

Syntactic Complexity Measures as Indicators of Teaching L2 Academic English Writing

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ABSTRACT

The purpose of this research is to examine the effectiveness of reforming academic English writing instruction via the perspective of the syntactic complexity of L2 learners' practice. The present study evaluates 14 measures of syntactic complexity as indicators of language growth in academic writing by 52 Chinese undergraduate students. The findings indicate that an intensive academic teaching design can be used to help students enhance their academic writing output ability. The findings of this study provide direct quantitative evidence for altering classroom instruction, textbook compilation, assessment practice, and curriculum development at the undergraduate level for academic English.

1. Introduction

English is widely regarded as a lingua franca both within and outside academia (Seidlhofer, 2005, 2009). The adoption of English as a global academic universal language is frequently backed up by evidence from the 27,000 journals indexed in the Web of Science (WoS), the majority of which are published in English. Academic English writing among non-native English speakers has been extensively studied over the last few decades, with a majority of the research focusing on ESL (English as a second language) writing and EFL (English as a foreign language) writing (Firth, 1996; Granger et al., 1997; Granger & Tyson, 1996; House, 2009; Huang, 2010, 2011, 2014, 2017; Hynninen, 2011; Jenkins, 2009, 2011; Martínez, 2005; Mauranen, 1993, 2003, 2009). Research interests include vocabulary features, syntactic and discourse features, pragmatic/discourse markers, overuse, underuse, and/or inappropriate use of syntactic, semantic, and stylistic elements, among others.

In recent years, academic English writing has become a hot research issue within China under the context of national demands for international talent training. In response to the globalization in academic settings and the promotion of high-level international communication, The State Council of China issued the *Outline of China's National Plan for Medium and Long-term Education Reform and Development (2010-2020)* in 2010 (henceforth the National Outline). Universities have been urged to "establish or participate in collaborative international academic organizations or global science plans", as well as to "be encouraged to collaborate with a world-class education and research institutes abroad in establishing a unified research and development center". To meet such requirements, universities in China have initiated curriculum modifications through which the cultivation of professional talents is targeted with a global vision, an understanding of international rules, and the ability to participate in international affairs and competition. In 2020, China's Ministry of Education specified the guideline of reforming university English teaching to promote the integration of the English language and professional education. This emphasized the necessity of interdisciplinarity between English proficiency and professional subjects. For the majority of universities, English language courses in the curriculum are stand-alone by focusing on language proficiency at the undergraduate level usually in the first and second academic year. English writing is generally involved in graduate programs in China in that graduate students are urged to publish in international indexed journals and to present their research at international conferences. Thus, a subsequent issue is how to transform stand-alone English proficiency training into a collaborative course with specific purposes. In China, some research universities have introduced academia-oriented English courses, such as *Fundamental Academic English*, to undergraduate students to replace proficiency-

oriented English courses in the curriculum. The objective of such an endeavor is to equip students with an international perspective and the ability to communicate academically in English in their professional fields.

A subsequent concern arises: how can academic English be taught at the undergraduate level, particularly to the first-year students with no professional backgrounds? We hold the point that academic English writing is primary, compared to speaking, listening, and reading, in that it directly associates with students' future professional productivity. In practice, we develop the textbooks and references, as well as writing tutoring and assessments, depending on the first-year students' majors and the future professional courses they will take in the third and fourth year. Under the above-mentioned context for academic English teaching reform in China, this paper focuses on the issues of undergraduate academic English writing from the perspective of syntactic complexity. To determine the efficacy of our efforts, we suggest the following three research questions in this paper:

- (1) In terms of syntactic complexity, are there substantial changes between L2 students before and after they participate in our tailored academic writing course?
- (2) What differences exist between L2 students and native speakers after L2 learners complete an academic writing course?
- (3) Among the L2 syntactic complexity measures, what aspects are strongly and weakly correlated?

The paper is organized into five sections. Section I contextualizes English academic education in China today and poses three research questions. Section II discusses syntactic complexity as an assessment of academic English writing. In the following section, the methodology is introduced. After presenting the data and outcomes in Section IV, detailed discussions related to the research questions are held. Section V concludes this paper.

