

DISCOURSE MATRIX ANALYSIS: AN EMPIRICAL STUDY OF A SAMPLE PEDAGOGY

by

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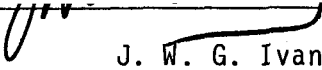
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DISCOURSE MATRIX ANALYSIS: AN EMPIRICAL STUDY

OF A SAMPLE PEDAGOGY

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## ABSTRACT

### DISCOURSE MATRIX ANALYSIS: AN EMPIRICAL STUDY OF A SAMPLE PEDAGOGY

This study was an attempt to better teach paragraph structure to engineering technology students using the Coe modification of a Nold-Davis discourse matrix. The students were randomly divided into matrix analysis and traditional instruction. As a pretest paragraph, the groups responded to similar questions designed to elicit a particular type of general-to-specific paragraph found in 'technical' writing and then received either matrix analysis or traditional instruction. In the posttest, the questions were reversed and the paragraphs were coded, drawn as a matrix and scored.

Paragraphs were scored as to how well they provided five characteristics: 1) a general topic sentence, 2) idea strings with three or more levels, 3) idea strings developed by coordination or subordination, 4) idea strings containing no irrelevant T-units, 5) no regeneration in the final idea string. Two ANOVAs were performed with the  $p=0.05$ .

First, the total mean scores of the groups were contrasted. The matrix analysis group scores improved by 1.0466 points while the traditional scores improved by 0.4006 points with a  $p=0.0000$ . Second, the mean scores of the two groups were contrasted characteristic by characteristic. The matrix analysis group scored higher in all characteristics than the traditional group did, and three of these scores were significant: idea strings of three or more levels, and idea strings developed by coordination and subordination,  $p=0.001$ ; no regeneration in the final idea string,  $p=0.003$ . In topic sentence production, the differences were not significant. In idea strings with no irrelevant T-units, the groups were not homogeneous before instruction.

These changes were produced by several of the matrix's characteristics. It is theoretically and empirically sound and actively involves students in the writing process. It extends previously learned information by forming a 'cognitive bridge' to new knowledge. This highly-adaptable structure may motivate the 'unmotivated' student by opening up new ways to generate 'rules' for paragraphs.

## ACKNOWLEDGEMENTS

I wish to thank the following colleagues and friends for their help and support. Dr. Richard Coe has inspired me in many ways and shown me the face of excellence while Dr. George Ivany gave me the freedom to learn what I needed to learn. Richard Lund at the British Columbia Institute of Technology has kept faith with my intentions, and Ellen Nold of Apple Computers, Inc. has answered all my questions with quiet good humor. My daughter, Allison McLaren, has provided me the confidence and love to do anything.

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## CHAPTER I

### INTRODUCTION

#### The Problem

This thesis, and the research behind it, sprang from a practical problem, not as a theoretical investigation of an aspect of rhetoric. As a composition instructor at the British Columbia Institute of Technology, I was dissatisfied with my students' ability to write well-developed, unified, coherent paragraphs in their day-to-day technical writing assignments.

Although most of the entering students had spent twelve years or more in the public education system of Canada and other countries, they wrote what I felt were poor paragraphs. Their paragraphs showed little or no consistent organization, lacked development and generally failed to completely and clearly explain a topic, one they knew from laboratory experience or from personal knowledge. In Burke's sense, they lacked form: "...an arousing and fulfillment of desires. A work has form in so far as one part of it leads the reader to anticipate other parts, to be gratified by the sequence." (Burke, 1953)

The following paragraph from one entering student is typical and by no means an extreme case. When asked why he chose to attend B.C.I.T., he wrote:

I chose B.I.C.T. because of its reputation. Students learn a lot of discipline and pressure. I went to B.C.I.T. and took another program. With my past experience and the employment force, I am able to identify and absorb important subjects

which will benefit both myself and my future employers.

With this student and others like him, I closely followed a number of technical writing texts' explanation of how to generate, develop and organize paragraphs in the writing-as-product methodology. From Houpp and Pearsall's Reporting Technical Information (1980), I taught classification and partition. From Mills and Walter's Technical Writing (1978) I taught outlining. After two or three weeks of lecture and practice, the students generally still wrote paragraphs that lacked unity, coherence and emphasis. To be sure, the paragraphs were a bit better. Many of them contained relevant topic sentences, but truly they were not substantively better organized or developed, nor were they more coherent. Clearly, the writing-as-product approach I used was not helping me teach students how to write better paragraphs than they had written two or three weeks before.

