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Exploring nominalization in scientific textbooks: A cross-disciplinary study of hard and soft sciences

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ABSTRACT
Given the importance of disciplinary specificity in terms of the potential differences in the functionality of nominalizations in scientific textbooks and the dearth of studies of this type, the current study explores the extent to which nominalization is realized across two disciplines. To this aim, eight academic textbooks from Physics and Applied Linguistics are analyzed to identify the nominal patterns and expressions and their related types. Findings indicate that, despite the similarity of the first three most prevalent patterns in the sample textbooks, the distribution of these patterns marks disciplinary distinctions. That is, Physics academic writers tend to (a) use a more complex, lexically dense style of writing and package more information into compound nominal phrases by deploying a pattern where nominals are followed by strings of prepositional phrases in comparison to writers in Applied Linguistics; and (b) express particularity using nominals preceded by classifiers more frequently than Applied Linguistics writers. Writers in Applied Linguistics, on the other hand, are found to manifest a greater tendency toward conveying generality by using a pattern where nominals are realized with few pre/post modifiers.

KEYWORDS: nominalization, scientific discourse, systemic functional linguistics, Physics, Applied Linguistics.

1. INTRODUCTION

In recent years, academic discourse has been studied broadly to describe not only a set of essential academic writing skills but also the ways in which novice second or foreign language writers learn to follow directions in academic writing and gain competence in the appropriate written mode in specific academic contexts (Leki, 2003; Leki & Carson, 1997;

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Macbeth, 2006; Swales & Feak, 2004). In academic contexts, language is used to display information using technical lexicon, and with an authoritative stance (Martin, 1993; Schleppegrell, 2004a). Being a social theory of language that provides researchers with unique constructs, tools, and insights for the analysis of texts, Halliday's (1978, 1990, 2004) Systemic Functional Linguistics (SFL) is well suited to provide both theoretical and practical guidance for investigations of academic discourse.

Language from this perspective constitutes a set of rules as well as a resource for making meaning (Halliday, 1990; Halliday & Matthiessen, 2004). It builds on the idea that language users construe meaning and produce texts in various contexts, i.e., various registers and genres (Liardét, 2013: 162), through a series of choices of "what *goes together with* what" and of "what *could go instead of* what", referred to as syntagmatic relations and paradigmatic patterns, respectively (Halliday & Matthiessen, 2004: 22). The construal of a particular form of reasoned argument, as Halliday and Martin (1993: 7) assert, has to do with the combination of two resources used in scientific English: lexical resources in the form of new technical terms, and grammatical resources in the form of nominal groups and clauses. In other words, the "distinctive quality of scientific language lies in the lexicogrammar (the 'wording') as a whole" (Halliday & Martin, 1999: 4).

Within the academic genre, writers are encouraged to construe language that is lexicogrammatically technical and specialized. This academic discourse is featured as abstract, lexically dense in comparison with informal spoken language, elaborated in nominal groups, extensive in relational processes, impersonal and evaluative (Biber, 1988, 2006; Biber, Conrad, Reppen, Byrd & Helt, 2002; Christie & Derewianka, 2008; Halliday, 1993a; Hyland, 2009; Schleppegrell, 2004b). To engender the above-mentioned features of academic language, SFL identifies a powerful language resource that "simultaneously builds cohesion, foregrounds meanings in static nominal groups, and backgrounds personal and subjective voice" (Liardét, 2013: 163). This powerful linguistic resource for construing academic language is grammatical metaphor (GM).

Taking the traditional *semasiological* perspective on semantic variation, researchers define the concept of *metaphor* as a movement from a literal to a new figurative meaning (Taverniers, 2004, 2006), and it is considered to be a lexical phenomenon. To Halliday, however, metaphorical variation was lexicogrammatical rather than simply lexical; consequently, he introduced the notion of *grammatical metaphor* where "the variation is essentially in the grammatical forms" (2004: 320). The very recognition of grammatical metaphor, which results from the comparison of different expressions of one meaning, as Halliday (2004) maintains, is defined in terms of markedness: the unmarked typical forms for expressing the same meaning, referred to as congruent realizations of the given meaning, are non-metaphorical variants. In other words, for any semantic configuration there is one congruent expression and a set of incongruent expressions or metaphoric variants (Halliday, 1985: 20). Then, as the example extracted from the corpus of this study in Figure 1 illustrates,

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if we want to talk about the student's role in class, the natural way to do it would be (1a). We could also talk about the student's role in a different manner, as in (1b):

a. Student participates in class
b. Student participation in class [Applied Linguistics (AL), Brown (2000: 434)]

Figure 1. Example illustrating grammatical metaphor from Halliday's perspective (1985).

