Part V : Word Construction

คำสั่ง จงสร้างคำใหม่ (ที่มีความหมาย)ให้มากที่สุดโดยใช้ตัวอักษรจากคำที่กำหนดให้

ตัวอย่าง เช่น
NOODLE : NO, ON, DO, NOD, DONE, DOLE,...

ESTABLISHMENT:

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Fast and Slow Materials and Methods Section: Disciplinary Variations between Biotechnology and Environmental Engineering Research Articles

Issra Pramoolsook*

School of English, Institute of Social Technology, Suranaree University of Technology

Abstract

The Materials and Methods is an important element in research articles, especially for those in science disciplines. It has been revealed that this section is composed in different ways in different disciplines. Due to these variations across disciplines, the section is found to vary in speed. While the style of the section in social sciences tends to be *slow* or extended, that in hard sciences tends to be *fast* or compact. Even among the science disciplines, the section also shows variations in terms of speed. This study aims to further support this claim by investigating the variations between Materials and Methods sections written by Thai scientists in two science disciplines i.e. Biotechnology and Environmental Engineering. The speed investigation was conducted on the basis of the hypotheses on both the functions and forms of the section. With respect to functions, the result derived from the frequency of evidence of fast and slow characteristics points out that the Biotechnology texts are slower than those of Environmental Engineering, as they contain greater justification, and more details and references to the research subjects. However, the investigation with respect to forms based on a statistical analysis yields a contradictory result that fails to support the previously reached claim. At the end, a comparison between Biotechnology and Environmental Engineering Materials and Methods with those in other science disciplines from a previous study was made, which also renders an inconclusive result. Thus, more studies on a wider set of corpus are encouraged.

Keywords: genre (ประเภทการสื่อสาร); research article (บทความวิจัย); the Materials and ethods section (วัสดุและวิธีวิจัย); disciplinary discourse variations (ความหลากหลายของสัมพันธสารจำเพาะแขนงวิชา)

* *Corresponding author.*
E-mail address: issra@sut.ac.th

บทคัดย่อ

วัสดุและวิธีวิจัย (The Materials and Methods) เป็นองค์ประกอบที่สำคัญส่วนหนึ่งของบทความวิจัยในปัจจุบันนี้ โดยเฉพาะอย่างยิ่งบทความวิจัยทางด้านวิทยาศาสตร์ งานวิจัยหลายชิ้นพบว่าการเขียนวัสดุและวิธีวิจัยนั้นแตกต่างกันไปในแต่ละสาขาวิชา โดยวัสดุและวิธีวิจัยทางด้านสังคมศาสตร์พบว่ามีรูปแบบการเขียนที่ช้าหรือยืดยาว ส่วนทางด้านวิทยาศาสตร์มีรูปแบบการเขียนที่เร็วหรือกระชับ และแม้แต่วัสดุและวิธีวิจัยทางด้านวิทยาศาสตร์ด้วยกันเองก็แตกต่างหลากหลายในด้านความเร็วด้วย งานวิจัยนี้จึงมุ่งที่จะสนับสนุนแนวคิดดังกล่าวเพิ่มเติม โดยทำการวิจัยความหลากหลายระหว่างวัสดุและวิธีวิจัยจากบทความวิจัยที่เขียนโดยนักวิทยาศาสตร์ชาวไทยในสาขาวิทยาศาสตร์ 2 สาขา ได้แก่ สาขาวิชาเทคโนโลยีชีวภาพ และวิศวกรรมสิ่งแวดล้อม การวิเคราะห์ความเร็วในงานวิจัยนี้ใช้สมมติฐานทั้งทางด้านรูปแบบการบรรยายและทางด้านรูปแบบภาษาเป็นฐานในการวิเคราะห์ ผลการวิจัยชี้ให้เห็นว่า เมื่อวิเคราะห์ด้วยสมมติฐานทางด้านรูปแบบการบรรยายโดยวัดจากความถี่ของหลักฐานที่แสดงออกถึงรูปแบบการเขียนที่ช้าหรือเร็ว พบว่าวัสดุและวิธีวิจัยในสาขาเทคโนโลยีชีวภาพช้ากว่าสาขาวิศวกรรมสิ่งแวดล้อม เนื่องจากมีการให้เหตุผลรายละเอียด และมีการกล่าวอ้างถึงหัวข้อวิจัยมากกว่า อย่างไรก็ตาม การวิเคราะห์ด้วยสมมติฐานทางด้านรูปแบบภาษาโดยใช้การวิเคราะห์ทางสถิติ ให้ผลที่ขัดแย้งกับผลที่ได้จากสมมติฐานทางด้านรูปแบบการบรรยาย ในตอนท้ายของบทความนี้ความเร็วของวัสดุและวิธีวิจัยของทั้งสองสาขาวิชาจะนำมาเปรียบเทียบกับสาขาวิชาอื่น ๆ ที่ได้เคยมีการศึกษามาก่อนหน้านี้ ซึ่งผลของการเปรียบเทียบนี้ก็ยังไม่สามารถให้ข้อสรุปที่ชัดเจนได้ ดังนั้นจึงควรมีการวิเคราะห์วัสดุและวิธีวิจัยที่มากขึ้นกว่านี้