Over the course of two years, as other students enrolled in my courses, I taught from more academic texts because I felt I needed a closer link with "real" writing texts. Instead of using technical writing texts, I selected general composition texts, the backbone of many high school and university writing courses. Much to their dismay, my students now received more academic information and assignments. However, after the same two or three weeks of instruction and practice, they wrote in much the same way as my first two or three groups of students wrote. Their paragraphs lacked today's holy trinity: unity, coherence and emphasis.

Though the composition texts clearly did not shed more light on the way I

should teach paragraph organization and structure, I saw many paragraphs analyzed and many illustrations of the shape of excellent paragraphs. Sheridan Baker's The Practical Stylist (1977) asked the writer to create a first paragraph like a funnel, and to produce an essay in the shape of a keyhole. James McCrimmon's Writing With A Purpose (1957) used a variety of small arrows to denote movement and coherence within a paragraph, and, using these arrows, demonstrated time and space order, inductive and deductive logic and question/answer or cause/effect. Even so respected a rhetorician as James Kinneavy's A Theory of Discourse (1971) added, "The principle is to state the most important facts first and then the facts of secondary importance, then those of tertiary importance...But importance is also a matter of surprise value; and headlines, subheads, and parts of the story are also ordered by ...the principle of the inverted triangle."

I abandoned university and college texts, and read more technical writing texts, hoping I would find the one that would tell me how to help my students write the kind of paragraphs I saw in technical manuals, proposals and reports. But the more technical writing texts I read, the more repetition I saw in the chapters devoted to "the paragraph".

Failing to find an answer in the traditional texts on my bookshelf, I turned to a more immediate resource--my teaching colleagues. When I asked for specific information about and techniques for teaching paragraph structure and organization, they responded warmly...with the same information I had read in a dozen texts. When I looked at their students' writing, I could not differen-

tiate my students' work from the work of my colleagues' students. Clearly, I was not alone.

### A Larger Perspective

In looking for fruitful approaches to "the paragraph", I discovered authors and teachers who also seemed dissatisfied with and critical of traditional composition pedagogy.

Perhaps nowhere else is the tendency to teach writing-as-product more evident than in the teaching of paragraphs ....Traditionally, paragraphs have been taught as 'things', as entities. They represent boxes students must wedge ideas into, adjusting their material until it fills out the specified shape. Paragraphs have also been taught through models and imitation. Students examine models in their reading assignments, label them as one of several 'methods of paragraph development', and imitate the method in a series of paragraph-writing exercises. (Lindemann, 1982)

Other writers and rhetoricians have expressed similar views on the problems that face teachers and students. Richard Larson's comment of ten years ago remains true today: "The array of critical and pedagogical pieces on [form and structure] to date highlights problems and uncertainties, but provides few insights."(Larson, 1976) Albert Kitzhaber comments more bitingly but in the same vein. "Instruction in the principles of rhetoric should not mean studying of rhetorical instruction is both sterile and stultifying." (Kitzhaber, 1963)

I found that the problem was not even a new one. In 1963, Francis Christensen recognized that the existing composition pedagogy did not meet the

needs of writing students.

In composition courses we do not really teach out captive charges to write better--we merely expect them to. And we do not teach them how to write better because we do not know how to teach them to write better. And so we merely go through the motions. Our courses with their tear-out workbooks and four-pound anthologies are elaborate evasions of the real problem. They permit us to put in our time and do almost anything else we'd rather be doing instead of buckling down to the hard work of making a difference in the student's understanding and manipulation of language. (Christensen, 1963)

### The New Beginnings

I.A. Richards (1936) pointed to the common error of separating what we write and say and the way we write and say it. He cautioned

To remember this may help us to avoid some traditional mistakes --among them the use of bad analogies which tie us up if we take them too seriously. Some of these are notorious; for example, the opposition between form and content, and the almost equivalent opposition between matter and form. We shall do better to think of meaning as though it were a plant that has grown, not a can that has been filled or a lump of clay that has been moulded.

