

Engineering Master Theses and Logical Persuasion: An Investigation of the Functions of Logical and Grammatical Structures

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Abstract: *This research paper discusses the use of grammatical structures in relation with logos or logical persuasion. The grammatical structures investigated in this paper are “because,” “therefore” and “thus” and the logical structure these words are used with is enthymeme. The texts chosen for the purposes of the study are American University of Sharjah (AUS) engineering master theses. In constructing arguments, “because” is used to introduce premises, and “therefore” and “thus” are used to introduce the concluding remarks of an argument. The results show that “because” is used much far less than “therefore” and “thus.” The discussion section presents justifications as to how these two latter adverbials are used to achieve logical persuasion in engineering writing. It also explains why and how different engineering disciplines use different linking adverbials; an issue which could be a topic for further research.*

Keywords: *engineering writing, enthymemes, logos, logic, linking adverbials.*

1. INTRODUCTION

All genres of academic writing must conform to logic. Logic is the study of reason, and its validity. By validity, it is meant to study if a reasoning route is fallacious or not. Aristotle (1994) studied the different modes of persuasion. His modes of persuasion are: ethos, pathos, and logos. Aristotle, in his book Rhetoric, encourages and strengthens the use of logos by creating a system for logic. According to Aristotle, enthymeme is to rhetoric; the same as syllogism is to dialectic. An enthymeme is the same as syllogism; however, an enthymeme is missing a premise. Here’s an example of syllogism:

All humans are mortals

Jane is a human

Jane is mortal

An enthymeme of that syllogistic structure would be:

- Because Jane is a human, she is mortal.
- Because all humans are mortal, Jane is mortal.
- Jane is mortal, because all humans are mortal.
- Jane is mortal, because she is a human.
- All humans are mortals, therefore Jane is mortal
- Jane is a human, therefore she is mortal.

The literal Greek translation of “enthymeme” would mean: in the mind. Meaning that one of the premises of an argument is in the mind, and not explicitly mentioned. In the College of Engineering at the American University of Sharjah in the United Arab Emirates, there are graduate programs that end with a student writing up a mini thesis as a partial fulfillment of the

graduation requirements. Since their theses are developed in an academic setting, students do appeal to logos in their writing. The question is: how do they achieve this? Often words like “because” and “since” introduce premises in an argument, and words like “hence” and “thus” introduce conclusions. These words are usually referred to in English grammar as cause and affect words or linking adverbials. These adverbials achieve logical persuasion by creating enthymemes in engineering theses that the students produce.

2. OBJECTIVE OF THE RESEARCH

It is now generally agreed that in the teaching of writing to non-native speakers of English it is acceptable, indeed advisable, to adopt a somewhat prescriptive approach. Provided one makes it clear that there are various ways of approaching writing, there are many advantages in suggesting to students a particular strategy for a given writing task in their subject, and certain language forms that could be used for that task. One needs, of course, to base one’s prescriptions on data-based analysis (EL-Sakran and Nada, 2014). The main question of this research is: How logical persuasion is achieved in engineering master theses. The adverbials examined in the theses are “because,” “therefore” and “thus.”

3. METHODOLOGY

3.1. Data

For this research, the authors have chosen ten master theses whose majority were produced by civil engineering students at the American University of Sharjah during the academic years 2011 and 2012. Before embarking on the research, a preliminary reading and investigation of three theses was conducted in order to examine the pattern(s) that the adverbials selected followed. Initially, the researchers aimed to work with twenty master theses to be able to submit an accurate representation of the behavior of the selected adverbials but after calculations and taking into consideration the huge number of word count in the theses, it was our contention that ten master theses are enough for this preliminary investigation. The ten theses were accessed through the archival website of the AUS library site: dspace.aus.edu. All the theses were in pdf format. Five theses were produced in the year 2011 and the other five in the year 2012.

3.2. Procedures

The Microsoft Word tool, Control-Find (Ctrl+F) and the Acrobat Adobe Reader Program were used to spot and highlight all instances of the adverbials under investigation. When examining the functions of the adverbials, the sentence before the one in which the adverbial is used and the one after were also looked at for full and accurate interpretation of the functions of the adverbial used. Explanatory uses of ‘because’ were dismissed; because there were not any arguments involved. The same was applied to similar cases of “thus” as the study mainly focused on enthymeme logical structures that occurred with the use of these words. Since “thus” and “therefore” are sometimes used in drawing mathematical conclusions. Such instances are dismissed since the research is only focused on written communication and arguments.