Introduction

The Materials and Methods is an important element in most research articles. It is even deemed compulsory for research articles in science disciplines, in which an account of scientific experiments is given. In the literature, this section of text is generally labelled *'the Methods'* (e.g. Swales, 1990; 2004; Swales and Feak, 1994; and Bloor, 1999) and it is concerned mainly with that of research articles with only a few mentioning about it as a dissertation chapter. As for its communicative purpose, Swales and Feak (1994) provide a definition of the Materials and Methods as '*The Methods section describes, in various degrees of details, methodology, materials, and procedures. This is the narrowest part of the RP'* (p. 156).

In this definition, Swales and Feak present the section in relation to other elements of the research article which are longer, more elaborate and more detailed. They point out that the section is simply a description of the experiment conducted and reported in the article, which includes the materials used and procedures that occurred in the experiment with the aim to show the readers what actually happened and how the experiment was carried out. This also proves that its purpose is *'to allow other interested members in the discourse community to learn about the experiment processes, and also to permit replication.'* (Swales, 1990, p. 121), or *'to describe the methods used in the research that is being reported'* (Bloor, 1999, p. 86). With these content requirements, this section is, therefore, usually written straightforwardly in a descriptive and narrative style (Swales and Feak, 1994; Weissberg and Buker, 1990), and hence the easiest section to write and often the section to be written first for the research article (Pramoolsook, 2007).

Another interesting aspect of the Materials and Methods is the different ways this section is composed in different disciplines. The variations in writing this section across disciplines are discussed in Swales (1990; 2004) and in Al-Ali and Holme (1999) and for the teaching purpose in Swales and Feak (1994) in which they point out that the Methods sections in the hard science disciplines are written in a different style to those in the social sciences. The reason for the variation is the difference in the content and purposes of the section in different academic disciplines. In science, engineering, and medical sciences, they found that standard experimental practices and established scientific procedures and methods are widely known and available to the people in those fields, whereas *'methodology is often a very important and hotly debated issue'* in social sciences, education, and public health disciplines (p. 165). This disciplinary variation results in the Materials and Methods in the latter category being explicit about details and procedures, providing in most cases justifications for the choosing of particular methodology, explanations, and sometimes containing examples to give a clearer account, while such details are not normally given in science Materials and Methods. Due to these variations across disciplines, they conclude that the section varies in speed, and propose to describe the

style of the section in social sciences as *slow* or extended and that in hard sciences as *fast* or compact texts. This division clearly requires different intuition on the readers' part to get the message presented in the section.

An interesting follow-up study to the variations of speed of the Materials and Methods is conducted by Bloor (1999). The study is an attempt to provide support to Swales' and Feak's description of the Methods section by a further analysis of the content of such sections. Linguistic features of such texts are also analyzed to find out how far they reflect the content variation. The corpus in Bloor (1999) study includes 5 Methods sections from academic journals in 4 science-oriented fields, namely, one from Applied Cognitive Psychology, one from Medicine, one from Materials Science, and two from Public Health. The analysis is conducted on the basis of the hypotheses on both the functions and forms of the Methods sections, which include:

With respect to functions:

Slow texts

1. *are explicit about procedures, incorporating details*
2. *explain any technical terms used*
3. *incorporate examples*
4. *present reasons/justification for procedures or choice of method*

Fast texts

1. *assume that the readers have expert knowledge of the field*
2. *assume that readers are familiar with the research method/s*
3. *do not incorporate examples*
4. *do not attempt to justify methods or procedures*

With respect to forms:

Fast texts:

1. *have shorter average sentence length than slower texts*
2. *have higher lexical density than slow texts*
3. *score higher on a readability index than slow texts*

(Bloor, 1999, p. 88)

The analysis results largely confirm the hypotheses in terms of the communicative functions, and it is also found that the speed variation of the Materials and Methods exists even in the science-oriented disciplines as the five texts can be put on a speed scale from slow to fast, as presented in the table below.

