

## Lexical Density, Lexical Diversity and Academic Vocabulary Use: Differences in Dissertation Abstracts

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### Abstract

This study examines lexical density, lexical diversity and academic vocabulary use in the dissertation abstracts written by EFL (English as a foreign language), ESL (English as a second language) and English L1 (Native Speakers) postgraduate students to find out whether these lexical features differ across different English language backgrounds of writers. The data for this study came from a total of 75 dissertation abstracts (n=25 per group) which were about English Language Teaching and related areas. The abstracts were analyzed whereby automated text processing tools and the mean differences were compared between groups with ANOVA and post hoc analysis. A correlation analysis was also computed between the investigated variables. According to the findings, the lexical diversity index produced statistically significant differences between EFL and NS groups, however, the subtle mean differences in lexical density and academic vocabulary use were not found significant. On the other hand, the correlation co-efficient scores offered insights into the nature of relationships of the variables in question. The findings are discussed within the framework of the idiosyncratic context of the ‘abstract genre’.

**Keywords:** *Academic Vocabulary Use, Dissertation Abstracts, Language Processing Tools, Lexical Density, Lexical Diversity*

### INTRODUCTION

Lexical density and lexical diversity, as two most accurate and popular measures of linguistic and lexical competence, have been thoroughly scrutinized both in L1 and L2 English writing studies. Such studies regard lexical density and diversity as crucial independent components of well-developed and refined pieces of student and academic writing (Crossley, Salsbury, McNamara, & Jarvis, 2011; Lu, 2012; Nasser & Thompson, 2021) and a strong index of L2 writing quality (Olinghouse & Wilson, 2012; Maamuujav, Olson & Chung, 2021). There are also studies that conclude that lexical density and diversity features of academic writing develop along with time, exposure to language and generic linguistic proficiency (Bulte & Housen, 2014; Kim, 2014; Mazgutova & Kormoz, 2015). Defining clear boundaries for these two lexical constructs is of great importance and holds certain challenges. Although lexical density and diversity will be defined and presented in detail in the following sections, broadly speaking, lexical density is the magnitude of content words to all words (tokens) in a written text, while lexical diversity is concerned with the use of unique and non-repetitious words, evoking variation. However, though closely associated, lexical density in a text does not necessarily guarantee lexical diversity or vice versa. For example, a text which is densely packed in terms of lexis may display low lexical diversity (Johansson, 2008).

As Nasserri & Thompson (2021, p.2) wrote “abstracts are self-contained microcosms of dissertations in which a student has to describe and summarize a whole research/dissertation in a limited number of words, usually between 200-300 words”. It is understood that dissertation abstracts are likely to be lexically dense and diverse as well as to contain academic vocabulary, which is described as “comparatively large, precise and formal” (Ranney, 2012, p.563). It may be concluded that trying to employ such academic language and vocabulary usage may bring on a supposedly high levels of lexical density and diversity in the idiosyncratic context of abstract writing. Thus, the aim of this study is to examine the lexical density and diversity features (and differences, if any) of dissertation abstracts written by EFL (English as a foreign language), ESL (English as a second language) and English L1 (Native speakers) post graduate students to find out whether these lexical features change across different language proficiency and L1 backgrounds of the writers. In the light of the stated research aim, the current study addresses two research questions;

To what extent do lexical density, diversity, and academic vocabulary use differ in the dissertation abstracts written by EFL, ESL, and NS postgraduate students?

Is there a relationship between the measures employed to assess lexical diversity and density?

## LITERATURE REVIEW

### Lexical density and lexical diversity: definitions and measures

Though closely associated, the terms ‘lexical density and lexical diversity’ do not exactly point to the same entity. Lexical density is defined as the percentage of content words to all words which are present in a text (Laufer & Nation, 1995). Johansson (2009), thus, argues that lexical density is firmly related with *information packaging*. While function words such as prepositions, pronouns and determiners, etc., rather serve syntactic functions in a text, content words (i.e., nouns, adjectives, and adverbs) carry more semantic information. As a result, texts with a larger percentage of content words are regarded as being dense because they include more information than texts with a higher percentage of function words (Johansson, 2009).