The emphasis on writing as a fluid process like Richards' plant, rather than writing as a product or a static form like his stamped clay, typifies a genre that is called New Rhetoric. Form and substance interact, and one shapes the other. Formal motives may create a structure that encourage students to invent material to fill the structure, but the process is generative, as Richards says, not static. The thrust of process-oriented pedagogy is on how writers begin, "middle" and end writing, on how they are influenced to make



and unmake choices in their work, and on how they choose and form their raw material.

Although we as teachers and writers have a number of guidelines about arranging topic sentences and support within a paragraph, until recently the relationships between sentences in a paragraph were poorly understood. The writers, researchers and teachers of New Rhetoric are attempting to discover how writers create this form. We are trying to find out how writers select and arrange arguments and support within a rhetorical situation (audience, purpose, genre, voice) in paragraphs and larger, longer texts. In short, we are currently attempting to create what Mina Shaughnessy (1977) called "... the principles of another kind of grammar, a grammar, let us say, of passages".

To this end, Young, Becker and Pike (Young and Becker, 1975) developed a tagmemic approach to discovering form based on the grammatical or surface characteristics of the text. Their central principle viewed discovering form as finding a series of patterns that function in specific relationships within the paragraph: the grammatical pattern, the continuity of pattern and the semantic pattern. This theory, like that of Miles, relied at least partially, upon what linguists would call surface structure, the traditional grammar of the sentence.

Miles (1965) also felt that any relationships of form must spring from a knowledge of the parts, the "grammatical" parts of a paragraph. This would lead to a deeper understanding of patterns and form within paragraphs.

While many of these early attempts to discover a 'grammar of passages' focussed on the purely grammatical characteristics of texts, other rhetoricians investigated related issues. Kellogg Hunt (1965) defined a smaller unit with which to investigate sentence and paragraph structure, the T-unit. By definition, a T-unit is a minimal terminable unit, one main clause and whatever subordinate clauses adhere to it. In sentence structure studies, the T-unit became part of the yardstick for syntactic maturity. In paragraph structure, it could replace the sentence as a propositional unit, cutting paragraph research free from the simple, compound and complex sentence, allowing researchers to focus more closely on logical relationships between propositions and underlying patterns of modification.

Working on a similar tack, Paul Rodgers (1967) defined a stadium of discourse, a rhetorical unit as long or longer than a sentence that implied specific forms of predication: by accretion, by adjunction or by analytic or synthetic pattern. With this contribution, Rodgers added a more complex (or perhaps a simpler) tool with which to examine form.

In 1967, Francis Christensen extended the more mature rhetoric of the sentence towards the paragraph. The title, "A Generative Rhetoric of the Paragraph", moved his concept of 'generative' to the paragraph. Borrowing from his seminal work on sentences, Christensen set out four principles with which writers could generate form in paragraphs: addition, direction or degree of modification, level of generality and texture. In his numbering system and the

placement of sentences on the page, he emphasized the heirarchical relationships of sentences in a paragraph as no funnel or keyhole could.

Many streams of inquiry flowed from Christensen's work. One of the most interesting was that of Ellen Nold and Brent Davis. They devised a plastic, three-dimensional model called a discourse matrix. This matrix represented paragraph structure and used the T-unit as the smallest unit of discourse. Using the terms coordination, subordination and superordination to define the level of generality, they derived a set of "principles" for unified, coherent paragraphs.

Patterns of coordination, subordination and superordination were seen to connect T-units in a flow of discourse. Coordination occurred between T-units at the same level of "abstraction" and was represented by the rhetorical actions of conjoining, contrasting and contradicting. These coordinate actions would be represented on the same level but different planes in a matrix. Subordination occurred at a lower level of "abstraction" and was represented by explaining, giving examples and defining. These relationships were represented on a lower level than the preceding T-unit but in the same plane. Superordination was exemplified in actions such as drawing conclusions, generalizing and going on to a new subtopic. These actions were represented on a higher plane and a different level. (Nold and Davis, 1980)

Nold and Davis numbered each T-unit to represent the path the reader

took as he moved through successive T-units and mapped this on the horizontal axis of the matrix. They added bars linking the T-units to represent movement from one T-unit to the next. The level of generality was represented on the vertical axis with the most general T-unit(s) towards the top of the matrix and the most specific towards the bottom. This simplified reading the matrix and provided a rough illustration of the pattern of modification within the paragraph or longer passage. Nold and Davis' original drawing and text example appear below. (Nold and Davis, 1980)

