1   # Towards a Part-of-Speech (PoS) Gram Approach to Academic

2   # Writing: A Case Study of Research Introductions in Different

3   # Disciplines

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5

6   **Abstract**

7

8   This study innovatively applies the Part-of-Speech-gram (PoS-gram)

9   procedure to the examination of language patterning and variability in a

10 largely conventionalized part-genre (i.e., research introductions). Based on

11 400 article introductions from computer engineering (CE) and cognitive

12 linguistics (CL), the study has identified key PoS-grams and their associated

13 lexico-grammatical frames, using the written academic component of British

14 National Corpus as the reference corpus. The analysis reveals key PoS-grams

15 shared in CE and CL introductions, e.g., those associated with the step

16 "purposive announcement" , as well as the discipline-specific ones such as

17 the PoS-gram for structure-outlining only found in CE introductions.

18 Compared to various forms of multi-word sequences like n-grams, the PoS-

19 gram has the unique strength of grouping phraseologies with similar or

20 identical structure and discursive functions and yet either recurrent or varying

21 lexical choices under the co-selected grammatical categories. The advantage

22 enriches analyses and helps yield pedagogically useful findings, in that

23 patterning and variability is revealed not only in the overall function, structure

24 and composition of PoS-grams but in such aspects of their recurrent or

25 diversified tokens. This study illustrates the innovative application of corpus-

26 based PoS-gram procedure to academic genres, which may inspire a

27 promising new line of inquiry and the current genre pedagogy.

28

29 **Keywords**

30 Part-of-Speech-grams; Introduction; Research articles; Phraseology; Cross-
31 disciplinary study
32
1. Introduction

34 The usefulness and effectiveness of corpus linguistics approaches to

35 patterned language use in specialized genres have been increasingly

36 recognized (Breeze, 2019; Golparvar & Barabadi, 2020; Güngör & Uysal, 2020),

37 as they are able to help profiling what is featured by such (part-/para-) genres

38 of a conventionalized nature. Among concepts related to corpus-approaches

39 to language patterning, *part-of-speech-gram* (hereafter PoS-gram) is an

40 important notion (Stubbs, 2007), which has however been largely overlooked

41 in EAP research.

42

43 A *PoS-gram*, as defined by Stubbs (2007, p. 91), is "a string of part-of-speech

44 categories", "the tokens of which are strings of words that have been

45 annotated with these PoS tags" (Pinna & Brett, 2018, p. 107). Stubbs (2007)

46 considered it a type of "routine phraseology", in addition to *n-grams* and

47 *phrase-frames*. *N-grams* refer to recurrent contiguous multi-word sequences

48 (e.g., *as a result of*) and can also be called *lexical bundles* (Biber, Johansson,

49 Leech, Conrad & Finegan, 1999), *clusters* (Hyland, 2008), *recurrent word-*

50 *combinations* (Altenberg, 1998), *multi-word sequences* (Butler, 2003) and

51 *chains* (Stubbs & Barth, 2003). *Phrase-frames* denote "an n-gram with one

52 variable slot" (Stubbs, 2007, p. 90). Based on a powerful phraseology data-

53 base developed by Fletcher (2003/2004), Stubbs identified the most frequent

54 PoS-grams of length 5 in the British National Corpus (BNC) and described

55 their example tokens, mostly being "parts of nominal and prepositional

56 phrases, which express spatial, chronological and logical relations" (Stubbs,

57 2007, p. 94).

58

59 While these findings are intriguing, PoS-grams in our understanding may not

60 be a type of phraseology (Stubbs, 2007), as phraseology is generally defined

61 in corpus linguistics research as "the recurrent co-occurrence of words"

62 (Clear, 1993, p. 277). Yet, the compositional unit of a PoS-gram is a PoS

63 category (grammatical category) rather than a word form. Accordingly, we

64 only treat it as a phraseology-related concept, since the exponents of each

65 PoS-gram may be potential phraseology (Section 3) and the identification of

66 it can be an effective way to extract recurrent phraseologies and patterns

67 (Pinna & Brett, 2018).

68

69 In corpus-based EAP research, PoS-grams have received extremely scant

70 attention. This is in stark contrast to the abundance of research on *multi-word*

71 *sequences* (*phraseology*). It might be attributed to the far-reaching impact of

72 the Sinclairian tradition of corpus linguistics research (Sinclair, 1991), which

73   does not favor corpus annotation but "takes the word-form as the focal

74   point in the presentation of data" (Hunston & Francis, 2000, p. 18). While the

75   past three decades have witnessed the focus of corpus linguistics research on

76   lexical and phraseological issues such as word frequency, keywords and

77   various forms of the recurrent co-occurrence of words (i.e., *phraseology*), "a

78   renewal of interest in grammatical issues" has been noted (e.g., Biber, Gray,

79   Staples & Egbert, 2020; Larsson & Kaatari, 2020) (Breeze, 2019, p. 80). The

80   under-investigated PoS tag sequences and individual PoS categories have

81   started to captivate scholarly attention for studying specialized genres such

82   as the fiction and newspaper genres (Thompson & Sealey, 2007; Brett & Pinna,

83   2015; Pinna & Brett, 2018) and the legal register (Breeze, 2019). Yet, hardly

84   any systematic research exists on PoS-grams in research articles (RAs) and

85   their sections to examine their language patterning for both pedagogical and

86   research insights.

87

88   Specifically, Thompson and Sealey (2007) compare the linguistic properties of

89   the fictional prose written for children and that for adults and of newspaper

90   texts through deploying word/PoS tag frequency analyses, word and PoS

91   sequence analyses, and semantic analyses. The PoS-gram analysis, as they

92   maintain, "makes possible a novel perception of the frequency of the

93   complex prepositional phrase" (Thompson & Sealey, 2007, p. 21). The

94   presence of this complicated prepositional phrase *(prep art NN1 of art NN1[1])*

95   together with the other two PoS-grams (*art adj NN1 prep art*

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[1] Preposition+Article+Singular noun+*of*+Article+Singular noun

96 *NN1*[2]*)* and (*art NN1 prep art adj NN1*[3]) is shared in all the three types of texts.

97 Nevertheless, the newspaper texts still contrast remarkably with the two

98 fiction corpora in the other linguistic analyses such as the multi-word

99 sequence analysis. For instance, the news genre comprises sequences

100 denoting causality (*in the wake of*) and those with a higher level of

101 metaphoricity (*at the heart of the controversy*), whereas the two fiction

102 corpora contain overwhelmingly the expressions of location, direction and

103 temporality (*at the top of the hill; to the end of the lane; at the end of the day*)

104 (p. 14). Noticeably, the sets of phraseologies characterizing genres as

105 illustrated above, such as those referring to location, direction and

106 temporality in the fiction genre, are analogous in forms and may be subsumed

107 under the same PoS-grams with a higher level of generality to indicate

108 recurrent grammatical structure and syntactic patterns.

109

110 Both Brett and Pinna (2015) and Pinna and Brett (2018) have validated the

111 effectiveness of PoS-gram analyses for extracting phraseologies and patterns

112 for the newspaper register. Brett and Pinna have corroborated the distinctive

113 use of the inflected superlative adjective in tourism writing based on their

114 PoS-gram analysis of 0.45M token of travel journalism texts collected from

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[2] Article+Adjective+Singular noun+Preposition+Article+Singular noun
[3] Article+Singular noun+Preposition+Article+Adjective+Singular noun

115 the BBC web, with the 100M token BNC as the reference corpus. Their analysis

116 has identified a very limited number of highly frequent constructions

117 featuring such inflectional superlatives. Given rather low variation in lexical

118 choices within these constructions, they reflected on the utility of PoS-grams

119 in capturing sets of phraseologies with similar functions and forms, and

120 suggested their unique strengths and suitability for analyzing specialized

121 genres (as compared to n-gram analysis).

122

123 Pinna and Brett (2018) undertook a PoS-gram analysis of 10 sub-registers of

124 the newspaper *The Guardian*, with BNC as the reference corpus. Their analysis

125 has clearly demonstrated the usefulness of the PoS-gram procedure for

126 extracting *loose formulae* (Pinna & Brett, 2018, p. 121). *Loose formulae* refer

127 to schemas with particular discursive functions, derived from *semi-*

128 *prepackaged phrases* (Francis, 1993; Philip, 2008, 2011) or phraseologies

129 grouped under statistically significant PoS-grams, with their components

130 consistently playing certain semantic and functional roles. In addition to

131 extracting such formulae which reveal patterned language features of

132 specialized sub-registers, their PoS-gram analysis shows linguistic variations

133 and commonalities across them. To illustrate, the statistically significant PoS-

134   grams AT0 AJ0 NN1 PRP AT0 NN1[4] (Example token: *a familiar figure in the*

135   *town*), AJ0 NN1 PRP AT0 AJ0 NN1[5] (Example token: *small town on the Dutch*

136   *coast*), AT0 AJ0 NN1 PRP AT0 AJ0[6] (Example token: *a perfect accompaniment*

137   *to a cold*) and PRP AT0 AJ0 NN1 PRP AT0[7] (Example token: *on a rocky shelf*

138   *above a*) have been shared by Travel and Obituaries. As seen above, the

139   recurrent patterns in these two sub-registers concern the description of

140   entities, whereas another sub-register Crime features constructions related to

141   "entities undergoing processes" (Pinna & Brett, 2018, p. 116), as evidenced

142   by one of its top-ranking PoS-grams (NN1 VBD VVN PRP AT0 NN1[8], Example

143   token: *body was found in the garage*).