Lexical diversity, on the other hand, is more straightforwardly concerned with variation and/or range of vocabulary. Malvern, Richards, Chiepere & Duran (2004, p.3) define diversity as “the range of vocabulary and avoidance of repetition, which means non-repetitious words which is used in a wide array of usage results in lexical diversity. Reciprocal terms have been proposed in the literature to define lexical diversity, several of which were ‘lexical variation’ (Engber, 1995), ‘lexical density’ (O’Loughlin,1995), “a combination of lexical variation and lexical sophistication” (Laufer, 2003, p.24), and ‘lexical richness’ as coined by Daller, von Haut & Treffers-Daller, 2003).

Despite the lack of universally agreed definitions, overlaps and independent conceptualizations with clear boundaries, lexical diversity and density have been regarded as a fundamental part of learners’ writing quality and their universal linguistic competence (Laufer & Nation, 1995). A number of highly regarded language assessments and computerized language evaluation tools take lexical diversity and density into consideration in their assessment criteria.

IELTS addresses lexical diversity whereby the term “the range of vocabulary the candidate has used” (IELTS, Handbook, 2007). “Appropriate and precise use of grammar and vocabulary” is referred by TOEFL iBT, which is another internationally regarded language test (TOEFL iBT Scores, 2005). Likewise, the essays of the candidates in Michigan English Language Assessment Battery must contain “a wide range of appropriately used vocabulary” (MELAB, Technical Manuel, 2003).

When it comes to the quantification methods of lexical density and lexical diversity, as its name suggests, lexical density is quantified and measured through a mere ratio of content words to all words (tokens) in a text. The higher the percentage score is, the more densely packaged the text is. However, the quantification methods of lexical diversity are more varied. The earliest and the simplest technique of measurement is called ‘the number of different words’ (NDW), which is solely the reliant on the counting of unique words (types) in a text as put forward by DeBoer (2014). NDW was, then, followed by the type-token ratio (TTR) method. As a modified version of NDW, TTR calculates a ratio of different words (types) to all words (tokens) in a given text. On the other hand, both of these methods have a serious flaw in that they are affected by text length. Malvern et al., (2004) state that the usage of a new word increases TTR on the condition that it has not been used before in the text. That is to say, when new words are introduced to a text, a number of types and tokens does not rise on the same scale. With technological advancement, NLP-based text processing tools such as Coh-Metrix have been introduced and made readily available for textual and linguistic analysis of written texts (Graesser, McNamara & Kulikowich, 2004; Crossley & McNamara, 2009; Crossley, Salsbury & McNamara, 2009). Coh-matrix offers two recent methods to quantify lexical diversity; Vocab D and MTLD (a *measure of textual length diversity*), which are also applied in analyzing the data of this study. Malvern et al., (2004, p.51) define that Vocab D, at random, calculates the TTR scores of 100 samples of 35 tokens, which is automatically repeated until reached the ultimate and most accurate TTR curve among suggested curves. As defined by McCarthy and Jarvis (2010), MTLD in a similar vein, functions on a segmental basis. In MTLD, separate segments of 100 word-length is randomly taken with the condition that each segment must first reach a TTR of at least .720. An MTLD score is then coined as the ultimate product of recurrent TTR calculations of different segments. Vocab D and MTLD measures are supposed to eliminate the so-called text length effect which seriously invalids the traditional TTR method.

### **Lexical profile of abstracts as a sub-section of academic writing and academic word list (AWL)**

According to a number of studies, the abstract section of a thesis, dissertation, or research article is a special type of academic writing that is distinguished by a lexically dense outline and a brief summary of the entire thesis or article that includes key findings, methodology, the significance, implications, and contributions of the research and findings (Gillaerts & Van de Velde, 2010; Pho, 2008). Bunton (1998, p. 72) describes abstracts as “some of the best writing of the author”. The abstract sections in academic written texts serve the function of persuading the readers to read the whole stud, satisfying them that they will read some attractive and decent content (Gillaerts & Van de Velde, 2010). Abstracts in general have captured the interest of researchers for a long time, and numerous works have examined the various linguistic, stylistic,

and structural aspects of this sub-genre. Abstracts which are included in internationally indexed journals are likely to be characterized by longer word length, shorter sentence length and with a denser load of noun phrases instead of verb phrases (Yoneoka & Ota, 2017). Hyland & Tse (2005) studied *evaluative that* in a corpus of 465 abstracts from published research articles as well as master and doctoral studies in six different academic areas (including *applied linguistics*) to discover the stance of the authors' evaluative expressions. They found that postgraduate writers less tend to arise their personal voice compared to publishing academics, however both expert and novice writer groups in this study "employed it [evaluative that] largely with abstract subjects to underline their conviction in the strength or reliability of their findings and made extensive use of research and discourse verbal predicates" (p.137).