Table 1: Variations in the Methods Sections of Research Articles across Disciplines (Bloor, 1999, p. 87)

Text type	Speed	Subject Field
Type 1	Slow	Applied Cognitive Psychology
Type 2	Fairly slow	Public Health A
Type 3	Fairly slow/fairly fast	Public Health B
Type 4	Fairly fast	Medicine
Type 5	Fast	Material Science

Confirming what is hypothesized for the slow text, Type 1 and Type 2 texts are explicit about procedures and present a considerable amount of details. The differences lie in the fact that the justification for some of the procedures employed in the experiment and examples are provided in Text 1, whereas Text 2 assumes that the readers are familiar with some of the established research techniques and procedures. A subsequent study by Swales and Luebs (2002) also confirms the elaborated nature of research articles in social psychology, a discipline close to that of Text 1. Text 5 is written in the opposite end of the speed cline. The Material Science text assumes the readers have a great deal of knowledge of the subject, as there is no justification or reasons for the procedures, the techniques, the choice of equipment given to the readers at all. Furthermore, neither examples nor definitions of technical terms are provided. Another variation found between the slow and fast texts is the way the subjects of the experiment are mentioned in the section. In the case of the slow texts, the subjects of the investigation are referred to throughout the text in Text 1, and there is a similar pattern but less extensive referencing to the subjects in Text 2. On the contrary, the subject of the investigation in Text 5 is mentioned only once at the beginning of the section and the rest focuses only on the methods.

Interestingly, Text 3 in particular is situated in the middle of the speed scale, resembling the slow text in terms of the less assumed background knowledge, and the fast text in terms of the distance from the subjects or objects of the research. While it provides a good amount of explanation on the techniques for the readers, the subjects of the research are not directly mentioned at all, due to, according to Bloor (1999), the complex nature of the topic itself. This overlapping nature of the Text indicates its speed as a fairly slow/fairly fast text.

In summary, the analysis of this study confirms to a large extent the general characteristics of the Materials and Methods in different disciplines. As for the hard sciences, the section is written by relying on the readers' background knowledge or experience of the field or topic of the study to create coherence in text. Swales (1990) summarizes physical and life science Methods section as *'enigmatic, swift, presumptive of background knowledge, not designed for easy replication, and with little statement of rationale or discussion of the choices made'* (p. 170), which is in contrast to the very detailed description and explanation for explicitness in the soft discipline Methods section. This distinction is further explored in Swales (2004) in which he proposes the term *'clipped'* for the fast Methods text and *'elaborated'* for the slow one (p.220). Some characteristics of the *clipped* and *elaborated* texts are similar to those explained in Bloor (1990).

However, Bloor (1999) cautions that the division of fast and slow texts might be a misnomer as the terms might be reversed from the reader's viewpoint. She argues that for the lay person, the slow texts can appear to be faster to read, while for the fast ones the readers may have to take longer time to understand. Therefore, in order to write a Materials and Methods section suitable for the target readers, she proposes that the writers have to make choices with respect to the amount of details, argument and explanation by depending on:

"(a) conventional forms and reader expectation (the culture of the discipline), (b) the degree of the readers' familiarity with the methods, (c) whether the methods are controversial or not, and (d) whether the methods have been especially constructed for the present research."

(p.96)

Finally, being aware of the small size of her corpus, Bloor (1999) urges more similar kind of analyses to be conducted with the Materials and Methods in other disciplines in order to consolidate the claims about the existence of disciplinary variations across disciplines.