Halliday and Matthiessen (2004) assert that, as an important facet of written language complexity, nominalizing metaphor probably took shape first in the scientific register. Known as one of the offshoots of SFL, a powerful resource that accounts for creating grammatical metaphor (Halliday, 2004), the prototypical example of grammatical metaphor (Briones, Fortuny & Pocovi, 2003), and a distinctive linguistic characteristic of academic writing, nominalization has garnered the attention of researchers interested in this area of inquiry (e.g., Baratta, 2010; Charles, 2003; Gao, 2008; Guillén Galve, 1998; Halliday & Martin, 1993; Hartnett, 2004; Hyland, 2006a). In nominalization, a process or attribute is reformulated metaphorically as nouns—a more abstract phenomenon (Halliday & Martin, 1993). In other words, as Halliday and Matthiessen (1999) maintain, nominalization is a linguistic process whereby a verb (e.g., *transform*), an adjective (e.g., *unstable*), or a circumstance (e.g., *with*) is transformed into a nominal group (e.g., *transformation*, *instability*, and *accompaniment*). The *grammatical energy* and *semogenic power* of nominalization to create, and then to recreate, meaning can be accounted for by the fact that while verbal groups expand grammatically—with tenses, modalities and the like—nominal groups can be expanded lexically by pre/post modifiers (Halliday, 1998: 39).

Reading scientific texts, as Halliday (1990, 1993b) asserts, is associated with difficulty. He further explains that such a difficulty is attributed to the fact that the conceptual structures and reasoning processes required for construal and representation of scientific knowledge are highly complex. This complexity has to do with the abstraction of academic discourse, which involves the deliberate hiding of participant (Halliday & Martin, 1993), as well as lexical density associated with scientific texts, which is a measure of the density of information in any text in terms of "how tightly the lexical items (content words) have been packed into the grammatical structure" (Halliday & Martin, 1993: 83). In addition, Halliday (1993b) highlighted GM as one of the linguistic aspects of scientific English which makes it problematic for learners. Despite a large body of research investigating grammatical metaphor and nominalization in scientific discourse (e.g., Banks, 2003; Baratta, 2010; Halliday & Matthiessen, 2004; Ho, 2010; Jalilifar, Alipour & Parsa, 2014; Martin, 1993; Sušinskienė, 2009, 2010; Tabrizi & Nabifar, 2013; Wenyan, 2012), further research is required to explore disciplinary specificity in deployment of nominalization in scientific textbooks.

Print ISSN: 1578-7044; Online ISSN: 1989-6131

In fact, research on GM and nominalization use indicates variation in different genres across disciplines, for instance, in scientific discourses vs. historical discourses (Martin, 1993), in Spanish academic writing (Colombi, 2006), in historical texts (Sušinskienė, 2009), in abstracts and in research articles (Holtz, 2009), in British newspaper editorials (Sušinskienė, 2010), in essay writings of undergraduate students (Baratta, 2010), in request e-mails (Ho, 2010), in business letters (Văn, 2011), in business and political texts (Hadidi & Raghami, 2012), in political and health texts (Tabrizi & Nabifar, 2013), in English pharmaceutical textbooks (Mẫu, 2012), in the discussion sections of medical research articles (Wenyan, 2012), in applied linguistics and biology textbooks (Jalilifar et al., 2014), and also in legal discourse (Gotti & Williams, 2010; Williams, 2004). These studies indicate that academic discourse varies in response to disciplinary conventions, as well as understandings and expectations of particular academic communities (Hyland, 2009). Yet, it still is not apparent how nominalization is realized in textbooks across disciplines. In other words, it is not clear how nominalization use is interrelated with typological distinctions between hard and soft sciences.

Therefore, even if there arguably are core features and characteristics in academic discourse, it is important to acknowledge the fact that many variations exist when it comes to how certain disciplines struggle with the challenges of conveying information and achieving academic writing. Various disciplines in the natural sciences, technology, social sciences, and humanities all have their specific, conventionalized ways of describing ideas, knowledge, methods, results, and interpretations (e.g., Basturkmen, 2011; Hawes & Thomas, 2012; Hyland, 2007; McGrath & Kuteeva, 2012; Parodi, 2010). This *discipline-specificity*, which stresses that "disciplines and professions are largely created and maintained through the distinctive ways" and that "members jointly construct a view of the world through their discourses" (Hyland, 2006b: 114), makes it necessary to go beyond the generalized view of academic writing and to pin down specific characteristics of the scientific discourse in each of these disciplines. The present study argues that exploring disciplinary specificity in terms of the potential differences in the functionality of nominalizations in scientific textbooks is of great importance and has yet to be sufficiently examined. This cross-disciplinary study, therefore, aims to examine the potential differences in the functionality of nominalizations in two disciplines from hard and soft sciences—Physics (PH) and Applied Linguistics (AL), respectively—as well as the frequency differences in them in terms of nominal deployment.

2. DATA SET AND DATA ANALYSIS

The data used in this study contains eight academic textbooks covering two disciplines from both hard and soft sciences, i.e., Physics and Applied Linguistics. The choice of these two disciplines rests on the most convenient way of grouping disciplines into four main areas: *Sciences*, *Social Sciences*, *Humanities / Arts*, and *Applied disciplines* (Coffin et al., 2003; Glanzel & Schubert, 2003). As illustrated in Figure 2, these four main areas are viewed in a continuum from *hard* sciences to *soft* applied disciplines (Hyland, 2009):

	Sciences	Social Sciences	Humanities / Arts	Applied disciplines	
HARDER	◄-------------	-------------	-------------	-------------►	SOFTER

Figure 2. Continuum of disciplines.