The concept of teaching academic vocabulary in English Language Teaching and specifically in the English for Academic Purposes (EAP) areas has a rooted past. Academic vocabulary is used to describe elements that are quite prevailing in a variety of academic genres but relatively infrequent in other types of texts (Coxhead, 2000). It is often believed that some words appear more frequently in academic papers than in other contexts and therefore, a variety of vocabulary lists have been created using corpora, or collections, of academic writings in order to determine the most important words used in academic genres. The Academic Word List (AWL) (Coxhead, 2000), one of the most recent compilation, has 570-word families that, regardless of the students' chosen field of expertise and interest, are seen to be crucial for those following higher education. AWL contains 10 sub-lists and 60-word families in each sub-list, except sub-list 10 which has 10. 1<sup>st</sup> sub-list is comprised of the most frequently used academic vocabulary, while the 10<sup>th</sup> sub-list has the most infrequent ones. It is widely acknowledged that the AWL mostly consists of terminology used in a variety of academic disciplines (Tsubaki, 2004; Li and Qian, 2010). Tsubaki (2004) analyzed the proportions of coverage by the GSL and the AWL in academic articles. The coverage of the GSL and AWL was evaluated using the Vocabprofile and Range tools, which were used to analyze the articles from TESOL Quarterly. According to the findings, the AWL has more coverage than the GSL. In another corpus-based study which investigated the coverage percentage of AWL, Li and Qian (2010) studied on a large financial services corpus and they found that AWL words covered 10.46% of the collected sample. This finding confirmed the assertion that AWL would cover 10% of any academic text made by (Coxhead & Byrd, 2007).

### **Lexical density and diversity in EFL/ESL writing studies**

Though scarce in number, L2 writing studies have found a positive relationship between lexical density and the overall writing scores of L2 essays assigned by human raters. For example, Kim's (2014) study showed that highly proficient EFL learners could produce lexically denser argumentative essays. While some, for example, Malvern et al. (2004) argue that as lexical density is a token-token ratio (content words / total words), text length does not affect it, there are still some others who have concerns regarding the power of lexical density in predicting writing quality scores. For example, Laufer and Nation (1995) posits that syntactic and structural aspects of an essay may conflict with lexical density, which means a writer could achieve with fewer function words syntactically more elaborate and complex sentences. Another consideration is the high

correlations between lexical density and diversity pointing at the blurring point among the indices of lexical characterization of a text (Johansson, 2009).

In a similar vein, a bulk of previous research conclude that lexical diversity differs across different proficiency levels of both L1 and L2 English learners at short and long terms as measured by several indices (Olinghouse & Leaird, 2009; Bulte & Housen, 2014; Mazgutova & Kosmoz, 2015). In a study in which corrected type-token ratio (CTTR) was used to assess lexical diversity, Olinghouse & Leaird (2009) found significant mean differences between 2nd and 4th graders in a written story telling task, meaning 4<sup>th</sup> graders displayed greater lexical diversity. In this study, mean syllable length (11%) and text length (6.1%) were found to be the strongest predictive of writing quality. In another study, Bulte & Housen (2014) made their 45 participants write essays at the beginning and at the end of a short term intensive English language course and used D coefficient as offered by Coh-Metrix. Although the overall writing quality scores significant increased until the end of the semester, lexical diversity as measured by Vocab D only showed a weak and non-significant correlation with the writing scores. When Bulte and House (2014) added Advanced Guiraud index (AG) to test lexical sophistication, their model explained the 45% of the whole variance in the writing scores. This finding clearly implies that lexical properties of L2 essays are to be seriously considered. Mazgutova & Kormos (2015), likewise, in a one month-long Academic English program using MTLTD measure tracked the development of lexical diversity of 45 EFL learners across two writing essays. Low-proficient groups achieved lower MTLTD scores and got lower overall writing scores compared to high-proficient groups at each writing task. Therefore, it is likely to conclude that lexical density and lexical diversity as two important constructs of learners' general lexical competence should be more probed and be included in lexical analysis and assessment of learners' written work.

