

A Study of Conjunctions in the Writing of Mathematicians

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Abstract: The present paper aims to study the use of conjunction in Mathematics books. We improved a database of conjunction to investigate its uses and effects in the Mathematicians writing. The book ‘What is Mathematics?’ written by German American Mathematician Richard Courant with Herbert Robbins is compared with a book ‘Differential Equations with Applications and Historical Notes’ by another American mathematician G. F. Simmons in the perspective of used conjunctions. Frequencies of various categories of conjunctions have been counted and each category has been given with a percent and highest percent category is identified. χ^2 -test is used to analyze whether conjunctions are evenly distributed across books or not. The result of the study found that conjunctions are not evenly distributed in mathematics books. Conjunctions are used according to the type of text which made mathematics more understandable. It has been observed that the authors especially the authors of mathematics books utilize conjunctions in writing mathematical texts to make it more understandable for the student.

Keywords: Cohesion; Cohesion categories; conjunction; χ^2 -test

1. Introduction

Halliday and Hasan¹ used the term cohesion to refer to non-structural text forming relations. Cohesion plays a special role in creating a text, but they do not constitute the structure. Text-forming relations are properties of a text. Cohesion serves to link information within a text so that the whole text is clear and readable achieved by several methods such as the use of conjunctions, the linking of phrases and sentences with words like he, they and that refer back to something mentioned previously. “The significant

property of the cohesive relation is the fact that one item provides the source for the interpretation of another". In general term, cohesion refers to the connectivity of ideas in discourse and sentences to one another in text, thus creating the flow of information in a unified way.

Most of the known study in the realm of cohesion includes work by Halliday and Hasan¹. They argue that cohesion is expressed partly through grammar and partly through the vocabulary. According to them It is necessary to consider that cohesion is a semantic relation but, like all the components of the semantic system, it is realized through the lexicogrammatical system. The lexicogrammatical system includes both grammar and vocabulary of the cohesive types reference, substitution, and ellipsis are grammatical; lexical cohesion is lexical; and finally, a conjunction is on the borderline of the two, mainly grammatical, but with a lexical component in it.

Cohesion as a major component of language ability plays a significant role in connecting the sentences and paragraph of text. Cohesive relation fits into the overall pattern of languages. Cohesion expresses the continuity that exists between one part of the text and another one. This continuity is significant from two aspects. The one is that in the discourse, continuity is showed by the points of the relation or contact with what has been said before. On the other hand, the continuity provided by the cohesion helps the readers to fill in the gap in the discourse, to supply all the components of the message which are not present in the text but are important and necessary to its interpretation. There are two main types of cohesion: grammatical, referring to the structural content, and lexical, referring to the language content of the piece. The purely linguistic elements which make a text coherent are included under the term cohesion.

There are two approaches to analyze cohesion in a text: first is the taxonomy of cohesive devices by Halliday and Hasan¹ and second is the lexical analysis by² which stresses lexical cohesion. Conjunctions are one of the most important explicit markers of cohesion.

According to Halliday and Hasan¹, cohesive devices in ELT taxonomy of categories and subcategories are as follows:

(a) **Grammatical cohesive devices including:**

- (i) **Reference:** Personal reference, Demonstrative reference, Comparative reference.
- (ii) **Substitution:** Nominal substitution, Verbal substitution, Clausal substitution.
- (iii) **Ellipsis:** Nominal ellipsis, Verbal ellipsis, Clausal ellipsis.

- (iv) **Conjunction:** Appositive, Clarification, Additive, Variation, Temporal, Comparative, Causal, Conditional, Concessive. and (2) Lexical cohesive devices including Repetition, Collocation.