Accordingly, Physics and Applied Linguistics were selected to allow comparisons across hard and soft sciences (Physics, as a subfield of Sciences, representing hard sciences and Applied Linguistics, as a subfield of Humanities, representing soft sciences). We e-mailed about 80 experienced male/female professors and instructors, currently teaching MA/PhD students either Physics or Applied Linguistics at Iranian state universities, and asked them to recommend textbooks they considered essential in their own field. Textbook selection was based on recommendations made by over 20 informants in each discipline who replied our e-mails. Accordingly, the first four most frequently suggested textbooks in each discipline were selected as the data for the study (see Table 2 for the list of selected textbooks, which are also collected in the reference list). Among the nine textbook authors, seven authors are native English speakers (Bachman, Boyd, Brown, Ellis, Gerry and Knight, and Widdowson), one is German (Demtröder), and one is Polish with American nationality (Gasiorowicz). Hence, the findings based on their texts can dependably be attributed to the language we concern, i.e., English.

In the present study, clause complex was used as the unit of analysis. The reason underlying this choice is grounded in the fact that clause complexes reveal "how the flow of events is construed in the development of text at the level of semantics" (Halliday & Matthiessen, 2004: 63). The analysis of the data was carried out in three phases: (1) identification, quantification, and classification of nominalization instances; (2) identification, quantification, and classification of the patterns of the nominal groups; and (3) exploring the nature and functionality of the dominant patterns of nominal groups.

In the first phase of the analysis, each instance of nominalization was counted and classified based on the four types of nominalizations enumerated by Halliday and Matthiessen (1999) (see Figure 3). Nominalization instances were identified manually and tagged according to their suffixes: nouns ending in suffixes such as *-ity* and *-ness* were tagged as Type 1 (deriving from adjectives, originally realizing properties); nouns ending in suffixes such as *-age*, *-al*, *-(e)ry*, *-sion/-tion*, *-ment*, *-sis*, *-ure*, and *-th* were tagged as Type 2 (deriving from verbs, originally realizing processes); and the nominalizations of the nouns with no affix markers were tagged through consulting dictionaries to find whether they were cases of zero-derivations from their corresponding adjectives, verbs, prepositions, or conjunctions:

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	CONVERSION		EXAMPLE
Type 1	Adjective → Thing		Unstable → Instability
Type 2	Verb → Thing		Transform → Transformation
Type 3	Circumstance → Thing		With → Accompaniment
Type 4	Conjunction → Thing		If → Condition

Figure 3. Halliday and Matthiessen's classification of nominalizations (1999).

Considering the nouns ending in *-ing*, an extensive manual checking was required to correctly categorize them as either instances of nominalization derived from verbs (e.g., *Their understanding of those concepts* [AL, Brown (2000: 436)] (*understand* > *understanding*), or not, for example as gerund (e.g., *detecting the presence of*… [PH, Gerry & Knight (2005: 144)].

In the second phase of the analysis, we extracted the patterns used in each discipline by analyzing the lexicogrammatical contexts in which nominals occurred. This was achieved by identifying the word order of the elements of the nominal groups in which instances of nominalization were found. The basis for extracting the patterns was Halliday's (2004) suggested experiential pattern embodied in nominal group structure, in which lexical expansion of nominal groups is attributed to pre/post-modification: a class of *Things* is specified and realized by nouns, and categorization within the class is typically expressed by one or more functional words organized around it. These functional elements—Deictic, Numerative, Epithet, Classifier, and Qualifier—serve to specify *Things* within "different systems of the system network of the nominal group" (Halliday, 2004: 312). The classes of the words which typically realize these functions, as suggested by Halliday (2004: 320), are illustrated in Figure 4:

DEICTIC	DEICTIC 2	NUMERATIVE	EPITHET	CLASSIFIER	**THING**	QUALIFIER
Determiner	Adjective	Numeral	Adjective	Noun / Adjective	**Noun**	Prepositional phrase / (non)finite clause

Figure 4. Experiential functions and word classes.

Given the possibility of variations in terms of the frequency and functions of nominalization across different sections of each textbook, analysis continued until we could identify dominant patterns of nominalization use in the textbooks and no further similarities or differences emerged in the way these patterns were realized in the textbook. Accordingly, over 280 pages from 8 textbooks were analyzed.