## METHOD

### Corpus

In this corpus-based study, three different groups of dissertation abstracts written by EFL (English as a foreign language), ESL (English as a second language), and English L1 (Native speakers) doctoral students were analyzed. In the analysis of abstracts, lexical diversity, lexical density, and academic language use measures were applied. The EFL abstracts were retrieved from <https://tez.yok.gov.tr/UlusalTezMerkezi/>. Doctoral students in Türkiye, upon having submitted their dissertation study to their institutes and after the final approval, have to upload their dissertation studies to the database of Council of Higher Education's Thesis Center. The ESL and NS abstracts were retrieved from <https://about.proquest.com/en/dissertations/>, which is a well-known global repository of international dissertations. The ESL and English L1 abstracts were taken from dissertations submitted to various universities in the USA and the UK. The ESL writers were chosen from different L1 backgrounds, namely written by Pakistani, Chinese and Iranian writers who carried out their doctoral studies in the USA and the UK. The collected corpus is comprised of a total of 75 texts and 22.195 words (25 texts in each category). The mean of total word count in each group range from 281 to 306 words. While searching for the dissertations,

expressions of ‘linguistic and language education’ and ‘English language teaching’ were typed in the search button of the databases. Therefore, the so-called topic and text length effects were controlled in the study. All the dissertations that were retrieved from the two mentioned databases were uploaded between years of 2015 and 2022.

## Measure Selection

To measure the lexical diversity of the selected abstracts, two indicators -Vocab D and MTL D were computed. The details of these two indicators were presented in section 2.1. To do so, Coh-Matrix, which is an automated and free web tool available at <http://cohmetrix.com/> was resorted. According to McCarthy and Jarvis (2010), Vocab D and MTL D were derived from the traditional Type Token Ratio (TTR) method to quantify various lexical profiles of texts and form a refined and revised version of TTR, which is free from text length effect and thus is more reliable. The higher scores of Vocab D and MTL D point to more lexical diversity of texts. Lexical density, as a strong index of dense academic writing performance, has long been measured whereby a ratio of content words to all words/tokens. This ratio was calculated for each abstract using VocabProfile, which is available at <https://www.lextutor.ca/vp/eng/>. Higher ratio scores indicate more densely packed abstracts. Academic Word List, which is also introduced in detail in section 2.2. was readily offered by VocabProfile at <https://www.lextutor.ca/vp/eng/>.

## Data Analysis

The statistical procedure for this study were carried out on the statistical software program SPSS 28.0.1. First, with a descriptive analysis using means and standard deviation, a plain outlook of the lexical measures is presented to see how the measures differ numerically across abstract types. Second, a Pearson correlation coefficient test was computed to find out to what extent the measures are related to each other. The correlation analysis also offers insights about the reliability of the measures. Then, a One-way ANOVA test was run between Vocab D and MTL D measures since only in these measures statistically significant mean differences were observed between groups. In order to detect between which groups of abstracts these statistically significant differences occur, a post hoc test followed the ANOVA test.

## RESULTS

In this section, the findings of the current study are presented. First, the differences in lexical diversity indicated by Vocab D and MTL D measures, lexical density, AWL and total word count across three abstract groups were displayed in Table 1. Second, the correlation coefficients among the five dependent variables were illustrated in Table 2. Lastly, the multiple comparisons of mean differences between groups were given in Table 3 and Table 4 respectively.

Table 1 *A descriptive outlook of the lexical profiles of the NS, ESL and EFL abstracts*

<b>Measures</b>	<b>Abstract Type</b>	<b>Mean</b>	<b>SD</b>	<b>N</b>
Vocab D	NS	81,43	21,340	25
	ESL	72,85	14,478	25
	EFL	64,56	11,051	25
MTLD	NS	77,88	20,776	25
	ESL	71,21	16,070	25
	EFL	62,15	10,741	25
LEXICAL DENSITY	NS	,641	,044	25
	ESL	,622	,042	25
	EFL	,621	,033	25
AWL	NS	29,240	12,255	25
	ESL	29,760	10,501	25
	EFL	25,720	8,126	25
WORD COUNT	NS	306,00	94,095	25
	ESL	300,56	94,155	25
	EFL	281,24	76,841	25