144

145   Different from the above three studies focusing on PoS sequences, Breeze

146   (2019) investigates key individual PoS categories across the four genre

147   families in business law (viz., academic texts, case law, legal documents and

148   legislation), with the BNC as the reference corpus. Her analysis has revealed

149   that NNSZ (plural possessive noun) is key in all four genre families, suggesting

150   it as the eminent grammatical feature of the legal register. However,

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[4] Article+Adjective+Singular noun+Preposition+Article+Singular noun

[5] Adjective+Singular noun+Preposition+Article+Adjective+Singular noun

[6] Article+Adjective+Singular noun+Preposition+Article+Adjective

[7] Preposition+Article+Adjective+Singular noun+Preposition+Article

[8] Singular noun+*Was/Were*+Past participle of lexical verb+Preposition+Article+Singular noun

grammatical specificity of these four genres have also been recorded: documents and legislation show "unusual patterns of cohesion and modality", whereas legal academic writing and case law "follow patterns comparable to argumentative texts" (Breeze, 2019, p. 79), featured with the frequent use of relative clauses and present tenses. Albeit these enlightening findings, Breeze recommends exploring PoS sequences, or combinations of PoS with specific lexical items for further research to increase our knowledge on language use in legal genres.

All the existing few PoS-gram studies have confirmed considerable potential and effectiveness of the PoS-gram procedure for specialized genre research. Yet, almost no study has hitherto systematically applied the PoS-gram analysis to RAs and their part-genres such as the largely conventionalized Introduction to be studied in this paper (Swales, 1990, 2004).

Previous introduction studies using genre and/or corpus approaches (e.g., Gledhill, 2000; Lu, Yoon & Kisselev, 2018; Swales, 1990, 2004) have repeatedly verified the patterned structure of language use in this section, suggesting its suitability for a PoS-gram analysis. In terms of its rhetorical structure, the well-established Creating a Research Space (CARS) model and its revised version (Swales, 1990, 2004) have suggested three obligatory moves (viz., Move 1

172 *Establishing a territory*, Move 2 *Establishing a niche* and Move 3 *Occupying a*

173 *niche/Presenting the present work*), under which steps of varying importance

174 are subsumed (e.g., the only obligatory step of *outlining the purpose* in Move

175 3). Numerous follow-up genre analyses have corroborated the validity of the

176 CARS model and its revised version, with some variations noted across

177 disciplines, genres and languages (e.g., Anthony, 1999; Kanoksilapatham,

178 2012; Sheldon, 2011).

179

180 Concerning its language patterning, most scholarly attention has so far been

181 devoted to different forms and variants of phraseology, most notably Bondi

182 (2010) on *semantic sequences*, Cortes (2013) on *lexical bundles*, Gledhill (2000)

183 on *collocations*, and Lu, Yoon and Kisselev (2018) on *phrase-frames*. Gledhill

184 (2000) examines the collocations of salient grammatical words and their

185 discourse functions in pharmaceutical sciences RA introductions, from which

186 semantic patterns associated with the salient grammatical words are derived,

187 which resemble *semantic sequences*[9] (Hunston, 2008). Along this line, Bondi

188 (2010, p. 99) has discovered outline introductory formulae and "framework

189 semantic sequences" associated with meta-discursive practices in economics

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[9] *Semantic sequences*, as defined by Hunston (2008: 271), are "recurring sequences of words and phrases that may be very diverse in form and which are therefore more usefully characterized as sequences of **meaning elements** rather than formal sequences".

190 RA introductions. Further, Cortes (2013, p. 41) has demonstrated the close

191 connections between bundles and moves/steps of introductions and

192 identified lexical bundles acting as *triggers* of moves and steps (e.g., *the*

193 *purpose of the present study, the objective of this study*) and as *complements*

194 ("used in the second part of the clauses or phrases identified as belonging

195 to a particular step" , e.g., *in the sense that*). The trigger-type bundles

196 together with many pedagogically useful phrase-frames identified by Lu et al.

197 (2018) from 600 social science RA introductions (e.g., the verb-based frames

198 "*we find [little, no, strong, suggestive, weak] evidence that*" and other-

199 content-word frame "*in the present study we [investigated, examine(d),*

200 *focus, test(ed)]*" [10]) have all suggested recurrent patterns and phraseologies

201 with similar forms and functions (and yet variability in lexical choices in certain

202 PoS position). The bundles in isolation together with the phrase frames and

203 their variants could be grouped under corresponding PoS-grams for a better

204 view of overall (syntactic) patterns and internal variability.

205

206 Compared to n-grams that focus on "identical, rather than very similar,

207 strings" (Pinna & Brett, 2018, p. 108) and phrase-frames with only one open

208 slot for lexical variants, PoS-grams may have the strengths of better

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[10] The words in square brackets, according to Lu et al. (2018: 81), suggest "variants that fill the open slot in each frame" .

209 uncovering variability and grouping patterns. This is because in every slot of

210 a PoS-gram, "any word can occur as long as it belongs to the PoS category

211 of that particular position" (Brett & Pinna, 2015, p. 52). The potential

212 advantages of PoS-grams over multi-word sequences have been neatly

213 summed up by Brett and Pinna (2015):

214

215 The quantitative analysis of strings of PoS categories and their relating

216 tokens casts a looser net over a wider area, allowing us to discover

217 widespread and characteristic patterns that fly below the statistical radar

218 of more traditional and stricter forms of analysis such as n-grams, which

219 can only reveal identity and not similarity. (p. 57)

220

221 Given such unique strengths of PoS-grams and the need to bridge the gap in

222 EAP research, this study applies key PoS-gram analyses to the largely

223 conventionalized article introductions from two contrasting disciplines (viz.,

224 cognitive linguistics (CL) and computer engineering (CE)), with the written

225 academic component of BNC as the reference corpus. The research aims are

226 three-fold: (1) methodologically, to examine the feasibility and usefulness of

227 the PoS-gram analysis to language patterning in a conventionalized academic

228 part-genre such as the Introduction section; (2) to generate patterns and

229 phraseologies represented by the key PoS-grams characterizing this part-

230 genre and to study the relevant cross-disciplinary commonalities and

231   differences; and (3) to examine the links, if any, between the key PoS-grams

232   specific to this part-genre and its functional moves and steps and the related

233   cross-disciplinary commonalities and variations. It illustrates an innovative

234   methodology of combining corpus-based PoS-gram analysis with EAP genre

235   research, which is expected to inspire a promising new line of inquiry and

236   shed new lights on the current EAP pedagogy.

237

238   **2. Corpus compilation and analysis**

239   **2.1 Corpus compilation**

240   To fulfill the research purposes, we have used AntCorGen 1.1.2 (Anthony, 2019)

241   to collect 400 RA introductions with 200 each from the two disciplines (viz.,

242   CL and CE) to compile the two corpora, i.e., Corpus of Cognitive Linguistics

243   introductions (CCL) and Corpus of Computer Engineering introductions (CCE).

244   AntCorGen 1.1.2, as introduced by its developer Lawrence Anthony from

245   Waseda University in its help file, is a reliable free computer software for

246   corpus generation. One of its important relevant functions is that it can help

247   researchers to download different sections (e.g., title, introduction) of journal

248   articles from the PLOS ONE[11] research database based on different subject

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[11] *PLOS ONE* is a peer-reviewed open access journal published by the Public Library of Science since 2006, according to Wikipedia (https://en.wikipedia.org/wiki/PLOS_One). It publishes primary research from a wide range of disciplines within science, engineering, social science and medicine.

249   category (i.e., disciplines and sub-disciplines). By adopting this function, we

250   have gathered all the introductions needed and their corresponding PDF full-

251   texts (in case of the need to reference the whole research) from the areas of

252   CL (under the category of "Social Sciences" —sub-category "Linguistics")

253   and CE (under the category of "Engineering and Technology" —sub-

254   category "Electronics Engineering"). After downloading all texts needed, we

255   have checked through them to ensure that all the introductions gathered are

256   from empirical RAs, rather than from other categories of RAs such as

257   theoretical or review papers.