In *unpacking* the grammatical metaphors, that is, the rewording of a metaphorical expression into a more congruent one (Ravelli, 1999: 77), we made sure that the excerpted instances truly functioned as nominals. In addition, to ensure that instances of nominalizations were identified with high degree of accuracy, coding procedures were

Print ISSN: 1578-7044; Online ISSN: 1989-6131

implemented: a small sample—about 5% of the corpus, i.e., fourteen pages—was double-checked by a second coder working independently to check the reliability; and to control intra-coder reliability, the researcher re-analyzed a sample of textbooks—thirty pages—within an interval of one month. In order to obtain the indices of reliability, the Kappa coefficient was employed. The index of inter-coder reliability was 0.79, and that of intra-coder reliability was 0.84 (see Table 1):

SYMMETRIC MEASURES					
		Value	Asymp. Std. error[a]	Approx. T[b]	Approx. Sig.
Measure of agreement Kappa	Inter coder	.792	.075	7.197	.000
Measure of agreement Kappa	Intra coder	.847	.066	7.613	.000
N of valid cases		82			

[a.] Not assuming the null hypothesis
[b.] Using the asymptotic standard error assuming the null hypothesis

Table 1. Kappa coefficient inter/intra coder reliability.

3. RESULTS AND DISCUSSION

In order to identify the principal types of nominalization and to explore disciplinary specificity in terms of different relations that nominalizations display (i.e., Qualities [Type 1], Processes [Type 2], Circumstances [Type 3], or Relators [Type 4]), each instance of nominalization was counted and classified based on the types of reconstrual involved in their derivation (see Table 2 for the textbooks and the number of tokens and types per discipline). The Kruskal-Wallis H-tests were subsequently applied to compare the occurrences of types of nominalizations in relation to the disciplines concerned (Tables 3, 4):

DISCIPLINE	TEXTBOOKS	ANALYZED PAGES	TOKENS (CLAUSE COMPLEXES)	TYPES OF NOMINALIZATION			
				Type 1	Type 2	Type 3	Type 4
Applied Linguistics	1. Bachman (1990)	31	842	9.61	72.68	---	0.71
	2. Brown (2000)	36	903	4.20*	39.64	---	0.66
	3. Ellis (1999)	48	1,269	7.09	52.63	---	0.71
	4. Widdowson (2004)	46	1,322	8.77	42.51	---	0.15
∑		127	4,339	7.49	50.70	---	0.55
Physics	5. Boyd (2008)	43	925	10.16	32.10	0.10	0.10
	6. Demtröder (2010)	48	854	4.09	48.59	2.34	---
	7. Gasiorowicz (1974)	22	961	3.64	42.97	0.83	---
	8. Gerry and Knight (2005)	46	1,212	5.52	48.01	1.32	0.08
∑		159	3,952	5.84	43.19	1.13	0.05

Table 2. Tokens of clause complexes and types of nominalizations in disciplines. [For the purpose of comparison, the data were normalized per 100 clause complexes].

What stands out from the statistics shown in Table 2 is that, although nominalization Type 2 is more prevalent than the other three types of nominalization in both disciplines, the asymptotic value for the occurrences of the four types of nominalization across the two disciplines is 0.392 ($p>0.05$), thus indicating no significant frequency difference in deployment of the four types of nominalization ascribable to disciplinary variation. This finding coincides to a large extent with that of Jalilifar et al. (2014), whose study did not indicate any significant difference between Applied Linguistics and Biology textbooks in terms of the types of nominalizations:

	N	MEAN	STD. DEVIATION	MINIMUM	MAXIMUM
Physics	4	12.5525	20.57912	.05	43.19
Applied Linguistics	4	14.6850	24.25074	.00	50.70
Type of nominalization	4	2.5000	1.29099	1.00	4.00

Table 3. Kruskal-Wallis H-tests, descriptive statistics.

TEST STATISTICS [a, b]		
	Physics	Applied Linguistics
Chi-square	3.000	3.000
df	3	3
Asymp. Sig.	.392	.392

[a.] Kruskal-Wallis Test
[b.] Grouping variable: types of nominalization

Table 4. Kruskal-Wallis H-tests for the occurrences of types of nominalizations.

In the light of Halliday's (2004) suggested experiential pattern embodied in nominal group structure and in considering the specific pre/post modifiers surrounding each instance of nominalization, 15 different patterns emerged. These patterns, along with illustrative related examples extracted from the corpus of the study, are represented in Table 5 (the rough basis for listing the patterns is the existence of shared elements in them, e.g., patterns #5, #6, and #7 include classifier(s)):