Until very recently, while numerous studies have been carried out to unveil the discourse variations among academic disciplines (e.g. Hyland, 2000; Bunton, 2005; and Nesi and Gardner, 2006), the discourse of Biotechnology and Environmental Engineering disciplines, to the best knowledge of the researcher, has never been studied and compared before. Moreover, when a focused comparison is conducted, more attention seems to be paid to other more popular textual components (e.g. Samraj , 2002a on Abstracts; Samraj, 2002b on research article Introductions between Wildlife Behaviour and Conservation Biology disciplines, and Samraj, 2008 on master's thesis Introductions from Biology, Philosophy, and Linguistics), leaving the Methods section relatively unexplored. In Thailand, there are few studies that examine scholarly publication in English of the Thai writers although it is a country that aspires to gain recognition in the competitive fast growing international community in academic advancement and research development. To respond to this scarcity, the purpose of this paper is therefore to investigate and compare the Materials and Methods in two science disciplines which have never been studied before i.e. Biotechnology and Environmental Engineering. These texts were taken from the published research articles, which are written by Thai scientists at Suranaree University of Technology in Thailand. The investigation aims to find out the speed of the Materials and Methods in the two disciplines in comparison with that of the other five proposed by Bloor (1999). In other words, it is interesting to explore the extent to which the sections of the two science disciplines in this study are different with respect to both functions and forms. One contribution from this investigation is that it will provide more insights into the disciplinary variations between the two and put them onto the cline that has been set out in Bloor (1999). It is hoped that this will broaden and enrich the little existing knowledge about the two disciplines and the Thai context and writers, and also to call for more attention to be paid to the Materials and Method and disciplinary discourse variations.

Methodology

Data

The Materials and Methods under this study were taken from three research articles in Biotechnology, and three in Environmental Engineering. All of these research articles were published in international academic journals. Although it is a concern that the size of a corpus should be large enough (Stubbs, 1996), it is certainly possible that the analysis results of this corpus of six texts can be used for a comparison with those from a larger collection later, potentially yielding further interesting findings.

Following the typical IMRD (Introduction-Materials and Methods-Results-Discussion) pattern of organization, these research articles contain a distinct section entitled *'Materials and Methods'*, from which the content was taken for analysis. In these sections, the word count is in the range of 300 to 1000 words. These research articles were produced under a joint collaboration between the students and their Thai supervisors (for Biotechnology) and a foreign supervisor (for Environmental Engineering), which is a normal practice at this particular university.

As for the surface structure of these texts, there is no clear division of the text into the Materials and the Methods sections, but the details are instead organized into smaller sections with headings and sub-headings on a variety of topics such as *'Culture medium'*, *'Experimental setup'*, *'Sampling'*, and *'Analytical methods'*. The list of the Materials and Methods included in this study is provided in the Appendix.

Analysis Framework

The focus of this study is the speed differences between the Materials and Methods in the two disciplines, Biotechnology and Environmental Engineering. As for this study, both Biotechnology and Environmental Engineering can be assumed to fall into the fast text category because of their nature of hard science, but it is speculated at this stage that their speed might vary due to their different nature of applied aspect of the science disciplines (Becher, 1989; Becher and Trowler, 2001).

The framework for the analysis to find out the disciplinary speed variations in this study was based on the division of fast and slow texts in the Materials and Methods, first commented by Swales (1990), between the sciences and humanities disciplines. The idea is then taken up again in the study by Bloor (1999) in which she argues and finds out that the division exists even in the science-oriented disciplines. For the purpose of the investigation, the analysis followed the hypotheses formulated by Bloor (1999) with regard to both the functions and forms of the fast and slow texts. The set of hypotheses is presented earlier in this article. The texts in the corpus were analyzed for the results of their communicative functions first before it was pointed out which is faster between the two disciplines. Then, an investigation on their linguistic features which relate to the form of text was conducted before the finding about the speed can be established. Finally, the conclusion about the disciplinary variations between the two disciplines was provided.

For a Methods section to be considered as a slow text, according to Bloor (1999), the procedures should be explicit with details incorporated for elaboration. Also, it should contain explanations of the technical terms used and examples of items or cases, as well as reasons or justification for the choice of procedure or methods. In her study, she quantifies the evidence of these communicative features and presents it in a table to illustrate the difference between the fast and slow texts. A similar method and presentation was used in this study.