(1) There is an amazement proper to the experience of all great art, (2) but the special amazement which War and Peace revives in me while I am reading it is like that of a child. (3) The child does not expect the unexpected; (4) that would already be a preparation against it. (5) He does not for an instant doubt that a certain event had to happen; (6) such a doubt obscures. (7) He may even have been told beforehand that it was going to happen; (8) such foreknowledge is as little part of him as a label in his cap. (9) He is able to look at the thing itself. (10) The event reaches him radiant with magical causes but not yet trapped in sufficient cause. (11) Tolstoy does not, as many do, achieve this freshness by transforming the reader into a never-never land. (12) On the contrary, his fictional mode is realistic. (13) The people in his novel appear and behave like possible people in the world we daily live in. (14) His achievement is the greater because he uses the mode of realism, (15) for realism offers a threat to which other literary modes are not subject, the encroachment of mediocrity.

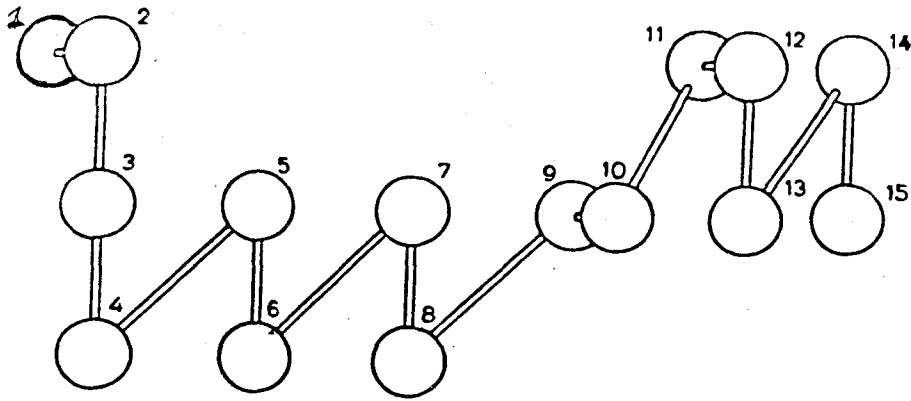


Figure 1- A Nold and Davis Discourse Matrix

Although the three-dimensional structure was hard to master and represent accurately on paper, this provided an orthography and focused attention on a little-discussed relationship between propositions, superordination.

Coe et al.(unpublished paper) made several significant changes and additions to the Nold-Davis discourse matrix while retaining its power. They further simplified the orthography by reducing the three-dimensional structure to a two-dimensional one and by adding and refining some of representations of relations between sentences. Nold and Davis' example, above has been redrawn in the simpler, Coe orthography.

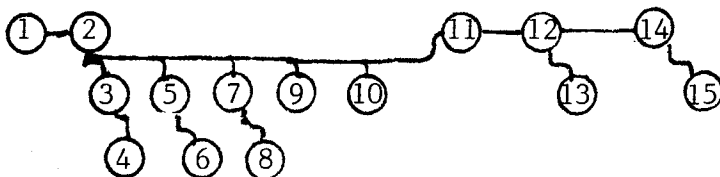


Figure 2- The Nold and Davis Redrawn in Coe Orthography

Coe et al. have further subdivided coordinate, subordinate and superordinate relationships into types following Christensen's work.

**Coordination:**

-contrasting, contradicting, conjoining, repeating (on the same level of generality)

Subordination:

-defining, exemplifying, providing reasons, deducing (deductive conclusions), explaining (restating more specifically), qualifying

Superordination:

-generalizing, drawing conclusions (inference), commenting (on a previously-stated proposition).

Pilot studies (Fahey, unpublished paper) indicate that many, if not most, technical paragraphs have a clearly-prescribed pattern of modification that is roughly described as general-to-specific. Technical paragraphs deal with applications of science or technology, are most often written for expert audiences and are structured from general to specific. Within this pattern, however, structural differences occur in the number of subtopics discussed and the amount of explanation that is provided. These modifications are related to the type of audience and their expertise, background, and reasons for reading. (Although the traditional division of readers into technical/expert, semitechnical and non-technical/naive audiences is imprecise, it is retained here since the categories provide convenient labels.)

