AUTOMATIC ANALYSIS OF LEXICAL COMPLEXITY: EVALUATING THE LINGUISTIC PERFORMANCE OF THE NATIONAL AND INTERNATIONAL PUBLICATION

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Abstract

This research is a kind of a comparison study that deals with lexical complexity in the Indonesian scholars' journal articles. The analysis covers 98 journal articles from the national and international publication using 25 lexical complexity indices. Results of the research showed that the journal articles of international journals have higher mean scores of lexical complexity indices than the national, but significant differences only occurred in the indices for the lexical sophistication and lexical variation, particularly the type-token ratio and verb variation. This may show the performance gap between the two publications from Indonesian academics as to share the lexical characteristic of the international publication surpass the national.

Keywords: EFL writers, lexical complexity, indonesia

Abstrak

Studi komparatif ini membahas lexical complexity dari artikel-artikel jurnal yang dihasilkan para penulis Indonesia. Analisis dilakukan terhadap 98 artikel jurnal terbitan nasional dan internasional dengan memakai 25 indeks lexical complexity. Hasil penelitian memperlihatkan bahwa artikel-artikel jurnal terbitan internasional memiliki rerata indeks lexical complexity lebih tinggi dibanding terbitan nasional, namun perbedaan signifikan hanya terdapat pada indeks-indeks lexical sophistication dan lexical variation, terutama pada rasio type-token dan verb variation. Hal ini bisa jadi merefleksikan adanya performance gap antara kedua kelompok publikasi yang dihasilkan para akademis Indonesia, sekaligus memperlihatkan bahwa karakteristik leksikal dari publikasi internasional lebih tinggi dibanding publikasi nasional

Kata kunci: *penulis bahasa inggris sebagai bahasa asing. kompleksitas leksikal, indonesia*

1. Introduction

In the literature of academic writing, publishing in scholarly journals has become a publication requirement for both faculty members and students. In Asian contexts, as the discourse of internationalization in higher education has been burgeoning, both graduate students and faculty members are required to publish nationally and internationally. The discourse of publish-or-perish games has created a dilemma among graduate students and faculty members. In China, for example, publishing research is an essential part of educators' professional works that some of them see that university demands the publication rather than other duties of being

educators, like teaching and supervising students (Yuan, 2021). In the Middle East, the government pours generous rewards for publication even though publishing research is a challenge itself for the scholars (Ahmed, 2020).

In Indonesia, the requirement for publication is regulated under tri dharma (three roles) of the lecturers which is added to the obligation of post research. With certain consequences related to publication, publishing in international journals, which is more recommended by universities mostly due to ranking, adds challenges for the academics in terms of language, particularly with EFL writers. They still face English as a barrier to write research articles and to publish them later internationally, as experienced by Indonesians (Arsyad, Purwo, Sukamto, & Adnan 2019). The problem makes it necessary to study the linguistic aspects of the journal articles written by Indonesian scholars in order to see the linguistic performance and the actual linguistic problems they face as writing journal articles in English.

Research on journal articles related to the Indonesian context compares the language features of the journal articles between the nationally and internationally publications or between Indonesian and international authors. Most of the studies cover the discussion on the linguistic aspects at the discourse level: rhetorical structure (Argument pattern (Bermani, Safnil, & Arono, 2017)), style (writing argumentatively (Arsyad, 2018); review and citation styles (Arsyad et al., 2018)), as well as the linguistic features and devices to develop the discourse (tense and aspect of citation (Arsyad, Zaim, & Susyla, 2018); Meta-discourse devices (Jasrial, Arsyad, & Arono, 2019); logical connectors (Kurniawan, Dallyono, &Cahyowati, 2019); authorial stances (Miasari, Arsyad, & Arono, 2018)). Generally, the research report more similarities than differences between the journal articles written by Indonesian and international authors and the journal articles published national and international.