Another feature that she proposes to distinguish between the fast and slow texts is the frequency of references to the subjects of the study. She concludes that in the fast text, there is a distancing in the description away from the actual subject of the research while focusing more on the methods. Therefore, the number of the reference is low. In contrast, the slow texts show more references to the subjects. The counting of the references to the subject of the research will also be conducted in this study but there is one constraint that needs to be mentioned. In Bloor's study, all of her samples of the Methods section are written as one long section without any sub-section to show boundary of different topics being discussed. However, the Materials and Methods sections in this study are divided into smaller

sub-sections with their own focused topic for discussion, so it is more difficult to restrain the discussion only to the subject of the study. Despite this restraint, an attempt was made in this study to highlight the extent of how the reference to the subject of the investigation can point out the speed difference between the two disciplines.

For the investigation with respect to form, linguistic characteristics, namely, sentence length and lexical density, were measured using free software available on the Internet. Furthermore, this was coupled with the result of the readability level according to the Flesch-Kincaid Grade index to strengthen the findings.

Results and Discussion

Analysis on Communicative Functions

Following are the results of the investigation of the Materials and Methods between the two disciplines to find out which is the faster text. This section will begin with the Biotechnology texts as summarized in the table below.

Table 2: Summary of Evidence of Communicative Features in Biotechnology Materials and Methods

Text	Research articles			
	Exemplification	**Justification**	**Details**	**References to subjects**
Bio 1	-	10	3	7 (cyanobacterials strains)
Bio 2	-	-	-	2 (*T.crassum*/mushroom)
Bio 3	-	4	2	6 (microbial strains)

The findings reveal that the writers have a high level of assumption that readers have expert knowledge in the field and high familiarity of the research methods. On various occasions, when the writers want to introduce the analytical methods or research apparatus, they tend to give only their names without providing details or reasons for choosing them. The assumed knowledge and familiarity helps the text to be read faster.

Examples:

"Cell pellets were filtered through Whatman no. 42 filter paper...."

(Research article 1, p. 674)

"For protein content, micro Kjeldahl method was carried out."

(Research article 3, p. 19)

Nevertheless, there are also a number of occasions when the writers support the readers with details and justifications, the provision of which is considered a characteristic of the slow text. The account of these characteristics is summarized below.

Exemplification

The Biotechnology Materials and Methods in this corpus do not contain any exemplification for the readers. This absence of examples is in contrast to the slow and fairly slow texts of Applied Cognitive Psychology and Public Health in Bloor's study (1999), thus pointing Biotechnology towards the fast direction.

Justification

The texts contain two types of features that are considered to be justification for the relevant aspects of the experiment. One is straightforward reasons for some of the procedure, and the other is references to previous work in the field. There is only a couple of instances of the first category in these texts, whereas the second has a bigger number. An example of the first type is given below.

Examples:

"The pellet was suspended in an appropriate volume of TE buffer to ensure that at least a few filaments or cells were present I the 1-2 ml which was used directly as a template for PCR as described above."

(Research article 1, p. 675)

According to Bloor, *'(these) references appear to support justification of aspects of the research methods'* (1999, p. 94). Therefore, all the references to previous work in the filed given in these texts are counted as justification for the methods or procedures. In these Biotechnology research articles, they are found to justify the selection of determination method by referring to a group of researchers that use the method before, as in:

"Protein is determined according to Lowry et al., 1951."

(Research article 3, p. 18)

and

"The population number in the growth tubes was determined according to the standard MPN method (Grant et al. 1985)."

(Research article 1, p. 674)

Details

There are instances that offer details of the experiment or procedure in the research articles. The details provided cover a wide range of topics. Firstly, the details of the source of the experiment subject or equipment are found in these texts.

Examples:

"Soil samples from the mountain areas, flat areas of agricultural cultivation (field crop cultivation, rice cultivation, rice in rotation with other crops) and uncultivated areas from northern, Central and northeastern parts of Thailand were chosen as sampling sites during the study period (1997-1999)."

(Research article 1, p. 674)

Sometimes, minor details about the components of a solution are also provided despite the assumed knowledge of the research article readers.

Examples:

"Cell pellets were harvested by centrifugation at 9000 rev/min for 10 min, resuspended with 3 ml o extraction buffer (100 mM Tris-HCL[pH 8.0], 250 mM NsCl, 100 mM EDTA and 0.4% 2-mercaptoethanol), ..."

(Research article 1, p. 674)

The amount of the details incorporated into the text can decide the degree of explicitness about procedures the text has. Certainly, the more details the text has, the more time the readers need to read the text, causing the text to be a slow one.