Coe et al. use two additional terms that provide insight into these

patterns of modification. First, to avoid confusing Rodgers' definition of a stadium with that of Nold and Davis, Coe et al. have substituted the term idea string to represent a series of T-units uninterrupted by any rise in level of generality. An idea string represents the lineal development of a single proposition. For example, when a writer, discussing one of two main points, defines, exemplifies, gives reasons and deduces, he is creating an idea string by subordination. When he moves on to another main point, he ends the first idea string. Second, they have defined a node string as unit containing two or more consecutive units above the lowest level of generality which are related to each other by any type of coordination except restatement. Node strings are equivalent to a subset of the "points" or subtopics the writer discusses in the paragraph.

Good technical paragraphs for the expert or highly technical audience, then, have only to three idea strings, but they are long ones, and this is to be expected. This audience primarily reads for the wealth of proof and detail that extend the main concept. A short technical paragraph and its attending matrix are provided below. (Student text, 1985)

(1) The mechanism by which the processor translates an instruction code into specific processing actions requires a more detailed explanation than is given here, (2)but the concept, however, should be intuitively clear to any logic designer. (3) The eight bits stored in the instruction register can be decoded and used to selectively activate one of a number of output lines. (4)In this case, it is possible to address up to 256 lines. (5) Each line represents a set of instruction code. (6)The enabled line can be combined with selected timing pulses to develop electrical signals that can then be used to initiate specific actions. (7) This translation of code into action is performed by the instruction decoder and the associated control circuitry.

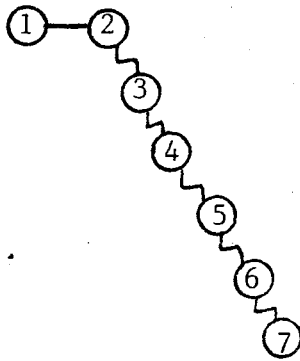


Figure 3- Sample Paragraph and Matrix for an Expert Audience

The knowledgeable, or semitechnical, audience may need more general information to understand explanations that follow. A discourse matrix for a semitechnical audience, in such cases, would contain more idea strings, but they would be shorter. My own explanation of an operating system, below, demonstrates this.

(1) CP/M is logically divided into four parts, called the Basic I/O System (BIOS), the Basic Disk Operating System (BDOS), the Console Command Processor (CCP), and the Transient Program Area (TPA). (2) The BIOS is a hardware-dependent module which defines the exact low-level interface with a particular computer system which is necessary for a peripheral device. (3) Although a standard BIOS is supplied with your computer, exact instructions are supplied for field configuration. (4) The BDOS component of your system controls the way your disk operating systems finds, retrieves and stores information on a disk and the way disks are recognized. (5) The BIOS and BDOS are logically combined into a single module with a common entry point, referred to as the FDOS, to make it easier for the computer to retrieve, store and output information and to control disk operation. (6) The CCP is a distinct program which uses the FDOS to provide a user-friendly interface to the information stored on the backup storage device. (7) Since this is the most user-friendly part of CP/M, the software arranges that you enter



and interface with CCP directly. (8) The TPA is an area in memory (ie., the area not used by FDOS or CCP) where various non-resident system commands and user programs are executed. (9) Program utilities such as ASM and PIP reside in the TPA and must be reloaded every time the computer is turned on since they do not stay in memory as does a program like DIR. (10) Other examples of non-resident programs are ED and SUBMIT.

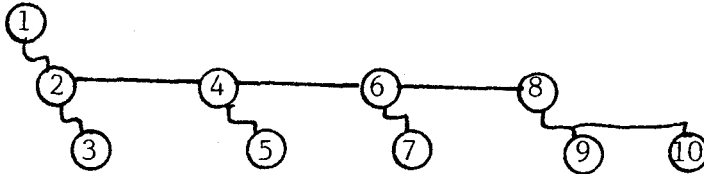


Figure 4- Paragraph and Matrix For A Semitechnical Audience

In neither the expert nor the semitechnical examples do the writers regeneralize at the close of a paragraph. This regeneralization, so characteristic of a student essay paragraph, is the hallmark of paragraphs for the naive technical audience. Expert or semitechnical audiences do not need this generalization. This, too, is logical since both audiences presumably have enough theoretical or background information to draw their own conclusions. The topic sentence provides enough generalization and structure for this group of experts.