258

259   Table 1 presents descriptive details of the two compiled corpora. As can be

260   seen, their sizes are not very large, due to the restricted lengths of journal

261   articles themselves and their introductions. However, as remarked by Hunston

262   (2002, p. 26), "a small corpus can be valuable under certain circumstances"

263   and one possible circumstance is to construct a specialized corpus for a

264   particular research purpose. There are significant disciplinary variations in the

265   lengths of the introductions, despite their similar numbers of word types

266   (Table 1). Specifically, the average length of article introductions in CL is

267   around 1, 363 words per text, much longer than that of introductions in CE

268   (approximately 900 words per text).

269

270 Table 1 The sizes and composition of CCL and CCE

Corpora	No. of texts	Tokens	Types
CCL	200	272,657	15,769
CCE	200	179,990	15,096

271

2.2 Key PoS-gram extraction and analysis

273 As Breeze (2019, p. 81) points out, PoS tag information on a particular corpus

274 is in itself "meaningless", and therefore "a reference corpus needs to be

275 selected in order to conduct a keyness analysis". While her study focuses on

276 individual key PoS based on a keyness comparison, the present work extends

277 to investigate key PoS sequences from the two study corpora. To make a

278 cross-disciplinary comparison of key PoS-grams possible, the same reference

279 corpus was selected for them.

280

281 While Brett and Pinna (2015) and Pinna and Brett (2018) used the entire 100-

282 million-word BNC corpus as the reference corpus for key PoS-gram analyses,

283 the present study used its written academic component processed by

284 TreeTagger pipeline v2.1 as the reference corpus (see

285 *https://app.sketchengine.eu/#dashboard?corpname=preloaded%2Fbnc2_tt2*

286 *1*, last retrieved on 25th July, 2020). It is around 17, 627, 082 word tokens (15.69%

287 of the whole BNC).

288

289 In the identification and concordance search of key PoS-grams, Sketch

290 Engine with their modified English TreeTagger PoS tagset was adopted

291 (Kilgarriff et al., 2014). This tagset contains 55 tags (see

292 *https://www.sketchengine.eu/english-treetagger-pipeline-2/#toggle-id-1*,

293 last retrieved on 25th July, 2020), most of which have identified features

294 conventionally considered as parts of speech (e.g., *adverb, adjective* and

295 *modal verb*). A few others such as SYM (symbols, e.g., ** or =*), SENT (sentence

296 break punctuation, e.g., *. or ?*), FW(foreign word, e.g., *d' hoevre*), CD (cardinal

297 number, e.g., *1, third*), LS (list marker, .e.g., *1), B) or b)*) and UH (interjection,

298 e.g., *uh, oh*) may interfere with the identification of meaningful PoS-grams by

299 SketchEngine (Breeze, 2019, p. 82). Consequently, they were excluded, a

300 practice Breeze (2019) also adopted. However, in her PoS keyness analysis,

301 Breeze additionally discarded the item Z (representing *miscellaneous symbols*

302 in her word), which was not followed here. The reason is that Z stands for

303 possessive ending (e.g., *´ s*) rather than miscellaneous symbols in the latest

304 version of modified English TreeTagger PoS tagset (pipeline version 2)

305 developed by SketchEngine, and thus may become an important constituent

306 of PoS sequences.

307

308 After rounds of trial analyses and close observation of the data, we decided

309 to set the length of key PoS-grams as six, a number recommended by

310 previous researchers (Brett & Pinna, 2015; Pinna & Brett, 2018; Thompson &

311 Sealey, 2007). A length of five or even fewer may yield an excessive number

312 of PoS-grams, whereas a number of seven or more PoS tags in the sequence

313 might limit the variety of PoS-grams produced and hence the restricted

314 insights (Thompson & Sealey, 2007). Additionally, the maximum length of

315 PoS-grams Sketch Engine could extract is six.

316

317 The minimum frequency set for key PoS-gram extraction was 30 per million

318 words and the "Distribution of Hits" function offered by Sketch Engine was

319 used to check how key PoS-gram candidates are distributed within the corpus.

320 Those distributed in less than five texts were excluded, to ensure that the key

321 PoS-grams extracted would not be tied to the topic of individual texts. As

322 such, in CCL, two key PoS-grams with their keyness scores originally ranking

323 as the first and the eighth (viz., *IN VVN JJ NN IN NP*[12] and *NN IN VVN JJ NN*

324 *IN*[13]) were excluded, as all their tokens were found to be in only two and one

325 texts respectively. They all contain the terminology "*reduced emotional*

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[12] Preposition+Past participle of lexical verb+Adjective+Singular noun+Preposition+Singular proper noun

[13] Singular noun+Preposition+Past participle of lexical verb+Adjective+Singular noun+Preposition

326 *resonance*"   (see their corresponding parts of speech underlined above),

327 which is exactly the topic of the two papers.

328

329 The keyness value offered by Sketch Engine is calculated based on a   "simple

330 maths"   procedure   (check

331 *https://www.sketchengine.eu/documentation/simple-maths/* for the formula

332 and other details), which has resulted in large quantities of results (see Table

333 2). As such, for the subsequent detailed concordance analysis to derive

334 potential lexicogrammatical frames and phraseological skeletons, only the

335 top ten key PoS-grams were selected for each corpus. Their discursive roles

336 and structure were carefully examined, with special reference to their co-texts,

337 context and the communicative functions of prototypical moves and steps of

338 this conventionalized part-genre, as suggested in the well-known CARS

339 model and its revised version (Swales, 1990, 2004). Finally, the key PoS-grams

340 and their tokens in terms of distribution, structure, meaning and functions

341 were compared across CCL and CCE to discern related cross-disciplinary

342 commonalities and variation.

343

344 Table 2 Numerical data on the key PoS-grams identified in CCL and CCE

Corpora	Key PoS-grams	Tokens
CCL	1,368	31,722

CCE	820	17,091

345

3. Results and discussion

347 This part is sub-divided into three sub-sections. In the first two sub-sections,

348 we report on findings from key PoS-gram analyses of CCL and CCE. Following

349 that, a summary of related cross-disciplinary similarities and differences is

350 presented in sub-section 3.3.

351

3.1 Salient PoS-grams in CCL

353 Table 3 shows the top ten key PoS-grams in CL introductions, with their raw

354 frequencies, relative frequencies in the two corpora, key scores and example

355 tokens listed. The PoS-gram with the highest key score is *IN DT JJ NN VBD*

356 *TO*[14] (82.5 times per million words), which together with *DT JJ NN VBD TO*

357 *VV*[15], ranking as the seventh, are found to be sub-grams of the 7-PoS-gram

358 (*IN DT JJ NN VBD TO VV*[16]). The numbers of their tokens are equal (*27*) (see

359 Table 3), among which 25 concordance lines are overlapping. Nevertheless,

360 all of their tokens function similarly to announce research purposes or aims

---

[14] Preposition+Determiner+Adjective+Singular noun+Verb *BE* in the past tense+ *TO* infinitive

[15] Determiner+Adjective+Singular noun+Verb *BE* in the past tense+ *TO* infinitive+Base form of lexical verb

[16] Preposition+Determiner+Adjective+Singular noun+Verb *BE* in the past tense+*TO* infinitive+ Base form of lexical verb

361 and a lexicogrammatical frame can thus be derived, i.e., "{The/A/One}

362 (primary/main/first/second) {aim/goal/purpose/focus} of the

363 {present/current} {study/experiment/investigation} was *to*-infinitive clause"

364 (Appendices 1 and 2).

365

366 The words enclosed within curly brackets represent a range of lexical choices

367 in the slot which often belong to the same semantic set, resulting in "the

368 formation of a series of loosely synonymous expressions" (Philip, 2008, p.