Reference to Subjects

In these Materials and Methods, there are references to the subjects or topics of the study, which are given in the table above. Although the sections are divided into smaller sub-sections under which different topics are being discussed, it is found that the main subjects are still mentioned from time to time throughout the section. These subjects are sometimes referred to in different names or referred to with other elements attached to them, but they are still considered to refer to the same things. For example, *'the cyanobacterial strains'* is the main subject in Biotechnology 1, but it is referred to as *'a single cyanobacterial colony'* and *'each cyanobacterial isolate'*. The number of the references made in each reveals the extent to which the description of the experiment is moving away from the subject and turning the focus to the method instead. It is proposed that the higher the number, the slower the text is (Bloor, 1999). The number of reference found in these texts will be compared to that in the Environmental Engineering texts in the next section.

Table 3: Summary of Evidence of Communicative Features in Environmental Engineering Materials and Methods

Text	Research articles			
	Exemplification	Justification	Details	References to subjects
Envi 1	-	-	1	2 (wastewater)
Envi 2	-	2	2	5 (samples)
Envi 3	-	1	1	4 (solid waste)

Exemplification

Similar to their Biotechnology counterparts, these Environmental Engineering Materials and Methods do not contain any evidence of exemplification. Then, it may be concluded that providing examples is not a characteristic of the Materials and Methods in the two disciplines of this study. This lack of exemplification tends to suggest that these disciplines are likely to fall on the fast end of the speed cline.

Justification

Also similar to the Biotechnology texts, a great deal of evidence which offers justification or explanation is found in these texts, including references to previous studies and reason statements. One example of a justification statement is given below.

Example:

"As the process had to be anaerobic, once the digesters were loaded, they could only be opened at the end of the run. However, it was also desired to follow the gradual change of various physical, chemical, and biological parameters of the composting materials during the run. Therefore, the four runs were planned as described below."

(Research article 3, p. 197)

In this example, there is a need to maintain the condition of a procedure, but the writers point out a reason that some changes to the condition are unavoidable. There is also an instance of providing references to previous studies as a means of giving justification for adopting a method.

Example:

"The acid digestion procedure was used for the preparation of aqueous samples following the EAP guidance for solids waste SW-846 (EAP 2001)."

(Research article 2, p. 32)

Details

The type of details given in these Materials and Methods covers a range of topics, including details about research and sampling sites, experiment equipment, and experiment procedures. Sometimes, equation for calculation is incorporated into details. There is one interesting instance in which the detail about the method selected for a procedure is provided.

Example:

"This method [EPA method] *is an interim method to determine whether a waste exhibits the characteristics of EP toxicity."*

(Research article 2, p. 32)

Reference to Subjects

There is a distancing from the subjects of the research in these Materials and Methods sections, and the increased focus on the experiment method. In Environmental Engineering 2, the bottom ash, frequently referred to as *'samples'*, is referred to 5 times, and *'solid waste'* 4 times in Environmental Engineering 3. Evidence shows that as the texts progress further from the first sub-section to the following sub-sections, these subjects are referred to less and less and new items take turn becoming the focus of the discussion. An interesting case is in Research article 1, where the actual subject of the research, *wastewater*, is mentioned only twice while the whole section focuses more on the experiment. All the sub-sections have titles related to the experiment, namely: *Experimental setup*, *Experimental conditions*, and *Experimental measurements*. Throughout the section, the experiment and its related aspects such as *experimental runs* are referred to 5 times.

Slower Biotechnology and Faster Environmental Engineering

The quantified evidence of the slow text characteristics presented above can be used to find out which of the two disciplines is the faster one. The comparison is shown in the table below.

Table 4: Comparison of Communicative Features between Biotechnology and Environmental Engineering Materials and Methods

Text	Biotechnology			Envi. Eng.		
	Justification	Details	Reference to subjects	Justification	Details	Reference to subjects
RA 1	10	3	7	-	1	2
RA 2	-	-	2	2	2	5
RA 3	4	2	6	1	1	4
Total	14	5	15	3	4	11

The result further supports the finding that the Biotechnology texts are slower than those of Environmental Engineering. They contain greater justification and more details and references to the research subjects, which are characteristics of a slow text. Therefore, it can be concluded that in the corpus of this study, if judged by the content of the text, the Biotechnology texts are slower than Environmental Engineering texts. This conclusion also confirms that the speed variation exists even in the science-oriented disciplines, and finding a place for different disciplines on the speed cline can be a beneficial attempt for the disciplinary variation studies.