2. Syntactic complexity as an assessment of academic English writing

Syntactic complexity, as the term suggests, refers to the sophistication of a piece of writing on its syntactic level. Numerous studies have attempted to establish syntactic complexity as a developmental indicator of language learners' writing since the late 1970s. It is widely regarded that syntactic complexity, along with linguistic accuracy and fluency, is a valid and reliable measure in L2 assessments. (Crossley & McNamara, 2014; Ferris, 1994; Lu, 2011; Ortega, 2003). Ortega (2003) conducts a large-scale research synthesis to evaluate the accumulated evidence on the use of syntactic complexity measures as developmental indices for college-level L2 writers' target language proficiency. According to his analysis, the link between L2 writing syntactic complexity and L2 proficiency varies between studies due to changes in how L2 proficiency is defined (Yau 1991; Henry 1996). Ortega (2003) also argues that ESL learners produce more sophisticated syntactic elements in comparison to learners in EFL contexts. It implies that syntactic complexity can be used as an index to represent L2 proficiency between ESL and EFL learners. Additionally, Beers & Nagy (2009) discover that narrative and expository essays have various levels of syntactic complexity by calculating the number of words per T-unit, clauses per T-unit, and words per sentence. Norris & Ortega (2009) consider syntactic complexity to be a "multidimensional construct" in assessing second language writing as it represents phrasal, clausal, and global features of writing. It provides quantitative indexes to signify how sophisticated and varied structures are used.

Measures of syntactic complexity as indices of L2 writers' language growth have been discussed in the literature (Ai & Lu, 2013; Lu, 2010, 2011; Wolfe-Quintero et al., 1998). The large-scale ESL writing data from the Chinese Learners' Written English Corpus in Lu (2010) contrast markedly to previous research that relied on small sample sizes and limited measures. Lu (2010) asserts that it is critical to compensate for confounding variables, including genre, time period, and institution, when examining the association between syntactic complexity measurements and language competency and that additional measures should be considered. Following his suggestions, we explore syntactic complexity measures as indicators of teaching and reforming academic writing courses.

Some critical measures of Syntactic complexity in L2 writing include the length of the production unit, amount of subordination or embedding, amount of coordination, range of syntactic structures, and degree of phrasal sophistication. Lu (2010) designs the *L2 Syntactic Complexity Analyzer* (henceforth L2SCA) to automatically measure the syntactic complexity of English writing samples with 14 measures, as listed in Table 1.

Table 1. 14 Syntactic complexity measures by Lu (2010)

Measure	Code	Formula
<i>Length of the production unit</i>		
1. Mean length of clause	MLC	#of words/# of clauses
2. Mean length of sentence	MLS	#of words/# of sentences
3. Mean length of T-unit	MLT	#of words/# of T-units
<i>Amount of subordination</i>		
4. Clauses per T-unit	C/T	#of clauses/# of T-unit
5. Complex T-unit ratio	CT/T	#of complex T-units /# of T-units
6. Dependent clauses per clause	DC/C	#of dependent clauses/# of clauses
7. Dependent clauses per T-unit	DC/T	#of dependent clauses/# of T-units
<i>Amount of coordination</i>		
8. Coordinate phrases per clause	CP/C	#of coordinate phrases/# of clauses
9. Coordinate phrases per T-unit	CP/T	#of coordinate phrases/# of T-units
10. T-units per sentence	T/S	#of T-units/# of sentences
<i>Phrasal complexity</i>		
11. Complex nominals per clause	CN/C	#of complex nominals/# of clauses
12. Complex nominals per T-unit	CN/T	#of complex nominals/# of T-units
13. Verb phrases per T-unit	VP/T	#of verb phrases/# of T-units
<i>Overall sentence complexity</i>		
14. Clauses per sentence	C/S	#of clauses/# of sentences

The above-mentioned 14 measures provide an intuitively applicable index of academic writing development. The indicators provide a quantitative framework for comparing linguistic development among L2 learners and between natives and L2 learners. In the following section, we will discuss the experimental approaches used to compare the academic writing performance of L2 learners to that of native speakers. Meanwhile, we will discuss how an intensive curriculum program is designed and represented by the indicators of syntactic complexity.