369 99). The curly brackets also indicate word choice within them being obligatory,

370 i.e., at least one word is supposed to be selected, whereas the words shown

371 in parentheses are all optional. This difference is intended to capture the

372 different importance of components within patterns, giving readers a clear

373 sense of overall patterning and internal variability. All the tokens of these two

374 key PoS-grams are closely connected to "outlining purposes/announcing

375 present research", the only obligatory step under Move 3

376   Table 3 Top ten key 6-PoS-grams in CCL

Key PoS-gram	F1	RF1	F2	RF2	Score	Example token
IN DT JJ NN VBD TO	27	82.5	75	4.3	15.9	*of the present study was to*
NNS VHP VVN IN/that JJ NNS	10	30.6	23	1.3	13.7	*Studies have shown that dyslexic readers*
DT NNS VVP IN/that JJ NN	10	30.6	30	1.7	11.7	*these findings suggest that semantic priming*
VVN TO VV JJ NN NN	13	39.7	45	2.6	11.5	*asked to provide explicit word recognition*
JJ NNS VHP VVN JJ NN	10	30.6	36	2	10.4	*Other studies have provided similar evidence*
JJ NNS VHP VVN IN/that JJ	11	33.6	42	2.4	10.2	*Previous studies have shown that short-term*
DT JJ NN VBD TO VV	27	82.5	151	8.6	8.7	*the present study was to examine*
NN NN VHZ VBN VVN TO	11	33.6	54	3.1	8.5	*adjustment model has been used to*
NN NN NN IN JJ NNS	18	55	108	6.1	7.9	*word segmentation processing of Chinese readers*
DT JJ NN JJ NN NN	11	33.6	62	3.5	7.7	*the masked priming lexical decision task*

377   **Notes**

378   1. F1 and F2 indicate raw frequencies of each key PoS-gram in CCL and the reference corpus respectively.

379   2. RF1 and RF2 represent their relative frequencies in CCL and the reference corpus respectively (per million words).

380   "occupy the niche" in Swales's (1990, 2004) CARS model. This finding

381   consolidates the importance of announcing present research descriptively or

382   purposively in the opening phrase of the article (Bondi, 2010) whilst

383   evidencing a high degree of formulaicity in language realizations of this step

384   (Cortes, 2013). Such arrays of exponents of the two key PoS-grams mapped

385   with this communicative function would be directly helpful to novice writers.

386

387   Another set of four key PoS-grams (viz., *NNS VHP VVN IN/that JJ NNS*[17], *JJ*

388   *NNS VHP VVN IN/that JJ*[18], *DT NNS VVP IN/that JJ NN*,[19], and *JJ NNS VHP*

389   *VVN JJ NN*[20]) with partly analogous structure are found to play similar textual

390   functions—summarising previous studies or synthesizing findings in the

391   literature (Table 3). A close examination of their concordance lines reveals that

392   they mostly relate to the essential step of "reference to previous research or

393   scholarship (normally more than one author) to make topic summarization"

394   suggested in Swales's (1990) CARS model, as illustrated below:

395

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[17] Plural noun+Non-3rd person singular present form of the verb *HAVE*+Past participle of lexical verb+*That* as subordinator+Adjective+Plural noun

[18] Adjective+Plural noun+Non-3rd person singular present form of the verb *HAVE*+Past participle of lexical verb+*That* as subordinator+Adjective

[19]Determiner+Plural noun+Non-3rd person singular present form of lexical verb+*That* as subordinator+Adjective+Singular noun

[20] Adjective+Plural noun+Non-3rd person singular present form of the verb *HAVE*+Past participle of lexical verb+Adjective+Singular noun

396   (1) **Studies have shown that dyslexic readers** elicited smaller N170
397   amplitudes compared to regular readers... [35]–[36]. (*NNS VHP VVN*
398   *IN/that JJ NNS*)
399

400   (2) ...**previous studies have shown that positive** or negative words, or
401   both, elicited a greater late positive complex... [3]–[9]. (*JJ NNS VHP VVN*
402   *IN/that JJ)*
403

404   (3) **These data suggest that whole word** representations exist and can
405   affect recognition... [23], [24]. (*DT NNS VVP IN/that JJ NN*)
406

407   (4) **Previous studies have used demographic information**...to explain
408   the variability in CI outcomes, but with limited success [7], [8]. (*JJ NNS*
409   *VHP VVN JJ NN*)
410

411   In particular, the tokens of the former two PoS-grams yield the

412   lexicogrammatical   frame   "{studies/works}   have

413   {shown/mentioned/demonstrated/found/reported} *that*-clause" , with the

414   verb *show* most often used (5 out of the 10 and 11 times respectively). These

415   two PoS-grams only differ in the modifier preceding the first NNS and the

416   composition of the noun phrase as the subject of *that*-clause. Specifically, for

417   *NNS VHP VVN IN/that JJ NNS*, not only adjectives such as *previous, several*

418   and *other*, but determiners like *these* and *some* could be used preceding the

419   first NNS (tokens being either *studies* or *works*) to summarise the studies

420   reviewed or to synthesize sources for a contrast (e.g., *other studies have*

421 *shown that...*). As for *JJ NNS VHP VVN IN/that JJ*, the structure after the

422 subordinator *that* is not complete and *JJ* is only one of the multiple modifiers

423 of the head noun as the subject, e.g., *positive or negative words (**JJ** CC JJ NNS)*

424 and *individual Chinese characters (**JJ** JJ NNS)*.

425

426 Functioning similarly to summarise the literature, the key 6-PoS-gram *DT NNS*

427 *VVP IN/that JJ NN* suggests another lexicogrammatical frame "{the/these}

428 {findings/results/data} {suggest/indicate} *that*-clause" (Appendix 3). It is

429 noted that only a very restricted set of verbs (i.e., *sugges*t, *indicate*) in the

430 simple present tense can be used in this pattern, with the subject being

431 *findings, results* or *data*, indicating the validity of generalisations of previous

432 findings. This is in stark contrast with the lexicogrammatical frame

433 "{studies/works} have {shown/mentioned/demonstrated/found/reported}

434 *that*-clause" we just discussed, where another set of verbs suggesting

435 research or discursive acts (e.g., *show, demonstrate*, *find, report*) are used in

436 the present perfect tense, which tend to be co-selected with the subject

437 *studies/works* as the agent. These two contrasting co-selection patterns with

438 analogous functions but fine-grained internal structural and compositional

439 variations might not have been fully detected, if we only study salient

440 individual words or PoS tags or multi-word sequences in isolation. This can

441 clearly demonstrate the unique strengths of the PoS-gram analysis in

442 grouping patterns and showing variability within patterns.

443

444 Within this set of four salient PoS-grams for topic summarization, the last

445 variant *JJ NNS VHP VVN JJ NN* involves using the present perfect "to make

446 a general statement about the state of research activity in a given area"

447 (Collins Cobuild English Grammar, 4th edition, 2017, p. 1102), which resembles

448 the aforementioned PoS-grams *NNS VHP VVN IN/that JJ NNS* and *JJ NNS*

449 *VHP VVN IN/that JJ*.

450

451 Yet, its difference lies in not having a *that*-clause but a noun phrase in post-

452 predicate position, which could be classified into two main categories, as its

453 concordance lines suggest: 1) a group of noun phrases with more abstract

454 head nouns denoting results, effects or a resulting phenomenon (70%)

455 (Examples 5-6), and 2) others referring to a specific research variable or target,

456 which often collocate with verbs denoting research procedures or acts (30%)

457 (Example 4). The former type obviously concerns what has been achieved,

458 whereas the latter category relates to what has been done.

459

460   (5) **Other studies have provided similar evidence,** … (see [3], [11] for
461   reviews). (*JJ NNS VHP VVN JJ NN*)

462

463   (6) Indeed, **many studies have demonstrated N400 mismatch** effects...

464   (for example [21, 22]). (*JJ NNS VHP VVN JJ NN*)

465

466   Further, regarding another salient 6-PoS-gram *VVN TO VV JJ NN NN*[21], four

467   out of its 13 tokens structured in the form of the past simple passive plus the

468   *to*-infinitive have been used towards the end of introductions to realise the

469   step of "summarizing the methods used" , as indicated in Swales' s (2004)

470   revised CARS model. The occurrence of this step is more likely in papers

471   "whose principal outcome can be deemed to reside in their methodological

472   innovations" (Swales, 2004, p. 231). One such example is provided below.

473

474   (7) ...participants in the present study were also **asked to provide explicit**

475   **word recognition** judgements at the end of each trial, making it possible

476   to.... (*VVN TO VV JJ NN NN*)

477

478   Another five tokens of this PoS-gram, if we expand their left context, are

479   noted to be in the structure of the present perfect passive plus the *to*-infinitive.

480   They all function to state synthesized findings, often accompanied with

481   multiple references encapsulated in a non-integral citation plus reporting

482   verbs such as *show, demonstrate* and *suggest*, as illustrated in Example (8):

---

[21] Past participle of lexical verb+*TO* infinitive+Base form of lexical verb+Adjective+Singular noun +Singular noun

483

(8) The incorporation of both serial and lexicalized varieties of fingerspelling in elementary reading instruction has been **demonstrated to enhance English vocabulary acquisition** in deaf children [35, 36, 37]. (*VVN TO VV JJ NN NN*)

488

Functioning differently, the remaining four tokens are parts of the structure—

"the lexical verb in the simple passive plus the *to*-infinitive", with two using

verbs in the present tense to indicate common research practices or generally

accepted knowledge (Example 9). The other two use verbs in the past simple

passive to review individual prior studies with probably inconclusive findings

(Example 10).