The studies on the linguistic features of the journal articles at the discourse level show some linguistic characteristics of how ideas are presented. Little to record the linguistic features composing a text, like lexical choice, as the basic components in writing and even used in assessing composition. Studies have shown that the indices of lexical complexity can be used to study the performance of academic writing (Ortega, 2012). Related to journal publication, lexical complexity has been identified to correlate with the quality of the articles (Lu et al., 2019). With the three most common dimensions of lexical complexity: lexical density, lexical sophistication, and lexical variation, it can be seen the surface aspects of the vocabulary composing journal articles, the depth, spread, and level of the vocabulary. With the advantage of technology development nowadays, the study of lexical complexity is open to study larger corpora and use the help of the automatically and user-friendly softwares.

In this study, Lexical Complexity Analyzer (Lu, 2010; 2012) is used to help to describe the lexical complexity of journal articles written by Indonesians which are published in national and international journals. The automatic software contains several lexical complexity indices gathered from different previous studies which can be chosen in relevance to the need for a particular study of lexical complexity.

Even though the software has been used in the studies of the second language learners' writings (Djiwandono, 2016; Johnson, 2017; Lu, 2012; Yoon, 2017), the indices can be used to describe the word choice in the written texts of the advanced level writers. To fill the gap of minimum existence of lexical complexity studies of journal articles, this study aims at comparing the lexical complexity of the journal articles written by Indonesian scholars which are published nationally and internationally by seeking the answer to the question How is the lexical complexity of articles published in the national journals different from the ones published in international journals?

1.1. Studies on lexical complexity

As one of the two forms of linguistic complexity (Lu et al., 2019), lexical complexity can be used to differentiate the feature between spoken and written language, including the distinct feature of scientific writing (Biber & Gray, 2010). Lexical complexity has been studied in the area of academic writing to describe the characteristic of the writings of second language writers, to compare the different features of academic language between native and non-native writers, and even in language assessment. It has been elaborated in similar way, that lexical complexity (Lu et al., 2014), or lexical richness (Lu, 2012), is used to describe "a multidimensional feature" of language (Lu, 2012). It is used to describe the variety of vocabulary size in order to describe some factors affecting writing quality as well as vocabulary knowledge and performance (Laufer & Nation, 1995). The evaluation of lexical complexity of a text is elaborated in certain "indices" (Lu, 2012), the measures that indicate particular variables characterizing a text's lexical composition. There are three main indices of lexical complexity commonly discussed in the literature of linguistic complexity: Lexical Density (LD), Lexical Sophistication (LS), and Lexical Variation (LV) (Lu, 2012).

Lexical Density (LD) refers to the ratio of the lexicon and the tokens used in a text (Lu, 2012). Lexical density is used to describe the depth of vocabulary in academic writing. Previous studies of lexical density compare two or more variables or find a correlation to particular variables. Lexical density studies reveal its correlation to gender and genre. (Ginting, 2018), for instance, found that females write more lexical density in descriptive writings than males. In relation to text genre (Vera et al., 2016), the three different genres of narrative, persuasive, and informative texts differ in lexical density.

Lexical Sophistication (LS), also referred to as lexical rareness, is related to the use of "unusual or advanced words" in a text (Lu, 2012). The study of lexical sophistication has been associated with language proficiency and development. In language proficiency, students of lower proficiency use the most frequent words that affect assessment on their writings; the lower proficiency students receive lower scores as they use less sophisticated words (Higginbothom & Reid, 2019). Therefore, the variables of lexical sophistication are used to predict second language writing quality (Kim, Crossley, & Kyle, 2018) as well as language assessment (Vögelina et al., 2019). Lexical sophistication is also used as an indicator of language development (Kim, Crossley, & Kyle, 2018); (Tracy-Ventura, 2017) which able to differentiate between non-expert and more

expert writers (Palfreyman & Karaki, 2019) and effectiveness of tasks performed during learning (Kyle & Crossley, 2015).

Lexical Variation (LV), also called lexical diversity or lexical range, refers to the range of vocabulary used in a text from the proportion of the types and tokens used in the text (Lu, 2012). Lexical variation is affected by several factors, like prior knowledge, text genre (Vera et al., 2016), and teaching/learning strategies (Çepni & Demirel, 2016). As lexical sophistication, lexical diversity is also used as an indicator of writing proficiency (Djiwandono, 2016) and development to indicate the effectiveness of a program (Allaw & McDonough, 2019) and source and objectivity of assessment, (Vögelina et al., 2019).