3. Methodology

3.1 Participants, Data, and Analyzer

The participants include 54 first-year undergraduate students majoring in biology. They enrolled in the courses of academic English in the spring semester of 2020. Each student was required to submit two computer-based argumentative essays on given topics. The first piece of writing was submitted during the first week of the semester, and the second piece was completed following a full training program. The files of students' writing are in TXT format and organized under students' names. In addition, a sample of COCA (Corpus of Contemporary American English) academic corpus text, containing 1,419,833 words, is used to compare the L2 syntactic complexity of the essays with native speakers. *The L2 Syntactic Complexity Analyzer* (L2SCA) developed by Lu (2010) was used to automatically measure the syntactic complexity of English writing samples through simple python commands.

3.2 Teaching Design and Procedure

The 54 students participated in the academic English course in the spring semester of 2020. The teaching focus is on fundamental academic writing skills. Students were taught critical writing skills, reading skills, and language abilities through the creation of sentences, paragraphs, and essays.

(1) Writing Task 1 (W1).

Students were initially introduced to an overview of academic writing throughout the first week of the semester, including stylistic elements, format, and academic vocabulary. They were required to have a writing task of a 300-word essay of a given topic in academic styles based on what they understand to be "academic". The writing samples are collected and labeled W1. Each student's essay is saved as an ordered TXT file under the student's name.

(2) Teaching Design

An intensive academic writing program was launched in the spring semester of 2020. The total teaching hours were 64 hours, with one-hour tutoring every working day. The textbook was titled *Xueshu Yingyu Zonghe (Academic English: An Integrated Course)* published by the Foreign Language Teaching and Research Press, China. Supplementary teaching materials were provided to students apart from the assigned textbook, including Judith A. Boss's internationally acclaimed textbook *Critical Thinking and Logic Skills for Everyday Life* and articles from the British journal *The Economists*, and editorials from newspapers. This is to increase students' awareness of the importance of being critical in their reading and writing. On the teaching of academic writing, students were taught how to compose simple, compound,

and complex English sentences, structured paragraphs with a topic sentence, supporting sentences, and a conclusion sentence, as well as how to organize paragraphs into an essay. Meanwhile, they were trained to summarize what they read by using appropriate words from academic word lists (AWL). In-class exercises focused on the training of critical thinking included identifying facts and opinions, describing facts in proper English, and defending opinions with sufficient evidence. Off-class exercises and homework included sentence building and developing, paragraph constructing, and essay writing. Feedbacks were back to students and revisions were welcome. Throughout the whole semester, students obtained specialized reading and writing instructions, including critical reading, sentence, paragraph, essay writing, and an AWL quiz.

(3) Writing Task 2 (W2).

At the end of the semester, students were required to write the other 300-word essay on a chosen topic. The writings were collected and labeled W2. The TXT files containing each student's essay were organized alphabetically under the student's name.

(4) Data Formatting and Writing Analysis Tools

The students' essays of W1 and W2 were saved in separate TXT files of UTF-8 encoding. Some residual information, such as students' names and other words not related to the essays, was cleared from the essay texts. Two students' essays were found not to satisfy the requirements of the topic assignment. Thus, the actual amount of essays involved in the analysis was 104 (52 students with two essays from each). The COCA academic corpus sample is in a well-formatted TXT file and the file was renamed as COCA-A.

3.3 Data Analysis

In this study, the *L2 Syntactic Complexity Analyzer (L2SCA)* developed by Lu (2010) is used for syntactic complexity analysis. SPSS is used for all statistical analyses. The 14 measures of syntactic complexity listed in Table 1 were descriptively presented. A one-sample t-test was used to determine whether there existed significant differences between W1/W2 and COCA-A. In addition, correlation analysis was also conducted to see whether any pairings of syntactic complexity metrics have any significant relationships.