Before moving on to the next section, there is another feature found in this Methods corpus that deserves to be mentioned with regard to the speed of text. That feature is the incorporating of graphic presentations into the text. In the Materials and Methods in both disciplines, the writers employ maps, figures, and tables in order to offer more details for the readers. Some of these elements serve as a summary of the elaborated details in order to save the writers' time to write and the readers' to read. Given this benefit of these graphic presentations, it is proposed here that they be considered a characteristic of a fast text. In this corpus, it is found that Environmental Engineering texts employ more of these presentations for the purpose of saving time for both the writers and readers. Therefore, the claim that Biotechnology texts are slower than the Environmental Engineering ones is strengthened by this proposition.

Thus far, the analysis has confirmed the hypothesis with respect to functions of these texts. The next investigation will continue to test the

hypothesis with respect to form.

Results of the Analysis on Form

This section reports an analysis of some of the measurable linguistic features of the Materials and Methods in this corpus. The result will be used to support the findings of the fast-slow texts reached above between the two disciplines.

Following Bloor's study (1999), the measurable linguistic characteristics focused in this study will be sentence length and lexical density. The analysis was conducted using the software available on an Internet website (www.textalyzer.net). Moreover, the result will be complemented with a result of the readability level of the texts using the Flesch-Kincaid Grade index, following Bloor (1999), which is commonly used in the corporate world and readily available on Microsoft Word. The score on this index is used to indicate the grade of students in the US school system who should be able to read the text without difficulty. For example, if a document has a score of 8.0, it means that students in the eighth grade would understand the document. The calculation of the readability score is based on the average number of syllables per word and the average number of words per sentence, and derived by this equation (http://www.wats.ca/resources determiningreadability/1).

$$(.39 \times ASL) + (11.8 \times ASW) - 15.59$$

Where ASL = "average sentence length" (the number of words divided by the number of sentences), and ASW = "average number of syllables per word" (the number of syllables divided by the number of words)

For the analysis involving word counts in this study, one chemical formula is counted as one word, such as NaCl and K_2PO_4, even though it represents more than one phonological word. In addition, words in the tables and figures as well as those in the captions to accompany them are not counted. It is hypothesized that the fast text should have shorter average sentence length, higher lexical density, and higher scores on a readability index. The results are summarized in the table below.

Table 5: Comparison of Analysis on Form between Biotechnology and Environmental Engineering Materials and Methods

Text	Biotech.				Envi. Eng.			
	Word counts	Words per sentence	Lexical density	US grade level	Word counts	Words per sentence	Lexical density	US grade level
RA 1	1,070	14.13	66.3	12	398	11.49	58.7	12
RA 2	290	13.29	76.3	11.5	690	14.43	61.4	12
RA 3	855	12.19	59.5	12	368	14.75	56.2	12
Ave.	738.3	13.20	67.3	11.83	485.3	13.55	58.7	12

Although text length is not included in the criteria for identifying fast and slow Materials and Methods, in Table 5 the size of texts is also shown through the number of words to provide a clearer picture of the texts in the corpus. The comparison of the Materials and Methods between the two disciplines reveals that the Biotechnology texts are faster than those of Environmental Engineering. They have stronger claims to be the faster ones as they exhibit slightly shorter average sentence length (13.2 and 13.55) reflected through fewer words per sentence and they have higher lexical density than their Environmental Engineering counterparts (67.3 and 58.7). Although their readability score is lower, the difference is very minimal and barely has an effect (11.83 and 12).

In summary, the investigation of the Materials and Methods speed with respect to forms, renders a contradictory result to that derived from communicative functions, thus weakening the conclusion that the Environmental Engineering Methods texts are faster than their Biotechnology counterparts. This discrepancy demonstrates the complexity of overlapping fast and slow characteristics that exist in writing in different disciplines, which poses demanding rhetorical tasks for writers in any discipline.

However, the results on forms between Biotechnology and Environmental Engineering Materials and Methods can be used to complement the findings in Bloor's study (1999), which places the two disciplines among the existing five on the speed cline. For this purpose, the average number of the three characteristics in the research articles, i.e. the sentence length, the lexical density, and the readability index, will be

compared to that of the five disciplines.