The present study is limited to conjunctive elements. Conjunctions are resources for making the transition in the unfolding of text. Conjunctive relations specify how what follows in a text is linked to what has gone before, based on their specific meanings. Hasan and Halliday¹ adopt a scheme of four categories, namely additive, adversative, causal and temporal conjunction. In some Conjunctive relations, the semantic relation is felt to be present but is unexpressed, possibly as a result of the presence of other cohesive elements. These types are called implicit conjunctions. However, conjunctions should not be assumed where they are not expressed. In English, the presence or absence of explicit conjunction is one of the principal variables of English discourse, both as between registers and as between texts in the same register. Thus variation is obscured if the conjunction is assumed where it is not expressed. Halliday^{3,4} proposes some headings which are useful in analysis purposes. Generally, the conjunctions are classified into the three main categories: Elaboration, Extension, and Enhancement.

Elaboration: Elaboration means one clause that expands another by elaborating on it by restating in other words, specifying in greater detail, commenting, or exemplifying. There are two categories of elaborative relation, namely apposition, and clarification for discourse.

Extension: Extension means one clause expands another by extending beyond it by adding some new element, giving an exception to, or offering an alternative⁵ Extension involves additive and Variation.

Enhancement: Enhancement means one clause expands another by embellishing around it by qualifying it with some circumstantial feature of time, place, cause or condition⁵. There are five categories of enhancement: Temporal, Comparative, Causal, Conditional, and Concessive.

2 . Literature Review

By Halliday and Hasan¹, Linguistics in the text is any written or spoken passage that forms a unified whole. Applications of cohesive devices have been studied from contra positive points of view. A significant number of researchers have found their work valuable in advancing further research related to cohesion. Cohesion was once known as a predictor of textual coherence but this idea was later rejected by empirical studies and theoretical works in the early 1980s^{6,7}. A more conservative idea is that

cohesive ties can contribute to textual coherence through they do not guarantee it. However, in the pedagogical atmosphere, there is a belief that cohesive devices are the major means to make writing clear.

Brown and Yule⁸ pointed out that any of formal markers does not stand in simple one to one relationship with a particular cohesive relation. Tierney and Mosenthal⁷ viewed the effect of cohesion in essays written by students of 12th class students. Halliday and Hasan^{4,5} the type, number and degree of utilization of cohesive devices used in the text contribute to the cohesiveness of a text. In written and spoken English discourses, grammatical connections link individuals' clauses and utterances that make a text cohesive. With the help of cohesion property certain grammatical or lexical features of the sentences of the text connect them to other sentences in the text. Further, Bamberg⁹ developed four-point holistic coherence scales. Wikborg¹⁰ investigates a random sample of persuasive papers written by 17-years olds during the writing evaluation and found that Swedish students had cohesion problems related to misusing or misleading sentence connection, malfunctioning cohesive devices, and finally using too great a distance between the cohesive items in a cohesive chain. Field and Yip¹¹ obtained that on average, Hong Kong students used more connectors (cohesive devices) than Australian students.

According to Baker¹² cohesion is the network of grammatical, lexical, and other relations which links various parts of the text together. Milton¹³ in a study compared the use of cohesive devices by nonnative and native speakers of English. The text consisted of examination papers of Hong Kong and UK students. Meisuo¹⁴ following the finding of previous studies, conducted a research investigation on cohesive devices in the writing of Chinese undergraduate EFL students in two PRC universities. In another study by Hinkel¹⁵ NS and NNS students' use of sentence-level and logical-semantic conjunctions were investigated. Some English essays from Japanese, Korean, Indonesian, Arabic and English students were collected. The findings revealed that all of the four NNS groups used sentence transition more frequently than the NS group. Bolton¹⁶ examined the use of connectors in Hong Kong students' writings.

In the paper¹⁷ authors have studied examiner college-level Arabic L1 user command of cohesive devices by exploring the extent to which Omani student-teachers of English and native English speakers differ in their use of cohesive devices in descriptive. A qualitative research methodology was utilized to analyze the writing of the two groups to reveal the points of strengths and weaknesses in their writing. In¹⁸ cohesive devices have been

used as an instrument of analysis in a plethora of research papers that have investigated a variety of textual types. The reason behind using the 1976 model of cohesion in the textual analysis is that it is probably the most comprehensive account of cohesive ties to date of equal importance are the notion of theme and Rhyme since the interplay of these components has a major effect in analyzing different genres.