Print ISSN: 1578-7044; Online ISSN: 1989-6131

PATTERN NUMBER	PATTERNS AND RELATED EXAMPLES	FREQUENCY	
		AL	PH
#1	*Nominal + Prepositional Phrase* Stabilization of method, Chouliaraki and Fairclough concede, would have institutional and pedagogical advantages […] [AL, Widdowson (2004: 168)]	410 18.56%	362 19.70%
#2	*Preposition + Nominal* In comparison, our approach is three times faster […] [PH, Demtröder (2010: 517)]	220 9.95%	109 5.93%
#3	*Preposition + Nominal + Prepositional Phrase* For simplicity of notation, we have introduced new symbol […] [PH, Boyd (2008: 297)]	146 6.60%	146 7.94%
#4	*Nominal* Most current frameworks of language use are based on the concept of language as communication. [AL, Bachman (1990: 9)]	469 21.23%	279 15.18%
#5	*Classifier + Nominal* However, quantum information itself can also be transmitted […] [PH, Gerry & Knight (2005: 281)]	363 16.43%	450 24.49%
#6	*Nominal as classifier + Nominal / Noun* […] how the learner makes use of existing knowledge to cope with communication difficulties [AL, Ellis (1999: 16)]	75 3.39%	158 8.60%
#7	*Classifier + Classifier + Nominal* A beam of light having a nonuniform transverse intensity distribution propagates through a material […] [PH, Boyd (2008: 12)]	62 2.80%	116 6.31%
#8	*Numerative + Nominal* One answer to the views expressed by Tarone et al. and Hatch would be to […] [AL, Ellis (1999: 687)]	145 6.56%	97 5.28%
#9	*Nominal + Participle* Evidently, we obtained the results expected for a classical light wave where the […] [PH, Gerry & Knight (2005: 140)]	34 1.53%	31 1.68%
#10	*Nominal + Relative clause* […] his work is motivated by the belief that 'Language does not occur in stray words or sentences, but in […]' [AL, Widdowson (2004: 3)]	136 6.15%	31 1.68%
#11	*Nominal + Gerund* […] what study must be one of… quantum, mechanics, namely the capability of detecting the presence of […] [PH, Gerry & Knight (2005: 144)]	51 2.30%	31 1.68%
#12	*Nominal + Adjunct* This is addressed in greater depth in chapter 6 [AL, Ellis (1999: 12)]	20 0.90%	15 0.81%
#13	*Nominal + Infinitive* […] so that attempts to characterize authenticity in terms of real-life performance are problematic [AL, Bachman (1990: 10)]	62 2.80%	0 0.00%
#14	*Nominal + Adjective / Adverb as postmodifier* The L1 system is utilized in the hypothesis construction responsible for interlanguage development. [AL, Ellis (1999: 338)] […] Rand and the President understand his remarks metaphorically so as to incorporate them into the context of their previous discussion. [AL, Widdowson (2004: 86)]	5 0.22%	6 0.32%
#15	*Adverb as classifier + Nominal* Only during the 19th century […] detailed and carefully planned experiments […] could collect sufficient evidence for […] [PH, Demtröder (2010: 6)]	11 0.49%	6 0.32%
∑		2,209	1,837

Table 5. Emerged patterns and related examples.

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Patterns in Table 5 include the core obligatory element(s) preceding or following the nominal. That is, the optional pre/post modifiers, which did not emerge in all instances of patterns, are not included in them. For instance, pattern #8 with core elements of [numerative + nominal] along with the associated sequence of optional pre/post modifiers can be seen in the following example taken from the Applied Linguistics corpus represented in Figure 5, which shows the elements of the nominal group with the related pre/post modifiers:

PREMODIFIER (DEICTIC)	**NOMINAL**	**PREPOSITION**	**PREMODIFIER (DEICTIC)**	**NUMERATIVE**	**NOMINAL**
an	integration	of	the	two	approaches

Figure 5. Expanded version of pattern #8 (from Bachman [1990: 357]).

As revealed in Table 5, the first three prevalent patterns are #5, #1, and #4 in Physics; and #4, #1, and #5 in Applied Linguistics, respectively. In addition, it was found that patterns #1 and #3, on the one hand, and #5, #6, #7, and #10, on the other hand, serve similar functions in developing an academic text. Hence, nominalization instances that emerged in these seven patterns were further construed by the analysis of their related congruent wordings in order to shed light on the textual functions that these patterns serve in each discipline.

In the corpus of the present study, pattern #1 with the syntactic structure of [Modifer] Head [Qualifier] (Bhatia, 1993) carries compound and complex nominal phrases. Such compound nominal groups, which also appeared in pattern #3, increase the lexical density of the text as a result of carrying more content words and fewer functional words than their congruent realizations (Briones et al., 2003). The expanded version of these patterns, along with their related examples extracted from the corpus, is represented in Figure 6:

Pattern #1 [premodifier + nominal + PP_1 + PP_2 + PP_3 + PP_4 + PP_n]
Metaphoric construction […] a RECOGNITION **of** the PRIMACY **of** psycholinguistic ACCOUNTS **of** COMMUNICATION PROCESS **in** recent RESEARCH […] [AL, Ellis (1999: 18)] **Congruent reconstruction** One COMMUNICATED. This communication was PROCESSED. This process was ACCOUNTED for from psycholinguistic perspective. This psycholinguistic account was of PRIMARY importance. This primacy was RECOGNIZED. This recognition was RESEARCHED recently.
Pattern #3 [preposition + premodifier + nominal + PP_1 + PP_2 + PP_3 + PP_4 + PP_n]
Metaphoric construction […] after the DISCOVERY **of** possible TRANSFORMATIONS **of** atoms through IMPACT **by** energetic particles […] [PH, Demtröder (2010: 1)] **Congruent reconstruction** energetic particles IMPACT atoms. Atoms are possibly TRANSFORMED. The possible transformation was DISCOVERED. Then […]

Figure 6. Examples from patterns #1 and #3 illustrating lexical density.