As can be seen in Table 1, in lexical complexity indices of Vocab D and MTLD and in lexical density index (comprised of a ratio of content words/total words), NS abstracts displayed the highest scores followed by ESL and EFL abstracts respectively. The longest abstracts were written by NS writers again followed by ESL and EFL abstracts respectively. When it comes to Academic Word List, the order changed. The biggest number of academic words was found in ESL abstracts although the mean differences are quite faint in this index, especially between NS and ESL groups. The AWL coverage percentages are in tune with the frequency of AWL words found in EFL (%13.05), ESL (14.74%), and NS (13.72%). It is found that AWL covered the 13.72% of the whole corpus on total.

Table 2 *Correlations among five lexical measures*

	Vocab D	MTLD	Lexical Density	AWL	Word Count
Vocab D	1				
MTLD	,845**	1			
Lexical Density	,370**	,325**	1		
AWL	,237*	,261*	-,099	1	
Word Count	,015	,021	-,070	,115	1

Correlation is significant at the 0.01 level (2-tailed).\*\*

Correlation is significant at the 0.05 level (2-tailed).\*

Table 2 demonstrates the Pearson correlation coefficient among the five lexical measures applied to all groups of abstracts. The highest positive and strongest correlation which is also statistically significant, was found to be .845 between Vocab D and MTLD measures which were provided by Coh-Matrix. Coh-Matrix asserts that these two measures of lexical diversity (Vocab D and MTLD) are free from the ‘text length effect’. Likewise the correlation coefficient scores seem to confirm this assertion although dissertation abstracts tend to be relatively similar in terms of text length. Since lexical diversity is concerned with the breadth and depth of vocabulary as well as variation and richness in vocabulary use, it correlates with lexical density. Though on a medium scale, lexical density positively correlates with Vocab D and MTLD on a statistically significant level, which suggests that using different tokens of content words may naturally increase variation in lexis. Similarly, lexical diversity indices manifest weak, however statistically significant correlation coefficients with AWL, which is a glossary of academic vocabulary, which points out lexical diversity that is an index of variation in use correlates with other lexical indicators. The correlation findings seem to certify that Coh-Matrix indices work in conformity producing consistent results.

A one-way ANOVA was computed to find out whether the NS, ESL and EFL abstracts differ in terms of lexical properties in question. As a result only lexical diversity measured through Vocab D and MTLD indices differ across three different groups of abstracts. Vocab D index posed a significant difference among three groups of abstracts [ $F(2.72)=6.77$ ,  $p<0.05$ ]. In addition, MTLD index of lexical diversity also was found to be different on a statistically significant scale [ $F(2.72)=5.80$ ,  $p\leq 0.05$ ].



Table 3 *Significant between - group comparisons*

Measures		Sum of Squares	df	Mean Square	F	p
Vocab D	Between Groups	3556,104	2	1778,052	6,776	,002**
	Within Groups	18891,914	72	262,388		
	Total	22448,018	74			
MTLD	Between Groups	3115,587	2	1557,793	5,803	,005*
	Within Groups	19326,973	72	268,430		
	Total	22442,559	74			

\*\*The mean differences between groups is significant at the 0.05 level

\*The p value  $\leq .05$

Post hoc comparisons using Tukey HSD test indicated that the mean differences of Vocab D index found across groups of abstracts are only statistically significant between NS (M=81.43, SD= 21.34) and EFL abstracts (M=64.56, SD=11.05).

Table 4 *Tukey HSD group differences*

Measures	Group Comparisons	Mean Difference	SE	p	95% CI Lower Bound	95% CI Upper Bound
Vocab D	NS - EFL	16,86600	4,58160	,001*	5,9017	27,8303
MTLD	NS - EFL	15,72720	4,63405	,003*	4,6373	26,8171

\*The mean differences between NS and EFL groups is significant at the 0.05 level.

In a similar vein, Post hoc comparisons using Tukey HSD test indicated that the mean differences of MTLD index found across groups of abstracts are only statistically significant between NS (M=77.88, SD= 20.77) and EFL abstracts (M=62.15, SD=10.74).