Recently in the paper¹⁹ the authors investigated the use and misuse of cohesive by 4th-year students. The primary aim is to investigate the teachers' role in encouraging the students to write well-timed writing using cohesive devices in classes naturally when they perform their lectures. Yin²⁰ also discussed the use of cohesive devices in news language.

The study in the paper²¹ showed some linguistic strategies used by the poet of achieving inter-sentence connection in the poetry. It also shows the network of interdependencies among linguistic and non-linguistic features, which give the poetry a thoroughly cohesive structure. In²² authors comparatively investigated the difference and similarities in the (incorrect) use of the cohesive device by the second year and fourth-year undergraduate Chinese EFL learners in their argumentative writing. Also, various researchers have explored the connection between the use of cohesive devices and the qualities of the writing^{23,24}.

3. Research Procedure

In this section we improved a database of types of conjunctions and some articles has been considered to pick used conjunctions for various categories (see, Appendix) and the analysis was done with the help of searching tools of Microsoft Pdf Program for counting the total frequency of all conjunctions in two books of higher mathematics i.e. 'What is Mathematics' by German American Mathematician Richard Courant with Herbert Robbins and 'Differential Equations with Applications and Historical Notes' by another American mathematician G. F. Simmons. Frequencies of various categories of conjunctions have been counted and each category has been given with a percent and highest percent category is identified. χ^2 -test is used to analyze whether conjunctions are evenly distributed across books or not.

4. Results and Discussion

The analysis itself was done with the help of searching tools of Microsoft PDF Program. Table 1 represents the frequencies of types of conjunctions used by both authors. First author used 8065 conjunction words while second author used 6995 conjunction words. Table 2 shows the frequencies of subtypes of conjunctions in detail.

Table 1. Types of Conjunctions used by both authors

Type	Book 1	Book 2	Total
Elaboration	401	697	1098
	(4.97 %)	(9.96 %)	(7.29 %)
Extension	5839	4152	9991
	(72.40 %)	(59.36 %)	(66.34 %)
Enhancement	1825	2146	3971
	(22.63 %)	(30.68 %)	(26.37 %)
Total	8065	6995	15060

Table 2. Subtypes of conjunctions used by both authors

Type	Book 1	Book 2	Total
Appositive	288	467	755
	(71.82 %)	(67.00 %)	(68.76 %)
Clarification	113	230	343
	(28.18 %)	(33.00 %)	(31.24 %)
Total	401	697	1098

Type	Book 1	Book 2	Total
Additive	5806	4096	9902
	(99.43 %)	(98.65 %)	(99.11 %)
Variation	33	56	89
	(0.57 %)	(1.35 %)	(0.89 %)
Total	5839	4152	9991

Type	Book 1	Book 2	Total
Temporal	832	847	1679
	(45.59 %)	(39.47 %)	(42.28 %)

Comparative	30	57	87
	(1.64 %)	(2.66 %)	(2.19 %)
Causal	259	446	705
	(14.19 %)	(20.78 %)	(17.75 %)
Conditional	622	669	1291
	(34.08 %)	(31.17 %)	(32.51 %)
Concessive	82	127	209
	(4.49 %)	(5.92 %)	(5.26 %)
Total	1825	2146	3971

We observe that extension (5839 in Book 1 and 4152 in Book 2) is the mostly used conjunction in both books. It forms 66.34% of all conjunctions in both books. The first author utilized extension with 72.40% (5839 out of 8065 conjunctions) in his book whereas the second author used 59.36% (4152 out of 6995 conjunctions) extensive words in his book. The use of ‘and’ is most frequent in the both books. It occurs 4589 times in the first book (78.60% of extensions and 56.90% of all conjunctions), and 2983 times in the second book (71.84% of extensions and 42.64% of all conjunctions). Extensive words except ‘and’ are 1250 (15.50% of conjunctions in book 1) and 1169 (16.71% of conjunctions in book 2). This clearly indicates that the use of ‘and’ makes the extension is the most utilized conjunction by authors. Otherwise, enhancement may have first rank.