As the examples in Figure 6 show, nominalization use reduces the number of clauses, and condenses more information into one nominal group (Halliday & Matthiessen, 1999)—in these examples, five and three clauses in the congruent forms are reconstructed as one clause in the metaphoric realizations.

The different distribution of patterns #1 and #3 illustrates disciplinary distinction: the occurrence rate of pattern #1 is 410 (18.56%) for the Applied Linguistics corpus and 362 (19.70%) for the Physics corpus; and that of pattern #3 is 146 (6.60%) for the Applied Linguistics corpus and 146 (7.94%) for the Physics corpus. In general, patterns #1 and #3, which serve the textual function of increasing lexical density and information load of the texts, were found to be distributed differently across the two disciplines. These patterns are more common in the Physics corpus (27.65%) than in the Applied Linguistics corpus (25.16%).

Pattern #4, where nominal expressions are realized without any pre/post modifiers, is a means of expressing generality in developing academic texts. Consider the following examples from the corpus represented in Figure 7:

Metaphoric construction Here we will illustrate how all […] and how EXPERIMENT and THEORY supplement each other to […] [PH, Demtröder (2010: 5)] **Congruent reconstruction** Here we will illustrate how all […] and how those things that one EXPERIMENTS and those things that one THEORIZES supplement each other to […]
Metaphoric construction ANALYSIS does not match INTERPRETATION. [AL, Widdowson (2004: 10)] **Congruent reconstruction** Those things that one ANALYZES do not match those things that one INTERPRETS.

Figure 7. Examples illustrating generality.

Here, in these examples, entities (*experiment*, *theory*, *analysis*, *interpretation*) are incongruent metaphoric realizations of actions (*to experiment*, *to theorize*, *to analyze*, *to interpret*). The metaphoric realizations refer to all *analyses*, *interpretations*, and *experiments* in general; and their hypothetical unpacked versions fall short of generality. Nominalizations arise to fulfill this function of conveying generality in those instances of pattern #4, where nominalization can emerge without any pre/post modifier.

The occurrence rate of pattern #4 is 469 (21.23%) for the Applied Linguistics corpus and 279 (15.18%) for the Physics corpus; however, in this pattern the number of nominalization instances serving the function of generality (i.e., those instances of nominalizations which emerged without any pre/post modifiers) is small in both disciplines (165 instances [7.46%] in Applied Linguistics and 65 instances [3.53%] in Physics), though still more common in the Applied Linguistics corpus than in the Physics corpus.

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Pattern #5—the first and the third most frequent pattern in Physics and Applied Linguistics textbooks, respectively—serves the function of particularity by using classifiers in nominal groups. In the corpus of this study, classifier(s) emerged in pattern #6, and pattern #7 as well. Consider the following compound nominal groups extracted from the data and represented in Figure 8:

Pattern #5 [classifier + nominal]
Equivalence […] has nothing to do with what **semantic** MEANING these stretches have but with […] [AL, Widdowson (2004: 1)]
[…] one photon of frequency 3 ω is created in the **microscopic** DESCRIPTION of this process. [PH, Boyd (2008: 11)]
Pattern #6 [nominal as classifier + nominal / noun]
These model interpretations could then be systematically related to […] pretextual conditions in **elicitation** EXPERIMENTS to find out […] [AL, Widdowson (2004: 170)]
A deeper understanding of the role of quantum entanglement […] will allow us […] to develop new methods of quantum **information** MANIPULATION. [PH, Gerry & Knight (2005: 7)]
Pattern #7 [classifier$_1$ + classifier$_2$ + classifier$_3$ + classifier$_n$ + nominal]
Minimalist accounts…acknowledge the role […] while denying […] any role for L1 in **interlanguage hypothesis** CONSTRUCTION. [AL, Ellis (1999: 336)]
The frequency comb can be used for **ultra-precise direct frequency** COMPARISON between the […] [PH, Demtröder (2010: 518)]

Figure 8. Examples illustrating particularity.

In these examples, the clusters of classifier(s) and nominal(s) in nominal groups were powerful assets to the writers in elaborating the concepts (*meaning*, *description*, *experiments*, *manipulation*, *construction*, *comparison*) more particularly. In fact, the concepts realized as nominalizations are premodified in terms of attributes which indicate their particular subclasses, i.e., in terms of classifiers (*semantic*, *microscopic*, *elicitation*, *information*, *interlanguage hypothesis*, *ultra-precise direct frequency*).

The distribution of pattern #5, as well as that of patterns #6 and #7, in the textbooks marks disciplinary differences: the occurrence rate of pattern #5 is 363 (16.43%) in Applied Linguistics and 450 (24.49%) in Physics textbooks; the occurrence rate of pattern #6 is 75 (3.39%) in Applied Linguistics and 158 (8.60%) in Physics textbooks; and that of pattern #7 is 62 (2.80%) in Applied Linguistics and 116 (6.31%) in Physics textbooks. In general, nominal groups with clusters of classifier(s) and nominal(s) in patterns #5, #6, and #7 are more common in the Physics corpus (724; 39.41%) than in the Applied Linguistics corpus (500; 22.63%).