4. Results and discussion

4.1 Overall syntactic complexity of students' writings

The main aspect of the overall syntactic complexity of the sentences is to identify whether there are differences caused by factors such as style between W1 and W2, and the data are shown in Table 2. The measure C/S indicates clauses per sentence. A one-sample T-test is conducted to compare whether there exists a significant difference between W1 and COCA-A, as well as W2 and COCA-A. The results shown in Table 3 imply that W1 is significantly different from native speakers' academic production on the clauses per sentence ($p_{C/S1} < 0.05$), whereas W2 shows that no such significant differences with COCA-A are found ($p_{C/S2} = 0.390 > 0.05$). In other words, students' writing after the intensive training program approaches to a near-native level on essay writing.

Table 2: Overall syntactic complexity of the sentences

Data source	W1		W2		COCA-A
	Mean value	Standard deviation	Mean value	Standard deviation	Value
C/S	1.8087	0.6797	2.1815	1.0811	2.3113

Table 3: One-Sample T-test between W1/W2 and COCA-A

$$C/S_{COCA-A} = 2.3113$$

t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		
				Lower	Upper	
C/S1	-5.281	51	.000	-.5026423	-.693710	-.311575
C/S2	-.866	51	.390	-.1298500	-.430834	.171134

A paired T-test is also conducted between W1 and W2 to examine whether the two writings exhibit any differences. The result ($t_{(51)} = -2.049, p = 0.046 < 0.05$) indicates that W2 is not different from W1 in terms of clauses per sentence. Since C/S is considered to be an overall indicator of syntactic complexity, it presents that there is no difference between W1 and W2 due to factors such as style. Thus, it is reasonable to compare all other measures of syntactic complexity between W1 and W2 to indicate what our teaching design of academic writing contributes to L2 students' writing improvement. Particularly, the response to our first research question implies that an intensive academic writing course enhances the academic writing abilities of L2 students.

4.2 Length of language output

The length of language output includes three measures: namely, mean sentence length (MLS), mean T-unit length (MLT), and mean clause length (MLC). Table 4 demonstrates that the three measures of both W1 and W2 are less than the COCA-A values. This implies that students' first writing W1 is, on average, shorter than that of native speakers. The one-sample T-tests in Table 5 indicate that there are significant variations in the length of language output between students and native speakers in W1 ($p_{MLS1}, p_{MLT1}, p_{MLC1} < 0.05$) but not significantly varied in W2 ($p_{MLS2}, p_{MLT2}, p_{MLC2} > 0.05$). The result suggests that the length of sentences has been improved after the L2 students participated in the academic writing course. The efforts of instructing students to analyze complicated sentences and tutoring them on sentence building are proved to be beneficial.

Table 4: Comparison of language output lengths

Data source	W1		W2		COCA-A
	Mean value	Standard deviation	Mean value	Standard deviation	Value
MLS	19.1992	7.6289	27.4413	14.3014	27.9922
MLT	17.2633	5.1473	24.5020	11.1169	24.4694
MLC	10.6926	1.9171	12.60815	1.9152	12.1111

Table 5: One-Sample T-test of MLS, MLT and MLC

$MLS_{COCA-A} = 27.9922$

t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		
				Lower	Upper	
MLS1	-8.311	51	.000	-8.7929635	-10.916864	-6.669063
MLS2	-.278	51	.782	-.5509096	-4.532462	3.430643

$MLT_{COCA-A} = 24.4694$

t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		
				Lower	Upper	
MLT1	-10.095	51	.000	-7.2061096	-8.639130	-5.773089
MLT2	.021	51	.983	.0325865	-3.062385	3.127558

$MLC_{COCA-A} = 12.1111$

t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		
				Lower	Upper	
MLC1	-5.335	51	.000	-1.4184750	-1.952214	-.884736
MLC2	1.871	51	.067	.4970462	-.036163	1.030255

4.3 Parallel phrases

The mean values of CP/C, CP/T, and T/S are listed in Table 6 with comparison to the value of COCA-A. The number of parallel phrases in each clause and the number of T units in each sentence of students' writing appear to be very close to native speakers' writing. The one-sample T-test in Table 7 indicates that L2 students used more parallel structures in W2 as native speakers do in comparison to those in W1 ($p_{CP/C}, p_{CP/T} > 0.05$). But there remains a significant difference between L2 students and native speakers on T/S ($p_{T/S} < 0.05$). Since a T-unit is defined as a minimal terminable unit of language that measures the smallest word group in a grammatical sentence (Hunt 1964), the result is interpreted that L2 students' writing still differs from native speakers on the components of sentence building in an academic style.