495

(9) As noted by some researchers [21], this type of test is routinely **used to assess oral language comprehension** in children with specific language impairments. (*VVN TO VV JJ NN NN*)

499

(10) However, early vocabulary level (assessed at the beginning of kindergarten) was **found to predict early reading comprehension** performances ... in other studies with English children [13]. (*VVN TO VV JJ NN NN*)

504

505   The key PoS-gram *NN NN VHZ VBN VVN TO*[22] contains a "NN NN"

506   construction as its subject, e.g., *adjustment model* (Table 3) and *negativity*

507   *bias* (Example 11). Functionally, it might arguably be considered as another

508   variant of the set of PoS-grams for synthesizing findings (e.g., *NNS VHP VVN*

509   *IN/that JJ NNS*). However, its difference resides in the subject being a concrete

510   research target or item (e.g., *negativity bias* in Example 11) rather than a

511   general term like *studies/findings/results/data* used in tokens of the four 6-

512   PoS-grams for topic summarisation. This perhaps necessitates the use of the

513   passive plus the *to*-infinitive to indicate summarised results.

514

515   (11) In middle-aged and older adults, the **negativity bias has been found**
516   **to** be reduced [13–14] .... (*NN NN VHZ VBN VVN TO*)

517

518   Concerning the last two key PoS-grams in Table 3 (*NN NN NN IN JJ NNS*[23]

519   and *DT JJ NN JJ NN NN*[24]), their grammatical structure may embody the

520   preferential use of nominalization in academic register (Biber et al., 1999).

521   Notice that the former PoS-gram *NN NN NN IN JJ NNS* comprise a

522   prepositional phrase (*IN JJ NNS*) postmodifying the noun phrase (*NN NN NN*)

---

[22] Singular noun+Singular noun+3rd person singular present form of the verb *HAVE*+Past participle of the verb *BE*+Past participle of lexical verb+*TO* infinitive

[23] Singular noun+Singular noun+Singular noun+Preposition+Adjective+Plural noun

[24] Determiner+Adjective+Singular noun+Adjective+ Singular noun+Singular noun

523   to give extra or specific information about the head noun (mainly possession

524   and identifying features). The head noun in these tokens is invariably a

525   discipline-specific specialized term such as *speech act processing, discovery*

526   *rate correction* and *word segmentation processing* (Table 3). The tokens of

527   the latter PoS-gram *DT JJ <u>NN JJ NN NN</u>* consistently contain the recurrent

528   terminology "<u>priming lexical decision task/experiment</u>" (72.7%) and

529   accordingly a simple lexicogrammatical frame could be derived, i.e.,

530   "{a/the/an} {masked/affective} priming lexical decision

531   {task/experiment/paradigm}", based on 9 out of the 11 tokens. As such, both

532   PoS-grams feature CL introductions with their tokens frequently suggestive

533   of disciplinary content.

534

535   **3.2 Salient PoS-grams in CCE**

536   Table 4 lists the top ten salient PoS-grams in CCE, their key value and example

537   tokens, as compared to the written academic component of BNC. In contrast

538   to CCL, the 6-PoS-gram with the highest key score identified in CCE is *DT NN*

539   *VBZ VVN RB VVZ*[25] (see concordance lines in Appendix 4), whose tokens are

540   structure-outlining sentences, "nearly always a final element in Move 3" of

541   the CARS model (Swales, 2004, p. 232). While the use of this element seems

---

[25] Determiner+Singular noun+3rd person singular present form of the verb *BE*+Past participle of lexical verb+Adverb+3rd person singular present form of lexical verb

542 absent in the disciplines with an established IMRD-like sectional arrangement

543 such as biochemistry studied in Kanoksilapatham (2003), "in other fields that

544 lack such an arrangement, such as computer science, information science,

545 biostatistics, or economics, this structure-outlining option becomes close to

546 obligatory" (Swales, 2004, p. 232). Given that CE is close to the field of

547 computer science, Swales's observation has well accounted for the strong

548 presence of this PoS-gram for roadmapping the structure of the paper in CCE.

549 The head verb "*organize*" or "*structure*" has been constantly used in the

550 present passive form and a lexicogrammatical frame could be derived: The

551 {reminder/rest} (of) (the/this) (paper/article) is {organized/structured} as

552 follows.

553   Table 4 Top ten key 6-PoS-grams in CCE

Key PoS-gram	F1	RF1	F2	RF2	Score	Example token
DT NN VBZ VVN RB VVZ	15	69.9	5	0.3	55.3	*This paper is organized as follows*
NN NNS VHP VBN VVN TO	10	46.6	38	2.2	15.1	*computer programs have been developed to*
NP NP NP NP NP NP	76	354.3	555	31.5	10.9	*Python Version Numpy Version Scipy Version*
JJ JJ NN NN VVN IN	10	46.6	60	3.4	10.8	*stochastic local search algorithm based on*
IN DT JJ NN VBD TO	11	51.3	75	4.3	9.9	*of the present study was to*
JJ NN NNS VHP VBN VVN	16	74.6	128	7.3	9.2	*several software applications have been proposed*
IN JJ NN NNS JJ IN	11	51.3	89	5	8.6	*of common simulation languages such as*
IN JJ CC JJ NN NN	13	60.6	116	6.6	8.1	*with free and open source software*
TO VV JJ NN NNS IN	15	69.9	143	8.1	7.8	*to provide adequate download speeds for*
DT JJ NN VBD TO VV	15	69.9	151	8.6	7.4	*the present study was to investigate*

554   **Notes**

555   1. F1 and F2 indicate raw frequencies of each key PoS-gram in CCE and the reference corpus respectively.

556   2. RF1 and RF2 represent their relative frequencies in CCE and the reference corpus respectively (per million words).

557 Indeed, this lexicogrammatical frame can be represented in a semantic

558 sequence, i.e., "outline introductory formulae" proposed by Bondi (2010):

559 DISCOURSE UNIT (e.g., this paper/the rest of the paper)+V-STRUCTURE (e.g.,

560 is organized/is structured)+CATAPHORA (e.g., as follows/in the following

561 way).

562

563 Further, a close look at all concordance lines of this pair of key PoS-grams

564 (*NN NNS VHP VBN VVN TO*[26], ranking the second, and *JJ NN NNS VHP VBN*

565 *VVN*[27], ranking the sixth) has revealed that five of their concordance lines are

566 identical, from which a longer 7-PoS-gram could be derived, viz., *JJ NN NNS*

567 *VHP VBN VVN TO*[28], as illustrated in Example 12.

568

569   (12) **Several computer programs have been developed to** analyze

570   relaxation data and generate the parameters…, including Modelfree [4],

571   relax [5] and MOLDYN [6]. (*JJ NN NNS VHP VBN VVN TO*)

572

573 The rest of their concordance lines has revealed slightly different co-

574 occurrence patterns for the two PoS-grams. For instance, different from the

---

[26] Singular noun+Plural noun+Non-3rd singular present form of the verb *HAVE*+Past participle of the verb *BE*+Past participle of lexical verb+*TO* infinitive

[27] Adjective+Singular noun+Plural noun+Non-3rd singular present form of the verb *HAVE*+Past participle of the verb *BE*+Past participle of lexical verb

[28] Adjective+Singular noun+Plural noun+Non-3rd singular present form of the verb *HAVE*+Past participle of the verb *BE*+Past participle of lexical verb+*TO* infinitive

575   PoS-gram *NN NNS VHP VBN VVN TO* which suggests only the *to*-infinitive

576   clause used immediately

577 after the present perfect passive, the prepositional phrase is equally often

578 used (as the *to*-infinitive clause) after the present perfect passive for *JJ*

579 *NN NNS VHP VBN VVN* (31.3%), as exemplified in the underlined part of

580 Example (13):

581

582 (13) Previous studies [7,8] have indicated that pattern matching
583 consumes approximately 70% of system execution time. Many
584 software- and **hardware-centered pattern-matching algorithms**
585 **have been proposed** <u>for NIDSs</u>. (*JJ NN NNS VHP VBN VVN*)

586

587 Despite this slight difference in collocational patterns, all tokens of both

588 PoS-grams with the shared use of present perfect passives have

589 uniformly functioned to synthesize the current state of knowledge or

590 advances on computer programs, software applications or computational

591 methods (see Examples 12-13). Consequently, a lexicogrammatical frame

592 can be extracted for most concordance lines of these two PoS-grams:

593 [computer programs/algorithms/models] have been

594 {developed/proposed/employed/used/applied/shown} (*to*-infinitive

595 clause or prepositional phrase). Note that the subject within the square

596 brackets represents a recurring semantic element rather than concrete

597 lexical choices, similar to "*meaning elements*" in Hunston's (2008)

598 definition of "*semantic sequences*".

