrase with embedded of-phrase fragment	*as a result of, as a function of, as part of the, as a consequence of, as a matter of*
	Other prepositional phrase (fragment)	*at the same time, between the two groups, by the fact that, for the first time, from the fact that*
Verb phrases	Anticipatory it + verb phrase/adjective phrase	*it is possible to, it is possible that, it is not possible, it is impossible to, it is likely that*
	Passive verb + prepositional phrase fragment	*is shown in figure, are shown in table, is based on the, be found in the, can be found in*
	Copula be + noun phrase/adjective phrase	*is one of the, are a number of, is part of the, be the result of, is a matter of,*
	(Verb phrase +) that-clause fragment	*should be noted that, be noted that the, has been shown that, has been suggested that, can be seen that*
	(Verb/adjective +) to-clause fragment	*are likely to be, is likely to be, more likely to be, has been shown to, been shown to be,*
	Adverbial clause fragment	*as shown in figure, as we have seen, as we shall see, if there is a*
Others	Other expressions	*as well as the, as well as in, than that of the, may or may not, the presence or absence*

In addition, the analysis also took into account the functions of LB. For this purpose, classification of functions by Hyland (2008b) was employed since it is applicable across various academic genres. Table 3 summarises the functions of LB.

Table 3. Functions of Lexical Bundles (Hyland, 2008b)

Functional types	Sub-types	Examples
Research-oriented	Location	*the end of the*
	Procedure	*in the process of*
	Quantification	*a large number of*
	Description	*the similarities and differences*
	Topic	*language teaching*
Text-oriented	Transition signals	*on the other hand*
	Resultative signals	*the results of the*
	Structuring signals	*in the current study*
	Framing signals	*on the basis of*
Participant-oriented	Stance features	*it is clear that*
	Engagement features	*can be seen in*

Findings and Discussion

Most frequent four-word LB

Table 4 shows the most frequent LB in methodology sections of education doctoral theses. A list of 111 four-word bundles is identified as LB with the minimum cut-off frequency of 20 and 10 text dispersion ranges. AntConc identifies LB across the methodology sections of education doctoral theses and presents the list sorted automatically from the most to the least frequent bundles. The findings resonate with previous studies that despite learning English as the second language, ESL learners are competent in utilising a broad variety of LB (Öztürk, 2014; Perez-Llantada, 2014; Pan et al., 2016).

Table 4. The most frequent bundles in COMCET

Freq	Range	Lexical bundles	Freq	Range	Lexical bundles
217	43	*in this study the*	55	30	*the purpose of the*
82	30	*validity and reliability of*	53	16	*in the current study*
81	32	*used in this study*	53	24	*the validity and reliability*
80	29	*the reliability of the*	49	20	*for the purpose of*
76	27	*the extent to which*	49	26	*the validity of the*
66	29	*as well as the*	48	22	*at the same time*
66	30	*to ensure that the*	48	22	*the purpose of this*
59	30	*and reliability of the*	48	31	*the results of the*
56	22	*is one of the*	47	20	*in the context of*
55	21	*as shown in table*	47	23	*of this study the*

As shown in Table 4, *in this study the*, with the frequency of 217 across 43 different texts, is the highest-ranking LB in COMCET. Another bundle, *used in this study*, is also ranked high in this section with the frequency of 81 and 32 texts range. These bundles are commonly used in COMCET for framing and situating studies. Another frequently used bundle is 'validity and reliability of' which appears in 30 different texts. It occurs 82 times in the corpus and thus placing it as the second of the most frequent LB in COMCET. Another version of this bundle includes *the reliability of the*, which appears in 29 texts with the frequency of 80 times. These bundles often serve the purpose of justifying the credibility of studies. Narkprom and Phoocharoensil (2022) also found that the most used LB in methodology sections including bundles like *in the main study*, *in the pilot study*, and *the reliability of the*.

Structures of LB

Analysis of the structural categories of COMCET reveal the use of 11 structures. The only structure missing in the corpus is *Pronoun/noun phrase + be*. As shown in Table 5, the number of types corresponds to the total number of the LB falls under the structure, while raw frequency refers to the number of occurrences of the LB. The value for frequency per million or normalised frequency (McEnery & Hardie, 2011) represents the number of LB occurrences in every million words. The calculation of the normalised frequency (nf) was calculated using the following formula:

$$nf = (\text{number of examples of the word in the whole corpus} \div \text{size of corpus}) \times (1{,}000{,}000)$$