Enhancements have the second one, which are mostly used conjunctions by authors after extensions. It occur with counts of 1825 out of 8065 (22.63% of all), and 2146 out of 6995 (30.68% of all) in the first and second book respectively. The mostly used words in this type are: ‘then, next, just’ from temporal, ‘similarly’ from comparative, ‘hence, therefore, because’ from causal, ‘still, however’ from concessive. A visual representation can be seen through the graph (see Figure 3). The most frequent subcategory of enhancements is Temporal. Temporal occur 45.59 % of enhancements and 39.47% of enhancements in the first and second book respectively. The second ranking subcategory of enhancements in both books is Conditional; may be because of overlapping of the highly used word ‘then’ in both subcategories Temporal and Conditional. The third ranking subcategory of enhancements in both books is Causal. The reason is

the frequent use of the words ‘hence’, ‘therefore’ and ‘because’ in mathematics.

The last employed conjunctions used by authors in the mathematics books is Elaboration; 4.97% of all (401 out of 8065) in book 1, and 9.96% of all (697 out of 6995) in book 2. Appositive is the first ranking subcategory of Elaboration than the Clarification. The highly frequent words of elaborations in the mathematics books are: ‘that is’, ‘for example’, and ‘thus’ from appositives; and ‘rather’, ‘at least’, ‘in particular’, and ‘in fact’ from clarification.

There were only 69 conjunctive words found in the writings of the authors. We have seen that frequencies of conjunctions in the first and second book. Table 3 shows observed and expected frequency and differences. Now we have to investigate ‘Is the difference is significant?’ This means we assume null hypothesis such that “Conjunctions are evenly distributed across books”. We used chi-square test for this investigation. The chi-square value is 76.02 with one degree of freedom and $\alpha = 0.01$. The p -value is the probability that a chi-square statistic having 1 degree of freedom is more extreme than 76.02. We use Microsoft Excel Function Tools Program for calculating p-value. The p-value obtained for this data 0.00 (correct to two decimal places; actual value is 2.80×10^{-18}), which is clearly less than $\alpha = 0.01$. So, with 99% of confidence it can be said that the difference between observed frequency and expected frequency is significant. So, we conclude that conjunctions are not evenly distributed in the books even authors are of same origin.

Table 3. Observed frequency, Expected frequency of conjunctions used in the mathematics books

	Obs. frequency	Exp frequency	D = (obs.- exp)	(obs. – exp) ² /exp
Book 1	8065	7530	535	38.01
Book 2	6995	7530	-535	38.01
	15060	15060	0	$\chi^2 = 76.02$

Appendix: Database of Conjunctions

(i) Elaboration

- (a) **Appositive:** in other words, that is to say, that is, for example, for instances, thus, to illustrate, i mean, to put in another way.
- (b) **Clarification:** rather, at least, by the way, in any case, anyway, in particular, more specifically, more especially, in short, to sum up,

actually, to be more, incidently, leaving that side, as I was saying, to resume, to get back to the point,in conclusion, briefly, as a matter of fact, in fact.

(ii) **Extension**

- (a) Additive: and, also, moreover, but, yet, however, and then, likewise, besides, equally, important, finally, further, furthermore, in addition, next, second, still too, on the other hand.
- (b) Variation: instead, on the contrary, apart from that, alternately.

(iii) **Enhancement**

- (a) **Temporal:** in the first place, then, next, just then, hitherto, previously, finally, in the end, soon, after a while, next time, that morning, until then, at this moment, before that, at first, formerly, at once, soon, to sum up, in conclusion.
- (b) **Comparative:** likewise, similarly, in a different way, all the same.
- (c) **Causal:** hence, consequently, because of that, as a result, on account of this, for this purpose, therefore, because
- (d) **Conditional:** then, in that case, otherwise, if not, even so, nevertheless, in that respect, in other respect
- (e) **Concessive:** yet, still, however, under the circumstance, ever so, in that case, in that event, despite this, elsewhere.

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