The authors of the theses are referred to in this research as “the author(s).” The results were checked and verified through personal consultations with a civil engineering academician from the Civil Engineering Department at the American University of Sharjah, Dr. Rami Haweeleh. He gave his insights about the field and how adverbials are used as persuasion tools in academic writing. Dr. Haweeleh graduated with 4.00 GPA from the University of Wisconsin-Milwaukee. He did his Ph.D. in civil engineering.

1. Literature Review

Engineering writing is often referred to as technical writing. In order to study logical structures in engineering, one can approach the grammatical structures and study how they express logical functions. Expert academicians in the engineering field know the writing conventions and practices in their respective field. Winsor (1996), in a longitudinal study, examined the writings of four engineers from their freshman year until they graduated. She was mainly concerned with how persuasive language was used and developed in engineering students’ writings. In her interviews with the students she followed up, she found out that the engineers who were on their

way to become managers were more rhetoric oriented than technical. Winsor argues that engineers develop persuasive tools through their study years at college. Engineers and academicians in the field know better the features and conventions of academic and technical writing in their field. Trimble (1985), working on Aristotle’s rhetoric and putting it to use in English for Science and Technology (EST), presented guidelines to EST instructors on how to teach rhetoric to native and non-native speakers of English. Trimble, in his book “English for Science and Technology: A Discourse Approach, discusses the patterns that occur in EST writing and notes that natural patterns and logical patterns use cause and affect markers to either indicate a natural or logical pattern in an EST paragraph development. Trimble (1985) refers to natural patterns as “those imposed by the nature of the content” and to logical patterns as “logic exercised by the writers” (p. 53).

For the purposes of this research, the researchers limited the discussion to “logical patterns.” These patterns are often used by writers to develop their paragraphs. One of the logical patterns that Trimble mentions is causality and result and one of their markers include the word “therefore.” Trimble explains that causality and result “help[s] other patterns, both natural and logical”, “with any of the logical patterns, but especially with analogy and exemplification” (p. 59). What he means by analogy and exemplifications, “compares things dissimilar,” and introductory markers, respectively. The connection that Trimble makes between causality and result and other logical patterns demonstrates that words such as “therefore” help to show logical thinking in developing an EST paragraph. This illustrates to the reader Aristotle’s concept of logos, and that it is logical persuasion.

2. Results and Analysis

Tables 1 and 2 present the frequencies of “because”, “therefore” and “thus” for the five master theses produced in 2011 and table 2 does the same for those written in 2012. Furthermore, table 3 provides the frequencies of the linking adverbials in all the theses.

Engineering is a problem solving field, meaning that engineers rely on results to draw conclusions from them. Scientists also rely on results for their conclusions; however, their conclusions might be wrong as they usually use inductive reasoning to reach their conclusions. Engineers also usually use inductive reasoning when it comes to experimentation and observations. They may also conclude with a slight margin of error. Although engineers could be wrong in their reasoning too, but a mistake in engineering could be expensive. For example, a wrong conclusion or a miscalculation a civil engineer makes may result in the collapse of a building, or other structural errors that may eventually consume a lot of financial resources or more importantly the loss of human lives. Deductive reasoning, if all the premises of an argument are factual, will essentially lead to a valid and a strong unarguable conclusion.

Table 1. *Frequency of “Because”, “Therefore” and “Thus” in the 2011 master theses*

Number of pages per thesis	Frequency of “Because”	Percentages	Frequency of “Therefore”	Percentages	Frequency of “Thus”	Percentages
139	3	2.2%	19	9.4%	0	0%
46	7	15.1%	6	13%	1	2.2%
141	12	8.5%	1	0.71%	23	16.3%
61	1	1.6%	5	8.2%	2	3.3%
96	1	1.04%	25	26%	27	28.2%
483	24%	5%	56%	11.6%	56%	11%

Table 2. Frequency of “Because”, “Therefore” and “Thus” in the 2012 master theses

Number of pages per thesis	Frequency of “Because”	Percentages	Frequency of “Therefore”	Percentages	Frequency of “Thus”	Percentages
98	5	5.1%	13	13.3%	13	13.3%
88	6	6.9%	16	18.2%	3	3.4%
102	2	2%	11	10.8%	30	29.4%
160	4	2.5%	6	3.75%	7	4.4%
45	3	6.7%	1	2.2%	N/A	N/A
483	20%	4%	47%	9.5%	53%	10.8%

Table 3. Frequency of “Because”, “Therefore” and “Thus” in all the master theses

Total Number of pages in 10 theses	Frequency of “Because” in all theses	Frequency of “Therefore” in all theses	Frequency of “Thus” in all theses
976	44	103	106
	4.5%	10.6%	10.9%

In constructing arguments, “because” usually introduces premises of any argument; however, the problem with “because” is that it is not only used to introduce premises, but also to explain things. The following is an example from one of the theses:

The author (2011) states:

“The beams were able to stand the fire up to 4 hours because the insulation system kept the temperature of the strengthening system below the critical temperature” (p. 31).