Table 5. Structures of LB in COMCET

No.	Structure	No. of Types	Raw Freq	Freq/ mil	%
1	Noun phrase with of-phrase fragment	32	1057	2465	27.85
2	Noun phrase with other post-modifier fragments	17	526	1227	13.86
3	Prepositional phrase with embedded of-phrase fragment	9	301	702	7.93
4	Other prepositional phrase (fragment)	23	935	2181	24.63
5	Anticipatory it + verb phrase/adjective phrase	1	32	75	0.84
6	Passive verb + prepositional phrase fragment	11	324	756	8.54
7	Copula be + noun phrase phrase	1	56	131	1.48
8	(Verb phrase +) that-clause fragment	2	101	236	2.66
9	(Verb/adjective +) to-clause fragment	4	113	264	2.98
10	Adverbial clause fragment	1	55	128	1.45
11	Other expressions	10	296	690	7.80
	Total	**111**	**3796**	**8853**	100.00

The analysis reveals the most frequently used structure is the *Noun phrase with of-phrase fragment.* It contains 32 unique LB with 2465 frequency per million which represents 27.85% of LB in the corpus. Some examples of the structure include *validity and reliability of* (82), *the purpose of the* (55), and *the results of the* (48). Biber et al. (2021) noted that the LB under this structure is often used to elaborate the physical elements of studies such as the identification of location, size, and amount. Further, it also recognises the abstract qualities of the studies. The other structure involving noun phrases, *Noun phrase with other post-modifier fragments* is also discovered in COMCET despite having the third highest occurrences in the corpus. This is expected since Biber et al. (2021) described it as a structure with "few recurrent expressions" (p. 1009). The structure records 17 instances and accounts for 13.86% of the LB. The bundles that are categorised under the structure include *the extent*

to which (76), *the data collection process* (39), and *the relationship between the* (26). The findings resonate with Lou (2012) and Ahmed and Ariannejad (2024) who discovered the noun phrase bundles as the most recurring in academic texts. Extracts 1 and 2 show how bundles with noun phrases took place in the corpus data:

> *Extract 1:*
> Respondents were informed regarding ***the purpose of the study***, the mechanisms that is being used to gather data, and that there will be no potential hazards or expenses associated.

> *Extract 2:*
> This was controlled through increasing the sample size by 40% to compensate for non-returned or uncompleted questionnaires and rejecting incomplete questionnaires from ***the data collection process*** while maintaining a valid number of completed questionnaires.

Additionally, LB with prepositional phrases are also used frequently in the corpus. This is evident from the analysis, with *Prepositional phrase with embedded of-phrase fragment* and *Other prepositional phrase (fragment)* recorded 7.9% and 24.6% of the total, respectively. Similar observation was also found in Hyland (2008b) who studied LB in postgraduate theses by ESL learners across five disciplines. This shows that despite being authored by writers of different backgrounds and research areas, academic writers share a similar understanding of language use in the genre (Chen & Baker, 2010). Some of the phrases under *Prepositional phrase with embedded of-phrase fragment* include *for the purpose of* (49), *in the context of* (47), and *at the end of* (40), while *in the current study* (53), *at the same time* (48), and *on the other hand* (43) are categorised under *Other prepositional phrase (fragment)*. Extracts 3 and 4 illustrate the use of prepositional phrases in COMCET.

> *Extract 3:*
> ***For the purpose of*** mitigating the third threat related to the subjects' reaction to the experimental condition, all subjects in this study were unaware of whether they would be assigned to the experimental or control group.

> *Extract 4:*
> Meanwhile, concurrent designs involve data collection in a single phase whereby qualitative and quantitative data are collected ***at the same time*** and are simultaneously implemented.

Biber et al. (2021) included six structures under the verb phrase category, making it the category with most structures. However, it only accounted for less than quarter of the overall LB in COMCET. This could be due to preferences of the thesis writers since academic writing prioritises objective and factual reporting which can be achieved using noun phrases. *Passive-verb with prepositional phrase fragment* is one of the verb phrases identified with 11 types of LB. The highest recorded lexical bundles under this structure is *used in this study* (81), followed by *is based on the* (30) and the lowest is *involved with this study* (21). The normalised frequency of this structure is 756, equalling 8.5% of the overall LB in the corpus. Wachidah et al. (2020) found in their study analysing the findings and discussion sections of graduate students' theses that prepositional phrase (fragment) is the most prevalently used among graduate students. This is supported by a study by Lou (2012) who observed the same trend in theses of 330 Chinese EFL learners. An instance of this structure is shown in Extract 5.

> *Extract 5:*
> The research design ***used in this study*** was randomised subjects, pre-test, post-test, and follow-up control group experimental design.