Table 6: Comparison of parallel phrases

Data source	W1		W2		COCA-A
	Mean value	Standard deviation	Mean value	Standard deviation	Value
CP/C	0.2011	0.1113	0.3237	0.1506	0.2862
CP/T	0.3326	0.2199	0.6130	0.3487	0.5782
T/S	1.0991	0.1182	1.1070	0.1670	1.1440

Table 7: One-Sample T-test of parallel phrases

$CP/C_{COCA-A} = 0.2862$

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
CP/C1	-5.512	51	.000	-.0851019	-.116099	-.054104
CP/C2	1.797	51	.078	.0375481	-.004390	.079486

$CP/T_{COCA-A} = 0.5782$

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
CP/T1	-8.054	51	.000	-.2455827	-.306797	-.184369
CP/T2	.719	51	.475	.0347885	-.062300	.131877

$T/S_{COCA-A} = 1.440$

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
T/S1	-20.802	51	.000	-.3408865	-.373786	-.307987
T/S2	-14.379	51	.000	-.3330231	-.379520	-.286526

4.4 Subordinate structure

The subordinate structure data in Table 8 shows that each value of the four indices in students' W1 is lower than that of the native speakers' texts, but fluctuates between W2 and COCA-A. The one-sample T-test in Table 9 reports significant differences between L2 students' W1 and native speakers' writing on subordinate structure ($p_{C/T}, p_{CT/T}, p_{DC/C}, p_{DC/T} < 0.05$), but such differences are not found in W2 ($p_{C/T}, p_{CT/T}, p_{DC/C}, p_{DC/T} > 0.05$). Subordinate structures were particularly concentrated on in teaching because subordination is a distinct feature that distinguishes English as a hypotactic language from Chinese as a paratactic language (Yu 1993). Students had sufficient training to refine sentences in the academic writing course. They were also asked to imitate sentences

under a given topic from academic reading materials. The result is inspiring that many students can compose sentences with subordinating structures as native writers' do.

Table 8: Comparison of subordinate structures

Data source	W1		W2		COCA-A
	Mean value	Standard deviation	Mean value	Standard deviation	Value
C/T	1.6286	0.4560	1.9566	0.8685	2.0204
CT/T	0.4231	0.1407	0.5141	0.2037	0.5000
DC/C	0.3366	0.0847	0.3944	0.1185	0.4057
DC/T	0.5777	0.3406	0.8494	0.6775	0.8197

Table 9: One-Sample T-test of subordinate structures

$$C/T_{COCA-A} = 2.0204$$

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
C/T1	-6.195	51	.000	-.3917692	-.518722	-.264816
C/T2	-.530	51	.599	-.0637731	-.305561	.178015

$$CT/T_{COCA-A} = 0.5000$$

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
CT/T1	-3.944	51	.000	-.0769365	-.116100	-.037773
CT/T2	.498	51	.621	.0140673	-.042637	.070771

$$DC/C_{COCA-A} = 0.4057$$

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
DC/C1	-5.889	51	.000	-.0691327	-.092700	-.045565
DC/C2	-.686	51	.496	-.0112788	-.044266	.021708

$$DC/T_{COCA-A} = 0.8197$$

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
DC/T1	-5.123	51	.000	-.2419558	-.336770	-.147141
DC/T2	.316	51	.753	.0297077	-.158907	.218323