1.2. Lexical competence and academic writing

Lexis in writing has been discussed in two groups, as a source of assessment and in the assessment itself. In the first group, lexical items are the resource for language production (Dabbagh & Enayat, 2017); (Crosson, McKeown, & Ward, 2019) to encode the writer's thoughts and views of meaningful information (Dabbagh & Enayat, 2017) in order to be able to perform the writing task in a readable text. As a resource, vocabulary knowledge is "a prerequisite for writing" (Li & Schmitt, 2009). As lexis is the source in writing, the performance of the writing is also assessed by certain aspects of lexical use in writing performance; the quality of writing is assessed through the use of vocabulary. Lexical use is included in the language use category to measure the writing performance (He et al., 2013). The idea is adopted in the assessment of English learning for assessing the essay quality of foreign language learners (Fritz & Ruegg, 2013). Hence, it is necessary to generate what kinds of aspects of the word knowledge that are able to enhance the vocabulary use in writing in order to be able to modify teaching instruction mediating writing performance.

Of the discussion of lexical competence, the vocabulary knowledge of L2 learners is described in various approach, with two, three, or four dimensions of the breadth (quantity), depth (quality), receptive-productive control, and lexical organization (Zareva, Schwanenfluel, & Nikolova, 2005) (Putri & Kardena, 2022). The two dimensions, breadth and depth, perhaps the most commonly adopted approach in assessing the writing performance of L2 writers. Breadth deals with the quantity of vocabulary used in a writing, the vocabulary size, in terms of the number of words known by the writer at a surface level of form-meaning associations (Crosson et al., 2019). Depth is related to the quality of lexical knowledge in which the knowledge of words (Crosson et al., 2019) is assessed by the indicators of associative behaviour, meaning the connectivity among words in the L2 mental lexicon and nativelikeness (Schmitt, 1998); (Zareva et al., 2005) (Putri & Melani, 2022). It is the measures of depth that contribute significantly to reading comprehension (Qian & Schedl, 2004) as it indicates text readability. (Dabbagh & Janebi Enayat, 2019) also adopted the two dimensions in their study considering the need of L2 writers for a rich vocabulary (breadth) and knowledge of word associations (depth) to best describe a person, object, place, or event in their essays. In their studies, (Wu et al., 2021).

concluded that vocabulary breadth contributed to EFL writing performance. The discussion on the assessment with three dimensions, quantity, quality, and receptive-productive control, were by (Henriksen, 1999). The receptive-productive dimension, as the third dimension, bridges lexical competence and performance. It is identified in the variables of word familiarity (Zareva et al., 2005), degree of automaticity (Meara, 1996); (Zareva et al., 2005), and word frequency (Laufer & Paribakht, 1998); (Zareva et al., 2005). As in a study by Zhong (2016), the production of sentence writing is related to the receptive knowledge of meaning, form, word class, collocation and association, and productive vocabulary knowledge. Then the assessment with the four dimensions adds lexical organization to the group (Qian & Schedl, 2004).

2. Method

2.1. Research Design

This research was conducted under comparison contrast design which belong to quantitative research. This research used comparative research since it aims to compare the lexical complexity of the articles between the nationally and internationally published journals, 98 texts written by Indonesian, or in collaboration with Indonesian scholars, have been gathered; 56 articles of the national publication and the other 42 of the international. For homogeneity, all articles are presented in English discussing topics on English linguistics and English teaching. The national journals were gathered from SINTA (Science and Technology Index), one of the Indonesian research databases containing various information related to the national publication. From thirteen journals, the top seven were taken as the sources for articles. The number of articles selected further represent each volume, as in Table 1 below:

Table 1. Sources for the nationally published journal articles

No	Journal	Level	Impact	Article
1.	Indonesian Journal of Applied Linguistics (IJAL)	S1	3.04	14
2.	Journal of English Education and Linguistics Studies (JEELS)	S2	1.73	4
3.	Journal of English Educators Society (JEES)	S2	1.05	8
4.	English Review: Journal of English Education	S2	1.02	14
5.	Journal on English As A Foreign Language (JEFL)	S2	0.92	4
6.	Edulite: Journal of English Education, Literature, and Culture	S2	0.89	4
7.	Studies in English Language and Education (SIELE)	S2	0.87	8
	Total			56

All of the 56 selected articles are all published in 2019. The articles of the international journals are published in 2019 and 2020 from reliable publishers and traceable at schimago, the recommended site among scholars for tracing the reliable reference sources.