In the above example, ‘because’ explains why the beams had the ability to withstand fire, and that it because of the insulation system. However, an argumentative use of ‘because’ would be the following:

“[i]t should be noted that the use of this technique is very useful if used in the FE simulation of such scenarios. Because the predicted stress in the CFRP system is a function of multiple parameters, this method requires accurate inputs in terms of material properties and loading/heating setup” (p. 103).

This example shows that the author is introducing the premise “predicted stress in the CFRP system is a function of multiple parameters” and reaches a conclusion. This structure is similar to the structure presented in the introduction to this research paper. Perhaps for accuracy, the authors may have used other introductory premise indicators such as “since” or “for.” But for the purposes of this research and study, the word that is chosen to represent an introductory premise is “because.” The words “therefore” and “thus” are used to introduce the conclusion of an argument. Also as mentioned in the methodology section of this paper, the explanatory use of “because” has been ignored as it does not convey an argument; it only explains issues; and that has resulted in a decreased use of “because.” Another reason for the decreased use of “because”, in comparison with “therefore” and “thus”, could be due to the samples chosen for this investigation. That is, the research involved in those theses does not require the use of “because” but rather needs to develop firm conclusions. In addition to that, different disciplines of engineering may require the use of “because” more than others. For instance, an experimental oriented engineering discipline may require more use of ‘because’.

4. DISCUSSION

The results show significant variations among the authors’ use of “because” in comparison with “thus” and “therefore.” Winsor (1996) points out that “engineers’ writing did not reflect persuasion. Persuasion was practiced by managers not engineers. “Engineers’ writings relied on data rather than persuasive language” (p. 87). Our results show that the authors very much rely on data to reach their conclusions. This supports Winsor’s conclusion that rhetoric is not something that engineers look for; rather they write for other engineers by simply showing results and analysis and, eventually, drawing conclusions. Winsor mentions that “[e]ngineering is

knowledge work. That is, although the goal of engineering may be to produce useful objects, engineers do not construct such objects themselves. Rather they aim to generate knowledge that will allow such object to be built” (p. 5). This indicates that engineers usually build their premises on previous relevant research in the field. This, perhaps, explains why conclusions are far more important in some engineering disciplines. This corroborates Charles’ (2011:58) arguments “... that a writer’s choice of a given adverbial ... depends upon multiple factors including genre, discipline and context, as well as the function performed”.

Raising these issues with our specialist informant, Dr. Haweeleh, he added that “because,” “thus” and “therefore” are used equally without any differentiation in civil engineering academic writing. He also noted that the linking adverbial “because” is used far more often due to the fact that engineers need to know why certain events occurred. Yet, this claim is confirmed in the data we examined. Dr. Haweeleh mentions that he, personally, prefers concluding indicators. (Dr. R. Haweeleh, personal communication, May 20, 2013) since, according to him, conclusions are more important. He added that the analysis of experimental results would involve a substantial use of “because” to explain these experiments. Although “because” predominates experimental reports, it is used not as an argument, but rather to explain observations in the experiment.

A civil engineering graduate student writes the following in one of the theses:

“Finally, Fig. 5.15 provides an insight on the axial stresses in the VG insulation. The VG insulation does not provide any structural stiffness due to its very low mechanical properties, thus it is only used for insulation purposes” (p. 98).

The author draws a firm conclusion on a material that cannot be used in the structure of a building as stated in the premise of his argument that the material does not have the strength to hold a structure. This is a clear illustration of Trimble’s (1985) comparison between causality and result and other logical patterns, such as “therefore”, or in this case, “thus” which help to show logical thinking in developing an EST paragraph.

5. CONCLUSION

The authors, through their use of adverbials, were able to achieve logical persuasion. Additionally, linking adverbials in different engineering disciplines may differ. This could be because of the nature of the discipline. For example, for a civil engineer who specializes in structure, conclusions would be far more important than understanding why or how things work. A civil engineer with a specialization in soil behavior considers the use of “because” more often. But essentially s/he will use both words. The cause and effect rhetorical technique has the ability to convey to the reader *logos* or logical persuasion. Also the technique shows to the reader how the author views and approaches his/her topic. Besides, the use of adverbials gives a sense of direction to the academic work. Enthymemes are universally used in all academic writing, because the structure itself is more rhetorically appealing, and with the use of adverbials they achieve *logos*.

Although the results of this study may not be generalized to other engineering disciplines or academic fields because of the limited corpus they are based on, they could be used as a basis for a comparative study to probe into the use of adverbials in different engineering disciplines.

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APPENDIX

Details of master theses used for this Investigation

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