Other than that, the structure of *Verb phrase with that-clause fragment* accounts for 2.7% of the overall LB with two types of lexical bundles recorded, which are *to ensure that the (66)* and *to participate in the (35)*. The frequency registered for this structure is 236. According to Biber et al. (2021), most phrases with a main clause verb followed by a that-clause are considered part of larger

sentence structure. This *Verb phrase with that-clause fragment* expression definitely overlaps *anticipatory it with verb phrase/adjective* phrase. However, this structure only records 1 type of LB, which is *it is important to (32)* equalling the normalised frequency of 75. Extract 6 serves as an example of both structures.

> *Extract 6:*
> The pilot pre-test was used at the beginning ***to ensure that the*** format and the length of time allowed were appropriate.

> *Extract 7:*
> In education, concepts are socially manufactured phenomena; ***it is important to*** focus on what participants experience and how they "experience and interact with a phenomenon at a given point in time and in a particular context" (Heigham & Croker, 2009, p. 7).

As for *Verb/adjective with to-clause fragment* structure, there are 4 types of lexical bundles recorded, two of them show close frequency count which are *used to determine the* (35) and *to answer the research* (32). This structure accounts for 3% of the data. This structure is also used in other academic texts, such as in academic essays, as reported by Ibrahim (2020), who found a 4.2% usage of this lexical bundle in graphic-oriented and open-ended essays by upper-intermediate English language learners at a public university in Malaysia. Extract 8 shows an instance of the structure as found in the corpus data.

> *Extract 8:*
> In contrast, the experimental design was ***used to determine the*** effectiveness of CDIM on career competencies.

On the other hand, *Copula be with noun phrase* and *Adverbial clause fragment* both recorded only 1 type of lexical bundle each. *Is one of the (56)* represents *Copula be with noun phrase*, while *as shown in table (55)* represents *Adverbial clause fragment*. The former registers normalised frequency of 131 which equals to 1.5% of the LB in the corpus while the latter recorded a slightly lower overall percentage of 1.4% with a frequency of 128. Gezegin (2019) also found the usage of both LB in his study on published research articles among L1 Turkish speakers of English on 6 different academic disciplines. Biber et al. (2021) found that these structures frequently appear as complement clauses in standard declarative structures. Extracts 9 and 10 show how both structures were used in COMCET.

> *Extract 9:*
> Thus, she ***is one of the*** responsible teachers who involve the students in identifying potential sponsorship for the school's activities and programs.

> *Extract 10:*
> The first step in testing the moderation effect is to sort and split the data based on a median score of moderators into two separate data files ***as shown in Table*** (3.15).

The final category is *Other expressions*, which refers to LB "that do not fit neatly into any of the other categories" (Biber et al., 2021, p. 1017). In the present study, 10 bundles are not comparable to any categories, thus, placed under this structure. They have a raw frequency of 296, which constitutes 7.8% of the overall LB. Some examples of the structure include *as well as the* (66), *disagree to strongly agree* (32), and *as well as to* (22). An example of this category is presented in Extract 11:

> *Extract 11:*
> Therefore, it is likely that the question being asked in the research, ***as well as the*** findings obtained from the research, have the potential to be framed within the cultural perspective of the researcher (McLeod, 2001).

Functions of LB

Table 6 below summarises the functions of lexical bundles according to Hyland's (2008b) functional categorisation, namely research-oriented (RO), text-oriented (TO), and participant-oriented (PO). Figure 1 shows the distribution of the three main functions in terms of their frequency in every million words and percentage.

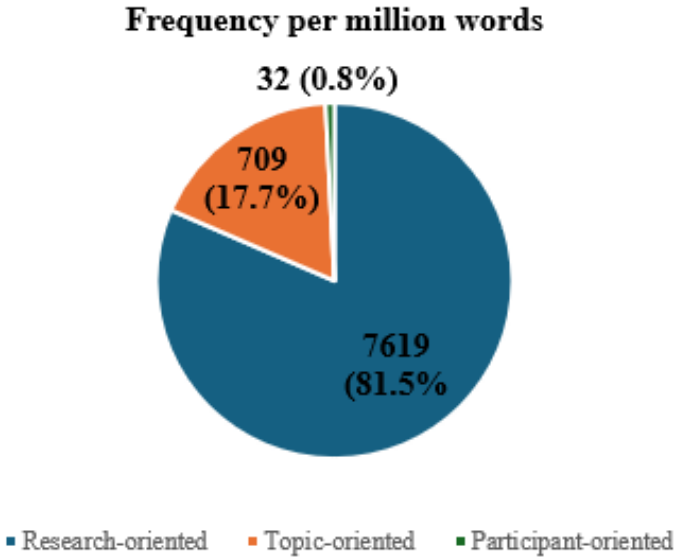

Fig. 1 The distribution of LB in the COMCET

As shown in Figure 1, research-oriented bundles constitute 81.51% of all lexical bundles, representing the largest proportion of LB types. Text-oriented bundles rank second and constitute approximately 17.69% of the total bundles, while participant-oriented bundles are used the least with only 0.80% of the total. The distribution could further be divided into ten subgroups as shown in Table 6.