Table 2. Sources for the internationally published journal articles

No	Publisher	Article
1.	Cogent OA	2
2.	Elsevier	1
3.	Emerald	2
4.	King Saud University	1
5.	Oxford	2
6.	Routledge	17
7.	Sage	1
8.	Springer	2
9.	Taylor & Francis	5
10.	Wiley	4
11.	Others	5
	Total	42

Each of the texts was then converted into Microsoft words for more editing purposes leaving only the text content. There was no grammatical editing in order to maintain the originality of the lexical performance of the writers. The conversion was also done to be able to process the texts later in the Lexical Complexity Analyzer (LCA) program.

Table 3. Summary of data

Group	National (NA)	International (IA)
Number of journal article	56	42
Average length of journal article	4,995.304	5,447.881
Standard deviation of length	1,318.777	2,214.922
Total number of words	279,737	228,811

2.2. Data analysis procedure

The data analysis was conducted in two main parts, gathering the indices of the lexical complexity and comparing the numerical results of the two data sets, the nationally vs. internationally published journal articles. For the first step, the LCA program reported numeric data from the calculation of each lexical indices of different categories. As each category of the indices had been gathered, the comparison was placed with a t-test.

2.2.1. Measurements of lexical complexity

The measurement tool of lexical complexity employed in this study was the online program of LCA (https://aihaiyang.com/software/lca/single/), which was developed by Ai and Lu (X. Lu, 2010) and has been used widely to help describing the lexical complexity performance of either spoken or written texts. The program consists of the measures, or indices, compiled from different experts. LCA can run an automatic calculation for each lexical complexity indices and provides a certain number for each index.

The LCA contains one indices of lexical density, five indices of lexical sophistication, and nineteen indices of lexical variation. Lexical density indices provide the ratio of the lexicons and tokens used in a text with the formula LD=Nlex/N (Lu, 2012, p.193), where LD: lexical density, Nlex: number of the lexicon, and N: number of tokens. Lexical sophistication offers five different measures:

Table 4. Indices of lexical sophistication

Indices	Code	Formula
Lexical sophistication-I	LS1	N_{slex}/N_{lex}
Lexical sophistication-II	LS2	T_s/T
Verb sophistication-I	VS1	T_{sverb}/N_{verb}
Verb sophistication-II	VS2	T^2_{sverb}/N_{verb}
Corrected VSI	CVS1	$T_{sverb}/\sqrt{2N_{verb}}$

(**Source**: (X. Lu, 2012)

and lexical variation comes with more numerous modes of indices, as described below:

Table 5. Indices of lexical variation

Indices	Code	Formula
Number of different words	NDW	T
NDW (first 50 words)	NDW-50	T in the first 50 words of sample
NDW (expected random 50)	NDW-ER50	Mean T of 10 random 50-word samples
NDW (expected sequence 50)	NDW-ES50	Mean T of 10 random 50-word sequences
Type-Token ration	TTR	T/N
Mean segmental TTR (50)	MSTTR-50	Mean TTR of all 50-words segments
Corrected TTR	CTTR	$T/\sqrt{2N}$
Root TTR	RTTR	$T/\sqrt{N}$
Bilogarithmic TTR	LogTTR	LogT/LogN
Uber Index	Uber	$Log^2N/Log(N/T)$
Lexical word variation	LV	T_{lex}/N_{lex}
Verb variation-I	VV1	T_{verb}/N_{verb}
Verb variation-II	VV2	T_{verb}/N_{lex}
Squared VV1	SVV1	T^2_{verb}/N_{verb}
Corrected VV1	CVV1	$T_{verb}/\sqrt{2N_{verb}}$
Noun variation	NV	T_{noun}/N_{lex}
Adjective variation	AdjV	T_{adj}/N_{lex}
Adverb variation	AdvV	T_{adv}/N_{lex}
Modifier variation	ModV	$(T_{adj}+T_{adv})/N_{lex}$

(**Source**: X. Lu, 2012)

The measurement results of all lexical complexity indices of the articles published in the national and international journals gained from the LCA were then paired for further test.