599

This phraseological pattern for the function of topic summarization embodies discipline-specific features, in that the subject has been specifically relevant to computer programs/algorithms/models and the collocational verbs following are dominantly *develop* or *propose* (together over 50% for both PoS-grams).

Another noticeable disciplinary feature is apparently more compact language use than in CCL, as evidenced in the intensive use of pre-modifications and post-modifications of noun phrases, and the total absence of the *that-clause* but strong presence of the *to-infinitive clause* in top-ranking key PoS-grams. To illustrate, the presence of the construction "noun +noun(+noun) ..." has been found in seven out of the 10 top-ranking key PoS-grams (Table 4). Additionally, a combination of multiple adjectives and nouns could also serve as premodifiers, as seen from the concordance lines of another PoS-gram *JJ JJ NN NN VVN IN*[29] in Appendix 5.

Further, the key PoS-gram "*NP NP NP NP NP NP*" ranking the 3rd in the list is noted to have as many as 76 occurrences (Table 4). While it is an important characteristic of academic writing to use one or multiple nouns to premodify a head noun (Biber et al., 1999), "using more than four

---

[29] Adjective+Adjective+Singular noun+Singular noun+Past participle of lexical verb+Preposition

621 premodifiers makes the noun phrase difficult to understand, especially

622 when this consists only of nouns" (Collins Cobuild English Grammar, 4th

623 edition, 2017, p. 1098). Nevertheless, all tokens of the key PoS-gram "*NP*

624 *NP NP NP NP NP*" represent discipline-specific technical terms, with

625 most being the names of operating systems Python version plus a couple

626 the names of regulations (Example 14), which may be another marked

627 disciplinary feature in language use.

628

629   (14) ...the recently enacted **EU General Data Protection Regulation**
630   **EU-2016** /679 (GDPR) not only raised .... (*NP NP NP NP NP NP*)
631

632 In addition to pre-modifications, the PoS-gram *JJ JJ NN NN VVN IN* also

633 suggests the -ed participle clause as a common way of post-modifying

634 the noun phrase, as exemplified in 90% of its concordance lines in

635 Appendix 5. Moreover, the tokens of another three PoS-grams *TO VV JJ*

636 *NN NNS IN*[30] (80%), *IN JJ NN NNS JJ IN*[31] (near 60%) and *IN JJ CC JJ NN*

637 *NN*[32] (near 50%) have been dominantly post-modifiers of a noun phrase,

638 as illustrated respectively in Examples 15-17. Especially, the former two

639 are suggestive of incomplete structures on both ends. According to

640 *Collins Cobuild English Grammar* (the 4th edition, 2017), participle and

---

[30] *TO* infinitive+Base form of lexical verb+Adjective+Singular noun+Plural noun+Preposition

[31] Preposition+Adjective+Singular noun+Plural noun+Adjective+Preposition

[32] Preposition+Adjective+Coordinating conjunction+Adjective+Singular noun+Singular noun

641 infinitive clauses and prepositional phrases are often used to reduce the

642 relative clause in academic writing to make language compressed whilst

643 giving more information about the noun phrase they modify. As for the

644 rest few tokens of *TO VV JJ NN NNS IN*, they are parts of the *to*-infinitive

645 structures entailed by verbs such as *attempt* (2 times) and *continue* (1

646 time). In contrast, the rest of the tokens for the PoS-gram *IN JJ NN NNS*

647 *JJ IN* serve as post-modifiers of a verb phrase in passive voice. This also

648 applies to the PoS-gram *IN JJ CC JJ NN NN* for most of its other tokens

649 not post-modifying a noun phrase (Example 18).

650

651 (15) ... a novel research direction is to investigate uncompensated
652 samples as a way **to conduct large scale studies with** the benefit of
653 being cheaper and better representative populations [1, 2]. (*TO VV JJ*
654 *NN NNS IN*)

655

656 (16) The Pipeline's task-manager provides..., and integrates the direct
657 and batch processing capabilities **of available grid-management**
658 **environments such as** Oracle Grid Engine.... (*IN JJ NN NNS JJ IN*)

659

660 (17) Concepts **of model-based and model-free reinforcement**
661 **learning** are incorporated.... (*IN JJ CC JJ NN NN*)

662

663 (18) ...several such orphan crops have been enriched **with full or**
664 **partial reference genome** sequence information. (*IN JJ CC JJ NN NN*)
665

666 Despite remarkable discipline-specific features, the concordance lines of

667 two salient PoS-grams ("*IN DT JJ NN VBD TO*" [33] and "*DT JJ NN VBD*

668 *TO VV*" [34]) have been consistently found to be purposive statements in

669 CCE as well (see Appendices 6 and 7). A lexicogrammatical frame could

670 thus be yielded, i.e., "{The/A} (main/major/first/second/secondary)

671 {objective/goal/aim/purpose} (of/for) (the/this) (present/current)

672 (study/review) was *to*-infinitive clause" . Among their concordance lines,

673 quite a majority are overlapping, which has implied the existence of a

674 longer 7-PoS-gram ("*IN DT JJ NN VBD TO VV*" [35]). As suggested earlier,

675 this is concomitant with the CARS model that indicates "announcing

676 research descriptively/purposively" to be an obligatory step in

677 introductions (Swales, 1990, 2004). The relatively high degree of

678 formulaicity in language realization of this step has again been confirmed

679 in CE introductions.

680

681 **3.3 Cross-disciplinary similarities and differences in salient PoS-**

682 **gram sequences**

683

---

[33] Preposition+Determiner+Adjective+Singular noun+The past tense form of the verb *BE*+*TO* infinitive

[34] Determiner+Adjective+Singular noun+The past tense form of the verb *BE*+*TO* infinitive+Base form of lexical verb

[35] Preposition+Determiner+Adjective+Singular noun+The past tense form of the verb *BE*+*TO* infinitive+Base form of lexical verb

684 The preceding two sub-sections have presented detailed findings on key

685 PoS-grams in CCL and CCE, with scattered mentioning of related cross-

686 disciplinary commonalities and differences. As introductions to RAs have

687 been acknowledged as a largely conventionalized part-genre (Swales,

688 1990, 2004), what is shared across the two corpora in their PoS-gram

689 analyses might be considered as features of language patterning specific

690 to this part-genre and what distinguishes one from the other might be

691 characterizing the particular discipline. The major cross-disciplinary

692 commonalities and differences are summarized below. First of all, the

693 PoS-grams with high keyness scores have been successfully identified for

694 introductions of both disciplines, with their representative

695 lexicogrammatical frames and phraseologies highlighted, which has

696 empirically validated the phraseological tendency and idiomaticity of

697 language use in academic genres (Sinclair, 1996; Gledhill, 2000). Second,

698 in both CCL and CCE, the key PoS-grams with their discursive functions

699 matching with the steps of "purposive announcement" and "topic

700 summarization/synopsis of previous findings in the literature"

701 suggested in the CARS model (Swales, 1990, 2004) have been identified.

702 This has not only evidenced the importance of these two functional steps

703 in the introductions, but has foregrounded a high level of formulaicity in

704 language use to realize them.

705

706 Regarding salient PoS-grams for realizing them, the couple associated

707 with "purposive announcement" (viz., *IN DT JJ NN VBD TO* and *DT JJ*

708 *NN VBD TO VV*) is shared in both corpora. In line with this, the

709 lexicogrammatical frames identified for purposive announcement in the

710 introductions of the two disciplines resemble each other very closely (see

711 Table 5).

712

713 Table 5 Lexicogrammatical frames for purposive-announcement

Corpus	Pattern	Examples	Frequency
CL	{The/A/One} (primary/main/first/second) {aim/goal/purpose/focus} of the {present/current} {study/experiment/investigation/review} was *to*-infinitive clause	- ***The primary aim of the present study*** *was to test...* - ***The purpose of the present study*** *was to explore...*	29
CE	{The/A} (main/major/first/second/secondary) {objective/goal/aim/purpose} (of/for) (the/this) (present/current) (study/review) was *to*-infinitive clause	-***The goal of the current study*** *was to extend...* -***The secondary objective*** *was to test...*	16

714

715 Yet, the key PoS-grams identified for realizing the step of "topic

716 summarization/synopsis of previous findings in the literature" are not

717 identical for the two disciplines. As pointed out before, in CCL, the

718 subjects tend to be words such as "*studies, works*" (co-selecting with

719 verbs like "*show, demonstrate*" in the present perfect tense and active

720 voice) or "*findings, results and data*" (collocating with verbs "*suggest,*

721 *indicate*" in the simple present tense and active voice). By contrast, in

722 CCE, the subjects are words related to computer programs or software

723 applications, often being particular algorithms or modeling frameworks,

724 and their collocational verbs are dominantly *develop* or *propose* used in

725 the present perfect tense and passive voice, which manifests its

726 distinctive disciplinary nature. In all, two lexico-grammatical frames could

727 be synthesized for CL introductions in contrast to one for CE

728 introductions for the function of "topic summarization or synopsis of

729 previous findings" (see Table 6). Such different language patterns for

730 realizing the same functional step across two contrasting disciplines

731 should be of particular attention to novice writers.