4.5 Phrase-specific Complexity

Table 10 shows the statistics for both complex noun (CN) and verb phrase (VP) indicators. The mean value of each indicator in W2 is larger than that of W1 and COCA-A, which means students' second writing contains more complex noun structures and verb phrases. The one-sample T-test results in Table 11 show that the usage of complex nouns in W1 differs from it in native speakers' writings ($p_{CN/C1}, p_{CN/T1} < 0.05$), whereas the usage of complex nouns in W2 is similar to native speakers' writing pattern. An interesting finding is the usage of VP. L2 students present a comparable writing manner with native speakers ($p_{VP/T1}, p_{VP/T2} > 0.05$). With the standard deviation of the mean values of VP/T in W1 and W2 considered, the value of VP/T in W1 ranges from 1.6667 to 3.2485, and the value in W2 ranges from 1.5691 to 4.1631. Approximately one-third of students intend to use more verb phrases than native speakers do. A possible explanation comes from the typological differences between English and Chinese, in which English is a noun-oriented language but Chinese is a verb-oriented language (Imai et al. 2006, 2008; Schelletter 2002; Scott 2006). It appears that the data expose an effect of negative transfer in students' English writing.

Table 10: Comparison of the complexity of specific phrases

Data source	W1		W2		COCA-A
	Mean value	Standard deviation	Mean value	Standard deviation	
CN/C	1.3513	0.4085	1.6307	0.3195	1.5556
CN/T	2.2123	1.0243	3.2735	1.9125	3.1429
VP/T	2.4576	0.7909	2.8661	1.2970	2.5544

Table 11: One-Sample T-test of phase-specific complexity

Test Value = 1.5556

t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		
				Lower	Upper	
CN/C1	-3.608	51	.001	-.2043442	-.318062	-.090627
CN/C2	1.696	51	.096	.0751404	-.013806	.164087

Test Value = 3.1429

t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		
				Lower	Upper	
CN/T1	-6.551	51	.000	-.9305635	-1.215737	-.645390
CN/T2	.492	51	.624	.1306192	-.401832	.663071

Test Value = 2.55449

t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		
				Lower	Upper	
VP/T1	-.883	51	.381	-.0968631	-.317054	.123328
VP/T2	1.732	51	.089	.3116138	-.049484	.672712

4.6 Correlation of syntactic complexity measures

Table 12 shows the Pearson Correlation between the 14 measures of syntactic complexity in W2. MLS and MLT are the two measures that strongly correlate² too many other measures. First, a strong positive correlation on subordination is found between MLC and DC/C. It means that the dependent clauses are positively related to words in clauses: the more words clauses contain, the more dependent clauses they could be. Second, we find a strong positive correlation between MLC and CN/C on phrasal complexity. It implies that the more words the clauses contain, the more possible it is for students to use complex nominals. Reconsider the data presented in Table 10, the number of complex nominals per T-unit of W1 is much less than that of W2. We speculate that L2 students may attempt to use more complex noun phrases in the second writing after taking the writing course. The high deviation value tells that some students may overuse complex nominals, which results that the mean value being even higher than that of COCA-A. Third, a strong positive relationship is found between CN/T and VP/T. The one-sample T-test of VP/T in Table 11 shows that students use more verb phrases than expected, which might be attributed to the negative transfer effect as mentioned in 4.5. The correlation between CN/T and VP/T shows that the usage of complex nominals and verb phrases might not be well manipulated or balanced by students.