2.2.2. t-test

The question addressed in this study is whether there are significant differences between the lexical complexity of the journal articles published nationally and internationally. A series of t-test was conducted on the two data sets of lexical complexity for each category of lexical complexity indices. As the investigation is done to 25 indices, indicating that there are 25 test are performed on the same dataset simultaneously, the Bonferroni correction is also done to set the new alpha value (α), resulting in at 0.002; the alpha value for each comparison is 0.05/25, or 0.002, where the 0.05 is the significant level for the complete set of tests, and 25 is the number of the individual test being performed. The t-test results are performed in the "differences" column of Table. 6. The results reveal a statistically significant difference (ϱ<00.2) in the mean values of the 25 indices between the IAs and NAs. The t-scores reveal the degree of significant differences between the two data groups. The differences show the gap of writing performance between the national vs international journal articles written by Indonesian writers in terms of lexical complexity.

3. Results and Discussion

At glance, the mean values of all lexical complexity indices of the IAs are higher than the NAs, but the differences in the mean complexity values between IAs and NAs behave differently, as seen in the following table:

Table 6. Mean complexity values and differences for the groups of national and international journal articles (NA and IA)

Indices	Code	National (NA)	International (IA)	Differences (NA vs. IA)
Lexical Density	LD	0.529	0.535	-
Lexical sophistication				
Lexical sophistication-I	LS1	0.317	0.371	+
Lexical sophistication-II	LS2	0.379	0.428	+
Verb sophistication-I	VS1	0.080	0.122	+
Verb sophistication-II	VS2	4.125	8.444	+
Corrected VSI	CVS1	1.369	1.954	+
Lexical variation				
Number of different words	NDW	927.214	1,023.976	-
NDW (first 50 words)	NDW-50	38.554	39.452	-
NDW (expected random 50)	NDW-ER50	40.036	40.712	-
NDW (expected sequence 50)	NDW-ES50	37.325	38.490	-
Type-Token ratio	TTR	0.183	0.201	-
Mean segmental TTR (50)	MSTTR-50	0.749	0.769	+
Corrected TTR	CTTR	9.136	9.679	-

Root TTR	RTTR	12.921	13.673	-
Bilogarithmic TTR	LogTTR	0.799	0.807	-
Uber Index	Uber	18.563	19.262	-
Lexical word variation	LV	0.284	0.313	-
Verb variation-I	VV1	0.324	0.390	+
Squared VV1	SVV1	61.099	77.890	+
Corrected VV1	CVV1	5.466	6.156	+
Verb variation-II	VV2	0.070	0.078	-
Noun variation	NV	0.260	0.280	-
Adjective variation	AdjV	0.058	0.065	-
Adverb variation	AdvV	0.024	0.024	-
Modifier variation	ModV	0.082	0.092	-

+ indicates a statistically significant difference ($\varrho<0.002$; - indicates a non-significant difference ($\varrho\geq0.002$)

3.1. Lexical density

The lexical density of both journal articles published nationally and internationally are slightly above 50 percent, which indicates that the articles of the journals form both groups contain dense lexical items. The obvious reason probably there are limitation of number of words to submit articles in the journal articles; the authors have to be able to report a complete research report in a certain word number. It is common to have a lexical density of 50 percent and above for scientific writings since the writers have to select words carefully to comprehensively express their idea. The high percentage for lexical density may also be related to the text type and level. concluded that texts in humanities tend to high in lexical density, particularly since they are informative (Gómez Vera et al., 2016) in reporting research results on English linguistics and English teaching. Then, the texts are also the high proficiency texts that are possible to have a higher lexical density (Delić & Jašić, 2017). Then, while the mean value of the IAs is higher than the NAs (0.535 vs. 0.529), it turns out that they are insignificantly different (0.210). It indicates that the lexical items used in the journal articles published in Indonesia and published internationally are equally dense.