Besides deploying clusters of classifier(s) and nominal(s), writers can elaborate and clarify concepts through using relative clauses as postmodifiers for nominalizations. Nominalizations followed by relative clauses emerged in pattern #10. Consider the following examples extracted from the corpus and represented in Figure 9:

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[…] the TRANSFORMATIONS *that Harris uses to identify structural equivalences underlying manifestations on the surface* are essentially devices of the same […] [AL, Widdowson (2004: 2)]

In order to relate our present treatment of the […] to the perturbative TREATMENT *that we have used in previous chapters*, we next […] [PH, Boyd (2008: 290)]

Figure 9. Examples illustrating elaboration.

In the first example, the restrictive relative clause (*that Harris uses to identify* […]) helps assign a greater degree of particularity and elaboration to the concept (*transformations*); the restrictive relative clause (*that we have used in previous* […]) does the same for the concept (*treatment*) in the second example.

Table 6 shows the contrast between Applied Linguistics and Physics textbooks in their differential deployment of relative clauses as a postmodifier in nominal groups, i.e., the contrast between the occurrence rate of pattern #10: 136 (6.15%) in the Applied Linguistics corpus and 31 (1.68%) in the Physics corpus. Accordingly, it can be claimed that nominal groups followed by relative clauses as postmodifiers are more common in the Applied Linguistics than in the Physics corpus. In fact, as stated before, the function of particularity is realized through deploying either clusters of classifier(s) preceding the nominals, which is more prevalent in the Physics corpus, or relative clauses following the nominals, which is more common in the Applied Linguistics corpus. Consider the following example extracted from a Physics textbook along with its congruent reconstrual, represented in Figure 10:

Metaphoric construction
This transformation constitutes a **Heisenberg picture** FORMULATION of the beam splitter. [PH, Gerry & Knight (2005: 139)]

Congruent reconstruction
This transformation constitutes a FORMULATION in which **Heisenberg pictures** the beam splitter.

Figure 10. Example illustrating particularity in the Physics corpus.

Here, two classifiers (*Heisenberg*, *picture*) preceding the nominal (*formulation*) in the metaphoric form are reconstructed into a relative clause in the congruent reconstruction functioning as the nominal's subject (*Heisenberg*) and its verb (*picture*). Consider the following examples extracted from two Applied Linguistic textbooks along with their congruent reconstrual, represented in Figure 11:

Metaphoric construction
Luke appears to believe that the NEED that Fowler **identifies** has already been met […] [AL, Widdowson (2004: 167)]

Congruent reconstruction
Luke appears to believe that Fowler **identified** NEED has already been met […]

Metaphoric construction
[…] EXPLANATIONS that are **faulty**. [AL, Ellis (1999: 680)]

Congruent reconstruction
faulty EXPLANATIONS […]

Figure 11. Examples illustrating particularity in the Applied Linguistics corpus.

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Here, in these two examples, a verb (*identifies*) and an adjective (*faulty*) in the metaphoric forms are reconstructed as classifiers in their congruent realizations.

Nominalization instances in the first four prevalent patterns that emerged in this study were further classified based on (a) their level of abstraction (e.g., abstract nominal in *self-help guide*, which refers to a generic concept, vs. non-abstract nominal in *student participation*, which pertain to a physical action), and (b) Martin, Matthiessen and Painter's (1997) taxonomy of process types in English (that is material, mental, relational, behavioral, verbal, and existential). Consider the following examples in Figure 12, extracted from the corpus, which illustrate the semantics, i.e., the process types of the nominalizations derived from verbs and adjectives:

MATERIAL	**Metaphoric construction** […] the MEASUREMENT of D_2 is determined by the result of D_1. [PH, Demtröder (2010: 513)] **Congruent reconstruction** D_2 is MEASURED. This MEASUREMENT is determined by the result of D_1
MENTAL	**Metaphoric construction** […] to avoid CONFUSION with the wavenumber […] [PH, Demtröder (2010: 253)] **Congruent reconstruction** Wavenumber CONFUSES one. To avoid this CONFUSION […]
BEHAVIORAL	**Metaphoric construction** This is a REFLECTION, perhaps of the general recognition that L_2 acquisition is extremely complex. [AL, Ellis (1999: 685)] **Congruent reconstruction** Generally, one recognizes that L_2 acquisition is extremely complex and REFLECTS this.
VERBAL	**Metaphoric construction** […] the significance of each of the two terms in this EXPRESSION is described […] [PH, Boyd (2008: 11)] **Congruent reconstruction** the significance of each of the two terms is EXPRESSED. This EXPRESSION is described […]
EXISTENTIAL	**Metaphoric construction** […] the EXISTENCE of the photoelectronic effect is… [PH, Gasiorowicz (1974: 15)] **Congruent reconstruction** […] the photoelectronic effect EXISTS. This EXISTENCE is […]
RELATIONAL	**Metaphoric construction** […] to clarify […] its RELEVANCE for the characteristic feature […] [PH, Demtröder (2010: 4)] **Congruent reconstruction** It is RELEVANT to the characteristic feature […] To clarify this RELEVANCE […]

Figure 12. Examples illustrating the process types of the nominalizations.