732

733 Table 6 Lexicogrammatical frames for topic summarization or synopsis of previous
734 findings

Corpus	Pattern	Examples	Frequency
CL	{studies/works} have {shown/mentioned/demonstrated/ found/reported} *that*-clause or noun phrase	-***previous studies have demonstrated that*** *emotional...*	26

		-*Other studies have provided similar evidence*...	
	{the/these} {findings/results/data} {suggest/indicate} *that*-clause	-*These results suggest that* lexical processing... -*these findings indicate that* ordinal processing...	10
CE	[computer programs/algorithms/models] have been {developed/proposed/employed/used/applied/shown} (*to*-infinitive clause or prepositional phrase)	-...various ***dual-system frameworks have been proposed*** [5, 7]. -several ***software applications have been proposed to*** independently evaluate selection pressures at the codon-level [15]–[18]	21

735

736   Another difference worth noting is the total absence of the *that*-clause in

737   all salient PoS-grams identified for CE introductions, indicating

738   compressed language use in this discipline, which contrasts with the

739   more substantial presence of the *that*-clause in CCL (e.g., present in three

740   out of the four key PoS-grams for realizing the topic summarization step).

741   As detailed earlier, the intensive use of the construction "noun

742   +noun(+noun) ..." as well as pre-modifications and/or post-

743 modifications of noun phrases, and the frequent adoption of the *to-*

744 infinitive clause to replace the *that-*clause have all contributed to

745 obviously more compact language use in CE introductions. In addition,

746 only CE introductions are distinctively featured with the strong presence

747 of the PoS-gram "*DT NN VBZ VVN RB VVZ*" for outlining paper

748 structure, which however is not a trend in CL. Finally, discipline-specific

749 features are also manifested in certain key PoS-grams identified, such as

750 the salient PoS-gram "*NP NP NP NP NP NP*" with 76 occurrences in

751 CCE, whose tokens are all the names of computer operating systems and

752 regulations.

753

4. Conclusion

755 This paper is unique in setting PoS-grams as the unit of analysis in a most

756 conventionalized research part-genre across disciplines. It is, to the best

757 of our knowledge, the first cross-disciplinary study of key PoS-grams in

758 RA introductions. This study has clearly demonstrated the huge potential

759 of the PoS-gram procedure in unfolding language patterning and

760 variability in specialized (part-)genres (Brett & Pinna, 2015). It opens up

761 a new way for examining discipline-specific and/or genre-specific

762 (patterned) language use and discursive features and the related

763 variations and commonalities thereof for EAP researchers and

764 practitioners.

765

To sum up, the present study has identified salient PoS-grams in research introductions from two contrasting disciplines (viz., CL and CE), which could be generally classified into three categories. The first category includes key PoS-grams with shared functions and identical composition and patterns in introductions from both disciplines, e.g., *IN DT JJ NN VBD TO* and *DT JJ NN VBD TO VV,* associated with the functional step "purposive announcement". The second category contains those with overlapping/similar discursive functions but varying composition and patterns in CCL and CCE. For example, a set of four key PoS-grams (viz., *NNS VHP VVN IN/that JJ NNS*, *JJ NNS VHP VVN IN/that JJ*, *DT NNS VVP IN/that JJ NN*, and *JJ NNS VHP VVN JJ NN*) identified in CCL together with another couple of key PoS-grams (viz., *NN NNS VHP VBN VVN TO* and *JJ NN NNS VHP VBN VVN*) in CCE play similar textual functions, i.e., to summarize previous studies or synthesize findings in the literature. However, a glimpse of their associated lexicogrammatical frames would reveal interesting but important differences in their subjects, the voice and aspect of the main verbs and their co-selected structure (i.e., whether to use the *that*-clause, the *to*-infinitive clause or the prepositional phrase). To detail, in CCL, the subjects tend to be either words like "*studies, works*" (co-selecting with verbs such as "*show, demonstrate*" in the present perfect tense and active voice) or "*findings, results and data*" (co-

787 occurring with verbs like "*suggest, indicate*" in the simple present tense

788 and active voice). By contrast, in CCE, another regular pattern is

789 generated for topic generalization/synopsis of previous findings. The

790 subjects are found to be terms relative to computer programs, model

791 frameworks, algorithms or software applications and their collocational

792 verbs are dominantly *develop* or *propose* used in the present perfect

793 tense and passive voice. Therefore, even for realizing the same functional

794 step in a largely conventionalized part-genre (e.g., the step of "topic

795 summarization/synopsis of findings in the literature" as discussed here),

796 writers from different disciplinary discourse communities have their own

797 distinctive patterns to use.

798

799 The final category comprises the other key PoS-grams uniquely found in

800 either CCL or CCE. Within this group, some may be directly reflective of

801 disciplinary nature, e.g., the PoS-gram with the highest key value

802 identified in CCE is associated with "*outlining the structure of articles*",

803 an optional element only favoured in introductions from a few disciplines

804 without an established IMRD-like sectional arrangement such as CE

805 (Kanoksilapatham, 2003; Swales, 2004).

806

807 In addition to identifying sets of characteristic lexicogrammatical frames

808 and phraseologies that could be directly transformed into EAP

809 pedagogical input, the PoS-gram analysis has also helped revealing

810 contrasting language styles in introductions of the two disciplines. The

811 apparently more compact language use has been noted in CE

812 introductions than in CL introductions, as evidenced in the total absence

813 of the *that*-clause but the strong presence of the *to*-infinitive clause and

814 the prepositional phrase instead in tokens of top-ranking key PoS-grams

815 identified in CCE. Contrastingly, in CCL, the use of the *that*-clause is far

816 more frequent, e.g., three out of the four key PoS-grams for realizing the

817 step of topic summarization do contain it. The more compressed

818 language style of academic introductions in CE could also be perceived

819 from the particularly intensive use of the construction "noun

820 +noun(+noun) …" as well as the pre-modifications and/or post-

821 modifications of noun phrases in them.

822

823 All these findings have important implications for the teaching and

824 learning of academic writing in English. The results of this study could be

825 utilized for the pedagogy of teaching EAP for computer engineering and

826 linguistics students in terms of the selection of typical grammatical

827 patterns, lexicogrammatical frames and phraseology for teaching and the

828 demonstration of language patterning and variability via the PoS-gram

829 procedure. In the light of this, language focus in teaching research writing

830 is supposedly not just on move-specific individual linguistic signals or

831 particular language features, but on salient language co-selection

832 patterns to facilitate fluency, naturalness and effectiveness in student

833 academic language use. Meanwhile, teaching activities such as asking

834 students to fill in the missing words of a given pattern need to be devised

835 to highlight lexical variants in certain PoS position, so that students could

836 pay due attention to fixedness and variability within the patterns.

837

838 Further, some salient language patterns represented by

839 lexicogrammatical frames and their associated phraseologies, as revealed

840 by the present PoS-gram analysis, are closely linked to particular

841 communicative functions of the (part-)genre. Nonetheless, even when

842 realizing the same functional move or step, different disciplinary

843 discourse communities may have their own preferential co-selected

844 linguistic patterns, a point that should be addressed in teaching to

845 enhance novice writers' understanding of the rhetoric, genre and

846 disciplinary conventions.

847

848 The utility of the corpus-based PoS-gram technique combined with

849 genre study awaits more systematic explorations, especially by EAP

850 teachers who promote data-driven learning (Charles, 2014; Otto, 2021).

851 Since the corpus-based PoS-gram analysis could be a promising line of

852 inquiry into language patterning in the EAP/ESP world, it needs to be

853 extended to other part-genres of the RA to arrive at a full description of

854 the most typical expressions for this genre, as well as to other specialized

855 genres for academic and professional communication.