3.2. Lexical sophistication

The results from the calculation of the lexical sophistication of the journal articles published internationally and in Indonesia show the percentage of the rare words used in the texts. The use of sophisticated lexical items is high, above 30 percent. It is related to the academic nature of journal articles in which scientific terms and academic words are used in the composition. The high percentage is also related to the proficiency level of the writers; that writers of high proficiency relied on low-frequency words the words which are rarely used in common texts. The results are in line with previous studies underlining that lexical sophistication is an indicator of advance in writing proficiency (Djiwandono, 2016).

As the mean values of the five different indices of the lexical sophistication are compared, they show that the IAs have higher mean values than the NAs. Different from the lexical density results, the differences in mean complexity values of the five indices are statistically significant. All of the indices results are close to 0.000 for both lexical sophistication and verb sophistication. The comparison on the lexical sophistication between the IAs and NAs indicates that the writers of the NAs may not employ lexical items as sophisticated as the other group, as indicated by the ϱ-value which is ≥ 0.002. This means that the articles published in international journals do employ more sophisticated lexical items as well as sophisticated verbs, the words only occur in fewer contexts (Kyle & Crossley, 2016).

3.3. Lexical variation

Similar to the lexical sophistication, the percentage of word type (T) used by the writers of the journal articles is also above 30, which indicates the high variant of words employed in the texts. As in the lexical sophistication, prominent diversity is also found in the verbs used. The parallel results occur may be due to texts with a high percentage of lexical sophistication take advantage of the lexical variation (González, 2017). The level of the writers is also another factor that may influence lexical variation; highly proficient writers write in highly diverse words.

In the comparison between the IAs and NAs, the mean values of the IAs' lexical variation are higher than the NAs'. However, the differences in mean complexity values show different significances at different indices. In terms of the overall lexical variation, only one measure convinces that the lexical items used in the IAs is significantly more various than the NAs, that is the MSTTR-50. Other indices of various uses of lexical items do not show significant differences in mean values. Significant differences are also found in the use of verbs (except in indices of VV2); the verbs employed in the IAs are significantly different from those of the NAs. This means that the articles published in international journals do use more various verb choices than national journals. To the indices of nouns, adjectives, adverbs, and modifier variation, the ϱ-values show insignificant differences between the journal articles published nationally and internationally. It means both publications used an equal variety of the word classes. The results are different from the research of (Djiwandono, 2016) and (Delić & Jašić, 2017), which show that a higher writing level should contain more various lexical choices, particularly nouns.

Overall, from the statistical results of ϱ-value, it seems that the articles written by Indonesian scholars published in national and international journals behave differently; there is parallelism between lexical sophistication and lexical variation; as the more sophisticated words are used in the IAs, the more various lexical choices. The similarity may indicate that the writers of both groups have equal prior knowledge (Bui, 2021) on English linguistics and English teaching.

4. Conclusion

The study provides a comparison of lexical complexity in the writing productions of Indonesian scholars publishing articles in national and international journals covering the areas of lexical density, lexical sophistication, and lexical variation. Even though the mean values of the lexical complexity indices of the international publication are higher than the national, significant difference only distinct in several indices of lexical sophistication and lexical variation, showing that the international publication surpasses the national in terms of the uses of sophisticated lexical items, especially sophisticated verbs, and contain more varied verbs. This information may give an insight into the writing performance gap between the national and international publications, as also sounded by Yin, Gao, and (C. Lu et al., 2019).

The different lexical achievement opens a possibility for the lexical complexity and its indices as an assessment tool for selecting reading materials for writing purposes (X. Lu et al., 2014) or managing instruction for publication writing. However, further study is still needed due to the limited scope of this study; the analysis focuses only at the lexical level in specific to the field of English linguistics and English teaching that may affect the working lexicons. Further research with a higher linguistic level and more data sources is needed to give a more comprehensive insight into the linguistic differences.

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