Table 6. Functional categories distributions in COMCET

Function	**Raw Freq**	**Freq/mil**	**%**
Research-oriented	**3267**	**7619**	**81.51**
Location	322	751	8.03
Procedure	1618	3774	40.37
Quantification	44	103	1.10
Description	1251	2918	31.21
Topic	32	75	0.80
Text-oriented	**709**	**1654**	**17.69**
Transition signals	202	471	5.04
Resultative signals	48	112	1.20
Structuring signals	459	1071	11.45
Framing signals	0	0	0.00
Participant-oriented	**32**	**75**	**0.80**
Stance features	32	75	0.80
Engagement features	0	0	0.00
Total	**4008**	**934800**	100.00

Similar findings as presented in Table 6 were also reported by Faqih and Harjanto (2022) who discovered a similar trend with research-oriented bundles leading, followed by text-orientation and participant-oriented in their examination of the functional categories of lexical bundles in the Master's theses they studied. This finding is expected as COMCET comprises only the methodological section of doctoral dissertations. The finding is also consistent with Liu and Pan (2023) that reported higher instances of research-oriented lexical bundles in the method section of medical research articles they analysed. According to the researchers, they aid in providing methodological rigour and specificity to the section.

The research-oriented category is dominated by the procedure and description subcategories, which account for 40.37% and 31.21% respectively. Among the most frequently used lexical bundles within the procedure subcategory include *validity and reliability of* (82), *the reliability of the* (80), *the purpose of the* (55), and *the data collection process* (39) all of which are used to describe the methodological procedures undertaken for data collection and analysis as exemplified by Extract 1. Meanwhile, the lexical bundles in the description subcategory are used to provide additional details about the methodology of the study. Among the bundles used include *the extent to which* (76), *is one of the* (56) and *validity refers to the* (31). It is important to note that the lexical bundles under the description subcategory are closely connected to those in the procedure subcategory, as exemplified by Extract 2 where the bundle *to the extent to which* provides the details for *construct validity*.

> *Extract 12:*
> In this research, CFA was conducted as the first procedure in SEM analysis to test the unidimensionality, ***validity and reliability of*** each dimension.

> *Extract 13:*
> Construct validity refers ***to the extent to which*** a constructed item measures the same construct, or whether a construct correlates with another item constructed (Trochim, 2006 in Tate, Alexander, Waikar & Patagundi, 2010).

As for text-oriented bundles, they are primarily employed as structuring signals to frame and organise texts. There are only 5 types of bundles belonging to this subcategory and they include bundles such as *as shown in table* (55), *in the current study* (53) and *in the context of* (47). These bundles are used to draw the readers' attention to specific information or location in the text as exemplified by Extract 3 and 4, thus, guiding the readers through the text. Similarly, Abdullah (2022) in his comparison of three advanced mathematical genres found that text-orientation lexical bundles in doctoral dissertation were mainly used to guide readers through complex analyses, ensuring that the text flows logically and coherently.

> *Extract 14:*
> This study adopted multistage cluster sampling ***as shown in Table*** 3.1.

> *Extract 15:*
> ***In the current study***, peer influence was measured with 7- point Likert scale which showed a reliability value of 0.892 while factor loadings were more than 0.5, AVE more than 0.5) while square root of AVE of each construct is greater than inter-construct correlation).

Another subcategory that records some instances within the text-oriented category is transition signal that mainly serves as the additives or contrastive signals. Only four types are recorded for this subcategory that include *as well as the* (72) *on the other hand* (43), *at the same time* (48) and *as well as to* (22). Similar to structuring signals, they help in guiding the readers by highlighting connections between ideas, indicating shifts in focus, or introducing contrasting information, thereby enhancing the overall coherence and readability of the text as illustrated by Extracts 5 and 6.

> *Extract 16:*
> This chapter identifies the most suitable sampling method to use to align with the research design ***as well as the*** methods of data collection and analysis.

Extract 17:
Participants of Cohort 2 ***on the other hand***, received CMLT-B programme as the treatment, in which three participant-centred learning tools (case studies) were used as part of the instructional methods.