With regard to the average sentence length, the results in Bloor's study (1999) are not conclusive. While the assumed fastest text of Materials Science contains 30 words per sentence, it is the fairly slow/fairly fast text of Public Health B that has the shortest average sentence length of 18.7, thus the fastest one in this category. In the present study, the average sentence length is 13.2 for the Biotechnology research articles and 13.55 for the Environmental Engineering. Based on this characteristic, the two disciplines are considered faster than the fastest one in Bloor's study, placing them at the fastest on the speed cline. One possible contributing factor for these very short sentences could be the writer factor. Given their limited writing skill, it might be easier for the novice research article writers who are non-native speakers of English like those in this study to produce simple sentences.

Turning to the next criteria, Biotechnology with lexical density of 67.3 stands between the fastest and the second fastest in Bloor's (68.42 for the Materials Science and 66.44 for Medicine). Surprisingly, the Environmental Engineering (58.7) falls between the slowest and the second slowest disciplines, i.e. 51.7 for the slow Applied Cognitive Psychology and 61 for the fairly slow/fairly fast Public Health B. This placement fails to support the positions of the two disciplines as determined by the average sentence length above.

Lastly, the result of the readability scale is also problematic. The Environmental Engineering with score 12 comes second to the fastest discipline of Medicine (score 14) in Bloor's (1999). The Biotechnology (score 11.83) then comes fourth on the cline after the second fastest Public Health B with 11.9 score. Again, the placement does not conform to the results found in the investigation of the previous 2 characteristics.

To sum up, the speed comparison against the five disciplines in Bloor's study using the three criteria on forms does not yield a conclusive placement of the two disciplines in this study. The results vary from one criterion to another and thus are too risky to provide an assertive conclusion. This is also similar to the results Bloor (1999) finds in her study where she

consequently advocates more studies for better understanding and more valid and reliable results. However, this comparison is an attempt to conduct an extension of the previous research to cover two more disciplines, whose result further highlights, if not completely, the existing disciplinary variations between the seven academic disciplines.

Conclusion

This present research is a pioneering study on the research article Materials and Methods written by Thai scientists in two science disciplines which have never been explored before. To provide a final summary, when the hypothesis with respect to the communicative functions of text is tested, it is found that the Environmental Engineering is faster than the Biotechnology. However, this claim is not well supported by the results from testing the hypothesis with respect to forms, which fails to provide a definite answer to which of the disciplines is faster. Therefore, more studies on a wider set of corpus are required if the categorical answer is needed, and potentially they will shed more light on the studies of composition methods and styles that Thai writers possess.

For ideas for further research, similar investigations can be undertaken with the Materials and Methods in other disciplines, including those in both sciences and humanities. The findings can be beneficial for writing classes in which a group of students from mixed disciplines are put together. They should be made aware of the typical ways the section is written in their own disciplines, and also of the different ways their colleagues in other disciplines use. Through this awareness, it is hoped that these writers will produce the Materials and Methods sections that are suitable for and meet the expectations of the readers in their own or related academic fields.

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Communication Strategies of College Non-English Major Students at Guizhou University

An Mei[1]* and Sanooch S. Nathalang[2]

[1]*College of International Studies, Guizhou University, China*

[2]*Human Language Technology Laboratory, National Electronics and Computer Technology Center, Pathumthani, Thailand*

Abstract

This paper reports on an investigation into the communication strategies (CSs) of College English students (non-English major students) at Guizhou University in China. These students are a large group who are studying English and need to use CSs to facilitate their communication because they do not have sufficient exposure to English in daily life. All of the subjects are first-year bachelor students from the Arts and Science fields and they are grouped into high and low proficiency levels. The data is collected by means of a questionnaire and a semi-structured interview. Frequencies and Chi-square tests are conducted to analyze the data. The results indicate that variables of proficiency level, academic field and gender are probably related to CSs use to varying degrees. The results of this study could be a great help in the teaching of English to Chinese EFL learners by making them aware of CSs already in their repertoire and by encouraging them to use CSs more frequently.

Keywords: Communication strategies; Interlanguage; Communication competence; Chinese EFL learners

Introduction

This paper investigates the interlanguage communication strategies of Chinese EFL learners and examines the role communication strategies play in the maintenance of communication in a classroom. The interest in the issue of CSs sprang mainly from the nature of the interaction among college

* *Corresponding author.*
E-mail address: anmaygd@hotmail.com or anmaygd@126.com