Table 12: Correlation of syntactic complexity measures of W2

		Correlations													
	MLS2	MLT2	MLC2	C/S2	VP/T2	C/T2	DC/C2	DC/T2	T/S2	CT/T2	CP/T2	CP/C2	CN/T2	CN/C2	
MLS2	1	.925**	.261	.949**	.864**	.840**	.579**	.781**	.519**	.602**	.614**	.058	.885**	.509**	
MLT2	.925**	1	.229	.889**	.953**	.936**	.696**	.911**	.175	.738**	.686**	.074	.976**	.523**	
MLC2	.261	.229	1	-.031	.056	-.103	-.246	-.115	.169	-.193	.496**	.699**	.141	.708**	
C/S2	.949**	.889**	-.031	1	.893**	.918**	.659**	.857**	.474**	.664**	.472**	-.150	.886**	.326*	
VP/T2	.864**	.953**	.056	.893**	1	.962**	.722**	.930**	.135	.747**	.535**	-.090	.956**	.408**	
C/T2	.840**	.936**	-.103	.918**	.962**	1	.770**	.976**	.109	.795**	.512**	-.160	.953**	.304*	
DC/C2	.579**	.696**	-.246	.659**	.722**	.770**	1	.847**	-.046	.887**	.454**	-.171	.683**	.103	
DC/T2	.781**	.911**	-.115	.857**	.930**	.976**	.847**	1	.026	.830**	.530**	-.148	.921**	.272	
T/S2	.519**	.175	.169	.474**	.135	.109	-.046	.026	1	-.054	.066	-.001	.141	.178	
CT/T2	.602**	.738**	-.193	.664**	.747**	.795**	.887**	.830**	-.054	1	.472**	-.148	.722**	.134	
CP/T2	.614**	.686**	.496**	.472**	.535**	.512**	.454**	.530**	.066	.472**	1	.716**	.615**	.564**	
CP/C2	.058	.074	.699**	-.150	-.090	-.160	-.171	-.148	-.001	-.148	.716**	1	.005	.466**	
CN/T2	.885**	.976**	.141	.886**	.956**	.953**	.683**	.921**	.141	.722**	.615**	.005	1	.565**	
CN/C2	.509**	.523**	.708**	.326*	.408**	.304*	.103	.272	.178	.134	.564**	.466**	.565**	1	

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

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

5. Conclusion and implications

This study has demonstrated the effectiveness of academic writing on 14 measures of syntactic complexity. It supports Lu's (2011) findings that syntactic complexity measures can be used to objectively indicate L2 learners' development in writing. The study also suggests that the measures of syntactic complexity can be used as indicators of the effectiveness of various instructional strategies in the teaching of academic writing. So far, we have had the answers to the three research questions raised in Section I. First, we find that students' writing is significantly different before and after they participate in a tailored academic writing course. As the length of the sentence is concerned, the sentences in W1 contain fewer words than W2. In the beginning, students may hedge on writing long sentences to avoid grammatical errors. In addition, the Chinese sentence-building strategies may be negatively transferred when students compose English sentences. However, students can produce long sentences as native speakers' do after involved the intensive training. Second, we find that almost all the measures of syntactic complexity are statistically different between W1 and COCA-A, which means that there was a big gap between students' writing and native speakers' before they participated in our academic writing course. The intensive teaching of academic writing is proved to be effective because the values of many indicators are close to them of native speakers'. However, we find that the usage of verb phrases by students remains more than that of native speakers. Third, strong correlations ($|r| \geq 0.650$) are found between many measures, in which three positive representative relations are between MLC and DC/C, MLC and CN/C, CN/T, and VP/T. Their relationship reveals possible strategies that students practice in academic writing.

The comparison of students' writings before and after they participate in our academic writing course from the perspective of syntactic complexity appears to be heuristic to the field of English teaching beyond proficiency level. By analyzing the sentences in the students' early writings, we find that students tended to use many colloquial expressions and wrote independent sentences,

² If the absolute value of the correlation coefficient ($|r|$) is equal to or larger than 0.650, it is regarded as a strong correlation; if $|r|$ is equal to or lower than 0.250, it is regarded as a weak correlation (see Wolfe-Quintero et al. 1998, Lu 2011).

or fragments, such as *Because many computer games are violent*. It does not satisfy the basic requirements of academic writing. In addition, we find that some students are influenced by the "universal writing template" from examination-oriented websites. It results in many mistakes widely spreading among students, such as comma splice errors and run-on sentences. When they are tutored in a more sophisticated and applicable writing course concentrating on advancing academic sentence writing, L2 learners may find it easier to learn how sentences and clauses are well built and modified. As a result, we have to emphasize students' acquisition of the notion of subordination, complex nominals, and verb phrases in their writing exercises. Continuing the reforming of academic writing instruction and monitoring the effectiveness of the curriculum modification by analyzing syntactic complexity will help to identify specific patterns in the development of academic writing for second language learners and provide direct quantitative evidence for the reform of textbook development and curriculum.

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