856

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Appendices

1014

1015 Appendix 1 Sample concordance lines of *IN DT JJ NN VBD TO* in CCL

Left context	KWIC	Right context
ent or nutritional status [19,24].The aim	**of the current study was to**	test whether the stimulation interventi
ther components of language. The aim	**of the present experiment was to**	examine language lateralization in a g
ex figure [41]. Therefore, the main aim	**of the current study was to**	better characterize early activation of
ne paper or display ([17], [18]).The aim	**of the present study was to**	examine the flexibility of the input cod
ninding patients of task goals. The aim	**of the present study was to**	investigate whether priming could be
espond quickly and accurately, the aim	**of the present experiment was to**	investigate whether priming can be us
ne tested in modern times.The purpose	**of the present study was to**	explore whether the segmentation rul
esearch question [30]. The primary aim	**of the present review was to**	examine the evidence for individual C
gnosed with ADHD.Therefore, the aim	**of the present study was to**	assess source discrimination in adult
of the target words.Therefore, the goal	**of the present study was to**	reevaluate syllabic segmentation in lig
g a lowest WN level of 65 dB.The goal	**of the current study was to**	test the hypothesis that different inten
of the context word. Thus, the first goal	**of the current investigation was to**	test the viability of the integration-elab
sent study. The present study The aim	**of the present study was to**	examine the contributions to reading
n partially processed. The primary aim	**of the present study was to**	test the early speech act recognition a

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Note

1018 In all, there are 27 occurrences of this PoS-gram. For a better visual
1019 display, a sample of about half of the concordance lines is presented.

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1033 Appendix 2 Sample concordance lines of *DT JJ NN VBD TO VV* in CCL

Left context	KWIC	Right context
ded. The present study The aim of	**the present study was to examine**	both learning and retention in childr
ie" comprehension.The first aim of	**the current study was to evaluate**	comprehension of words across va
over that they had lied.The goal of	**the present research was to examine**	if speakers indeed distance themse
mponents of language. The aim of	**the present experiment was to examine**	language lateralization in a group o
, see [11; 39–41]). One purpose of	**the present study was to apply**	our knowledge of current research
RAD-NP battery.Hence, the aim of	**the present study was to investigate**	possible differences in cognitive prc
d with ADHD.Therefore, the aim of	**the present study was to assess**	source discrimination in adult patiei
:arget words.Therefore, the goal of	**the present study was to reevaluate**	syllabic segmentation in light of this
er or display ([17], [18]).The aim of	**the present study was to examine**	the flexibility of the input coding sch
1 question [30]. The primary aim of	**the present review was to examine**	the evidence for individual CBAT as
/est WN level of 65 dB.The goal of	**the current study was to test**	the hypothesis that different intensit
:ontext word. Thus, the first goal of	**the current investigation was to test**	the viability of the integration-elabo
:udy. The present study The aim of	**the present study was to examine**	the contributions to reading compre

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1043 **Note**

1044 Similar to Appendix 1, around half of all the 27 concordance lines are

1045 listed for a better visual display.

1046

Appendix 3 Concordance lines of *DT NNS VVP IN/that JJ NN* in CCL

Left context	KWIC	Right context
mance at the task. Together,	the data suggest that declarative memory	deficits in SLI may be due lar
our current hypothesis. Also,	these findings indicate that ordinal processing	has a biological base and, he
nditions [10]. Taken together,	these findings suggest that linguistic knowledge	significantly contributes to the
view benefit. Taken together,	these findings suggest that phonological recoding	"is an automatic process at s
laries do not [7,8]. Together,	these findings suggest that semantic priming	is driven by several factors in
xt of a word than in isolation.	These data suggest that whole word	representations exist and car
less skilled readers [10, 11].	These findings indicate that extra-foveal information	is an important determinant o
ated uncrowded prime word.	These findings indicate that semantic information	is activated even when a wor
nguage activation either [33].	These results suggest that language-specific speech	cues were exploited by biling
l power is sufficient [20, 43].	These results suggest that lexical processing	does not require central atten

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Appendix 4 Concordance lines of *DT NN VBZ VVN RB VVZ* in CCE

Left context	KWIC	Right context
al for modeling open source labware.	This paper is organized as follows	. In the next section, script-based FC
improve the classifier performance).	The paper is organized as follows	. Section Materials and Methods pro
the basis for Section 1 of this paper.	The remainder is organized as follows	: Section 2 reviews related work; Se
al for modeling open source labware.	This paper is organized as follows	. In the next section, script-based FC
analysis of the controller. The rest of	the paper is organized as follows	: Section 2 describes work related to
are also interchangeable. The rest of	this paper is organized as follows	. In section two, we illustrate the con
ed with uncertainty.The remainder of	this paper is organized as follows	. The Material and Methods section i
e functions are the same.The rest of	the paper is organized as follows	. In the next section, we first give a n
evelopment of IQM, the remainder of	this paper is organized as follows	. We review existing open source ap
sults are compared.The remainder of	this paper is organized as follows	. In the Materials and Methods sectic
such functionalities.The remainder of	the paper is structured as follows	: while Section 2 introduces our nove
analysis of the controller.The rest of	the paper is organized as follows	: Section 2 describes work related to
nces, see e.g., [2, 12–19]The rest of	the paper is organised as follows	. Next section shows the main methc
ram of proposed method. The rest of	the paper is organized as follows	, section III summarize the existing n
ching search terms.The remainder of	this article is organized as follows	. Section 1 details the methodologica

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1067 ## Appendix 5 Concordance lines of *JJ JJ NN NN VVN IN* in CCE

Left context	KWIC	Right context
named Bi-Manu Trainer), a	**game-based virtual reality system designed for**	upper-limb rehabilitation, ha
this study was to design an	**on-line fNIRS-based inference system dedicated to**	: estimating the pilot's state
ral activity into a correlated	**mechanized prosthetic arm movement used for**	self-feeding [4]. Other than
ual Operative Assistant) for	**complex technical task enhancement based on**	explainable machine learnin
ual Operative Assistant) for	**complex technical task enhancement based on**	explainable machine learnin
g units (GPUs), which have	**superior parallel processing power compared to**	CPUs, are likely candidates
akes too long.In sports, the	**likely first transfer study focused on**	simulator training for playing
Section 6, we propose the	**stochastic local search algorithm based on**	QCCA heuristic. In Section
yment of new services. The	**novel centralized management paradigm introduced by**	SDN has resulted in an esc
yment of new services.The	**novel centralized management paradigm introduced by**	SDN has resulted in an esc

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1071 ## Appendix 6 Concordance lines of *IN DT JJ NN VBD TO* in CCE

Left context	KWIC	Right context
nents [3], [4], [5], [7], [8], [9], [10].The aim	**of the present study was to**	investigate whether identical simple mover
s are used in the simulator. Thus, the goal	**of the current study was to**	determine skill transfer from simulator trair
e introduced angular deviations. The goal	**of the current study was to**	extend this paradigm to investigate the rol
illingness to return for treatment. The aim	**of the current study was to**	study both immediate and more long-term
ntly reduced cost. Thus, a major objective	**for the current review was to**	quantitatively explore the effectiveness of
d overlapping spectral envelopes.The aim	**of the present study was to**	assess the influence of sequential groupin
for chronic pain syndromes. The purpose	**of this present study was to**	determine the impact of a brief VR sessior
r eliciting mindfulness.The main objective	**of the present study was to**	explore the feasibility, acceptability and the
nces in stress processing [9,10]. The aim	**of the current study was to**	explore the impact of individual differences
s an established trauma film [47].The aim	**of the current study was to**	test if individual differences in HA modulat
nd other emotional tests [42–44].The aim	**of the present study was to**	replicate the Billington et al. [19] study in li

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1074   ## Appendix 7 Concordance lines of *DT JJ NN VBD TO VV* in CCE

Left context	KWIC	Right context
e could be changed after this practice.	**A second aim was to assess**	the extent to which self-reported meas
sed in the simulator. Thus, the goal of	**the current study was to determine**	skill transfer from simulator training to
n stress processing [9,10]. The aim of	**the current study was to explore**	the impact of individual differences in
duced angular deviations. The goal of	**the current study was to extend**	this paradigm to investigate the role of
ess to return for treatment. The aim of	**the current study was to study**	both immediate and more long-term e
stablished trauma film [47].The aim of	**the current study was to test**	if individual differences in HA modulat
apping spectral envelopes.The aim of	**the present study was to assess**	the influence of sequential grouping c
ng mindfulness.The main objective of	**the present study was to explore**	the feasibility, acceptability and the po
3], [4], [5], [7], [8], [9], [10].The aim of	**the present study was to investigate**	whether identical simple movements p
er emotional tests [42–44].The aim of	**the present study was to replicate**	the Billington et al. [19] study in light o
er to elicit with a non-clinical sample).	**The first aim was to gauge**	VRE effectiveness of agent-based sof
ecution in new, untrained participants.	**The main purpose was to establish**	that the activation patterns from differe
ld elicit distress within each scenario.	**The second aim was to determine**	whether within-scenario and between-
absence of a metronome set to 4 Hz.	**The secondary objective was to test**	the reliability of these phenomena bet
onic pain syndromes. The purpose of	**this present study was to determine**	the impact of a brief VR session on the

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