## DISCUSSION AND CONCLUSION

This study aimed to investigate lexical density, lexical diversity, and academic language use displayed in dissertation abstracts written by three cohorts of authors EFL, ESL, and NS. A small-scale corpus was compiled from the dissertation abstracts of three writer groups and selected indices were used to measure the lexical qualities of these abstracts. Deciding and selecting the indices which are plenty in number is of great significance in this research area. With the advancement of technology, recent automated computational tools readily provide a number of both lexical, syntactic, and textual indices for text analysis. However, this abundance of indices may present a serious challenge for the researchers since it makes generalizing and, more importantly, comparing the results problematic. It is not only the indices that change across studies, but also different sampling methods or data sizes also puts challenges on the way to a more tangible view of research findings. Thus, in this section, a comparison of the previous research which has used similarly calculated indices, has been given due attention.

According to the findings of the current study, English language backgrounds of the abstract writers do seem to have a little effect on the lexical density, lexical diversity and academic language use. Although, except for the AWL, in all other indices of lexical density and diversity, NS outperformed the ESL and EFL groups, these descriptive differences were not found to be statistically significant. NS writers also wrote the longest abstracts followed by ESL and EFL writers, however, abstracts as a the sub-genre of academic research writing is generally limited with 200-300 words at most. Thus, the text length effect is controlled in this study. There is a previous bulk of research which conclude that lexical density and diversity positively correlates with proficiency levels of learners (Bulte & Housen, 2014; Kim, 2014; Mazgutova & Kosmoz, 2015). Though partially, our findings are in tune with these studies as the only significant differences were found in lexical diversity measures (Vocab D and MTL D) between NS and EFL groups. This finding may suggest that EFL writers fall behind in the lexical proficiency (particularly in lexical diversity) compared to their NS and ESL peers. To fill this proficiency gap, syllabus and course developers explicitly highlight the significance of lexical proficiency in academic writing. Moreover, dissertation supervisors may develop teaching strategies regarding the density and variation of lexis in research abstracts by means of addressing to use of nominalizations, more complex noun phrases and low-frequency words to achieve a denser information packing and diversification of lexis in the limited area of abstracts (Biber & Gray, 2010). Promoting the integration of automated text processing tools into research evaluation processes might also be useful, since the delicate features and calculations of lexical proficiency are likely to be overlooked by human raters, evaluators and researchers (Crossley et al., 2011; Kalantari & Gholami, 2017; Lu, 2012; Nasserri & Thompson, 2021).

ESL group wrote abstracts which were parallel with those of NS group in the investigated lexical indices. Since the ESL writers reside and communicate in an English-speaking country, in this study's case in the USA and the UK, lexical proficiency of the ESL writers could be positively affected by the academic immersion programs (Mazgutova & Kormoz, 2015). A shared context with the L1 English speakers seems to be to the benefit of ESL learners, however, much research is needed to explore and confirm to what extent these academic immersion programs are effective in raising the learners' lexical proficiency. The coverage percentage and the number of AWL words in the study corpus, in spite of descriptive differences, were not found to be statistically significant. The idiosyncratic context and limited space of abstracts might compel the authors from different language backgrounds to use as many academic words as possible, which also makes the lexical density index incomparable across groups in this study. This finding of the study contradicts with Maamuujav's (2021) study in which high positive correlations were found between AWL coverage and overall writing quality scores of L2 learners. In their study Marti, Yilmaz and Bayyurt (2019) examined the use of reporting words in a collected corpus of L1 English professionals, Turkish professional writers and native and non-native novice writers and found statistical differences only between non-native novice writers and other groups. They call for further discussions on expertise vs. nativeness in writing for academic and research purposes in English. In a similar vein, Lei & Yang (2020) compared the lexical diversity and density of research articles of native experts, native undergraduates and Chinese postgraduate students and found that native experts outperformed the other two groups in all indices, followed by Chinese postgraduate students and native novice students respectively. This finding, in tune with our findings, may suggest that expertise might be more important than nativeness in academic research

writing. The findings of our study and that of Lei & Yang (2020) also point out that developing lexical diversity may be more challenging than using informative content words as native speakers significantly excelled the other groups (non-native or native-novice) in lexical diversity in both studies. We may suggest that studies uncovering the so-called effect of nativeness on EAP writing should be conducted to see whether being a native speaker can be a benchmark at differentiation the linguistic and lexical proficiency.

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