The distribution of tokens and types of nominalizations based on their abstractness and process are illustrated in Table 6:

	AL		PH	
Total tokens	1,487		1,300	
Abstract	1,417	(95.29%)	1,245	(95.76%)
Non-abstract	70	(4.70%)	55	(4.23%)
Material	803	(54%)	746	(57.38%)
Mental	274	(18.42%)	139	(10.69%)
Relational	261	(17.55%)	280	(21.53%)
Behavioral	41	(2.75%)	5	(0.38%)
Verbal	96	(6.45%)	95	(7.30%)
Existential	12	(0.80%)	35	(2.69%)

Table 6. Tokens and types of nominalizations based on their abstractness and process.

The distribution of process types that was construed by the analysis of congruent wording in the two disciplines revealed the higher frequency and dominant textual force of material process types in both disciplines (54% in Applied Linguistics and 57.38% in Physics). However, when the distribution of other process types is compared, the usage of the processes found in Applied Linguistics textbooks differs from the processes collected from Physics textbooks. For Applied Linguistics, mental process types are the second most frequent ones. Next comes the use of relational, verbal, behavioral, and existential. For Physics, however, the second most frequent process type is relational, followed by mental, verbal, existential, and behavioral. Accordingly, the results suggest that material, relational, and verbal process types are more common in the Physics books while mental, behavioral, and existential process types occur more frequently in the Applied Linguistics books.

A rather obvious expectation, revealed in Table 6, was a great predominance of abstract nominalizations in both disciplines: 95.29% and 95.76% in Applied Linguistics and Physics, respectively. This finding concurs with the idea that in nominalization, processes and properties are transformed into more abstract phenomena (Halliday, 2004; Halliday & Martin, 1993).

The high frequency and dominant textual force of material process types realized in both disciplines, as indicated in Table 6, enable writers to express comments about concepts rather than actions. Consider the following excerpt (Figure 13) extracted from an Applied Linguistics textbook:

Metaphoric construction
[…] the use of L1 in COMPREHNESION, PRODUCTION, and hypothesis CONSTRUCTION […] [AL, Ellis (1999: 339)]

Congruent reconstruction
When language is COMPREHENDED, when language is PRODUCED, and when hypothesis is CONSTRUCTED, learners use L1.

Figure 13. Example illustrating reduction of clauses.

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In this example, in addition to the reduction of the number of clauses in the metaphoric reconstruction, three processes (*comprehend*, *produce*, *construct*) in the congruent forms are reconstructed as concepts in the form of nominals (*comprehension*, *production, construction*) in their metaphoric realizations.

4. CONCLUSION

The results of this study have revealed that, although the first three most prevalent patterns that have emerged in both Applied Linguistics and Physics corpus (i.e., patterns #1, #4, and #5) are the same, the distribution of these patterns marks disciplinary distinctions. That is, academic writers in Physics tend to (a) use a more complex, lexically dense style of writing and compress more information into compound nominal phrases by deploying pattern #1, which includes nominals followed by strings of prepositional phrases, in comparison to writers in Applied Linguistics; and (b) express particularity by using nominals preceded by classifiers in pattern #5 more frequently than Applied Linguistics writers do.

Academic writers in Applied Linguistics, on the other hand, were found to manifest a greater tendency toward conveying generality through using pattern #4, where nominals are realized without any pre/post modifiers. In spite of Applied Linguistics writers' less frequent use of classifiers in developing academic texts, they elaborate and clarify concepts by using relative clauses as postmodifiers for nominals.

The realized differences in deployment of nominal groups in textbooks of hard and soft sciences can be pedagogically inspiring. Situating nominalizations explicitly within the academic writing instruction helps students deploy more abstract concepts and develop a more objective and authoritative tone appropriate for academic purposes in their own writing. Indeed, developing students' awareness of the functions of patterns of nominalization—for example, enabling writers to pack more information in fewer clauses and increase information load of the text, expressing particularity by using classifiers in nominal groups, elaborating and clarifying concepts by using relative clauses as postmodifiers for nominalizations—helps them understand how this academic writing feature might help shape their writing in their specific discipline, and allows them to construe academic knowledge in a more compact and dense manner.

As the study was based on a limited data set, the results cannot be seen as conclusive. Future research could investigate whether textbooks in other disciplines from hard and soft sciences may vary with regard to reflection of frequency of nominal expressions and patterns in their functionality. Given that the study design was text-based, this investigation can be extended by enquiring into academic writers' intentions and awareness about using nominal expressions in their writing. Interviews might be designed so as to gain insights into why the academic writers make use of particular patterns of nominalizations in developing their texts.

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