Nevertheless, the limited types and frequencies of text-oriented bundles in the methodological sections of the dissertations in comparison to the research-oriented bundles reflects the nature of the section that places heavy emphasis on the objectivity of the study rather than the narrative structuring.

The findings also reveal that participant-oriented bundles are scarcely used, with only one stance feature recorded; *it is important to*. It is used mainly to provide justification to the methodological procedures undertaken by the studies as exemplified by Extract 7 and 8.

Extract 18:
To make the cases comparable, ***it is important to*** note here that this study does not intend to judge which teachers have displayed the best practice in grammar teaching.

Extract 19:
It is important to mention that not all participants in the interviews and discussion participated in member checks.

The limited employment of the writer's stance and engagement lexical bundles further reflects the objectivity of the method section that aims to present procedures of the research, rather than directly engaging with the readers. Similarly, Salazar (2011) observed limited usage of participant-oriented bundles in published scientific prose especially among non-native writers of English, which according to the researcher is the result of overusing certain bundles and underutilising participant-oriented bundles. However, the same conclusion could not be drawn in this study, as it would require a more in-depth analysis.

Conclusion

This study analysed the use of lexical bundles (LB) in the Methodology chapters of Education doctoral theses by students at a Malaysian public university. A total of 50 Methodology chapters were extracted to form a corpus referred to as COMCET. To reveal the use of LB, the study first examined the most frequently used four-word LB, ranking them according to their raw frequency. Additionally, the structures and functions of the LB were investigated. The findings demonstrated that LB played a pivotal role in structuring the Methodology chapter, enhancing clarity, and assisting readers in comprehending complex processes. Furthermore, the results showed that research-oriented bundles associated with procedure and description occurred frequently. This was exemplified by LB such as *validity and reliability of*, *the purpose of the*, and *the extent to which*. These bundles highlighted their importance in conveying a detailed and precise explanation of the chapter.

The findings of the structural analysis of LB unveiled noun phrases as the most frequently used structures, signifying their roles in framing sentences and conveying complex ideas succinctly. Further, noun phrases also serve a referential function which allows writers to refer to specific concepts or theories without redundancies (Cortes, 2004). Besides noun phrases, COMCET also had a rather high frequency of prepositional phrases. This category is often associated with expressing logical relationships between ideas which helps with clarification of the connections and transitions in academic writing (Pan & Liu, 2019). Besides that, LB categorised under verb phrases were also found in the corpus. However, it had a relatively low percentage of occurrences compared to the other phrases which could be as a result of writers' preferences or functional limitations that the phrases have (Cortes, 2013). The last category included other phrases that did not fit any previously mentioned structures.

As for the functions, research-oriented bundles were the most prevalent in the methodology sections of doctoral dissertations, followed by text-oriented. Meanwhile, participant-oriented bundles

were much less common. This trend is consistent with previous studies by Liu and Pan (2023) and Faqih and Harjanto (2022), which suggest that research-oriented bundles help maintain methodological rigour and clarity, by providing detailed descriptions, explanation and justification for the methodological procedures involved in doctoral research. Whilst, text-oriented bundles provide the means for text organisation and structure, which is also crucial in maintaining text clarity (Abdullah, 2022). Participant-oriented bundles, however, were not used as frequently due to the nature of the methodological section, which emphasises on the objectivity of research rather than interaction with the reader.

To conclude, the current study is an addition to the growing body of knowledge on LB in academic genres by focusing on the understudied Methodology chapter of theses. The findings serve as valuable implications specifically to educators and postgraduate students as well as to readers in general. ESL learners who are at the writing stage of their theses may learn how LB helps to make their writing coherent and makes them sound fluent in their writing (Hyland, 2008b). As for the language instructors or thesis supervisors, they may incorporate targeted LB into their curriculum. The practice will help students to achieve native-like academic writing skills. Lastly, this study will assist readers to understand the importance of structures and functions of LB in composing cohesive texts (Pan et al., 2016).

Suggestion for Future Research

Since the study analysed only the methodology section of the doctoral thesis, future research should be expanded to include analysis of other sections of the thesis and examine the differences and similarities in the structures and functions of bundles across these sections. Further analysis of how the differences and similarities affect the quality of the thesis is also needed, as the findings can provide valuable insights into effective academic writing practices and guide learners in structuring their work more effectively.

Co-Author Contribution

The authors confirmed that there is no conflict of interest in this article. Author 1 initiated the idea, obtained the corpus, wrote the introduction, methodology, findings and conclusion. Authors 2 and 3 cleaned the data, wrote the literature review and findings and interpreted the analysis. Author 4 interpreted the analysis, wrote findings and conclusions.

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