By contrast, paragraphs for the non-technical or naive audience do have closing regeneralizations. Presumably this audience, lacking the scope theoretical and background information, cannot generate implications or conclusions from the data. This, then, is the audience for High Technology and

Science Digest. Typical non-technical paragraphs for them have more idea strings but shorter ones. This coincides with the audience's purpose for reading. Since they do not read for technical detail and do not have specialized backgrounds, naive audiences presumably read for what may be called a general overview. They read to "keep up with what's going on", to determine how technical development will effect them, and out of just plain curiosity. They read for the conclusions that apply to them. The paragraph below, written by one of my students typifies this.

(1) When I had enough money, I felt my best alternative was to buy a microcomputer and some software that would make it process words instead of data. (2) Before I went shopping, though, I did quite a bit homework. (3) I went to a few computer shows, (4) I bought practically every magazine on the subject, (5) and I talked to dozens of people who had computers of their own. (6) I set my price range early on so I would not be tempted to overspend on impulse. (7) When the time came to call on sellers, to see what they could offer me, I was ready to choose a microcomputer and software that would do the job for me.

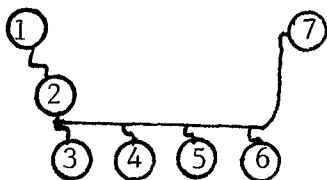


Figure 5- Paragraph and Matrix for a Naive Audience

### Research Hypothesis

If the discourse matrix provides structural insight into 'a grammar of passages', then it may also provide a visible tool for explaining the relationships among sentences, in particular, within a technical paragraph. This study tests the proposition that instruction in the use and interpretation of the discourse matrix can help students produce better-formed technical paragraphs than does traditional paragraph instruction.

To investigate the learning produced by both methods of instruction, my colleagues who participated in the study with me and I taught a particular paragraph form that is commonly used by technical writers addressing technical and semitechnical audiences. For the purpose of this study, this type of technical paragraph was defined as well formed when it met the following five criteria:

1. paragraphs should contain a relevant topic sentence as the first and most general sentence in the paragraph;
2. all the T-units or independent clauses in the paragraph should be relevant to the topic, to the topic sentence and to one another;
3. paragraph should contain two or three idea strings, each string demonstrating at least three levels of generality (including the topic sentence);
4. an idea string should progress by either subordin-

ation (i.e. downward on the matrix drawing) or by subordination and coordination (i.e. downward and horizontally on the matrix drawing) in a general-to-specific pattern;

5. paragraphs should close on a specific T-unit. In other words, technical paragraphs of this type do not generalize as they may do in essays or texts.

To test this hypothesis, I enlisted the help of two of my colleagues at B.C.I.T. and 168 entering students. The full research methodology for this study follows in Chapter 2.

## CHAPTER II

### RESEARCH METHODOLOGY

To test the thesis that students write 'better' technical paragraphs after instruction in matrix analysis than after traditional pedagogy, students were divided into two groups: traditional paragraph instruction was given to the control group (Group T) and matrix analysis instruction was given to the treatment group (Group M). Both groups were tested before and after instruction (a conventional writing sample and a midterm examination) on their ability to meet the five characteristics defined in Chapter 1:

- a relevant, general topic sentence
- only relevant T-units
- two or three idea strings per paragraph
- downward or downward and horizontal movement of idea strings (i.e., no rise in level of generality within an idea string)
- the absence of a closing regeneralization.

When all students had completed their pre- and posttest paragraphs, matrices were drawn for all paragraphs by an experienced, independent analyst whose work had been previously validated. The pre- and posttest paragraph matrices were then scored for the characteristics demonstrated. Students could therefore receive any score between 0 and 5 (depending on how many of the requisite characteristics were present in their paragraphs).

## Sample Composition

The entire group of first-year Electrical and Electronic technology students at the British Columbia Institute of Technology served as test subjects. The subjects were formed into two groups: those who received traditional paragraph instruction and those that received instruction in the use and interpretation of the Nold-Davis matrix. Two instructors and a teaching assistant worked with these basic writers.

The 168 students were first randomly subdivided on a first-come, first-served basis into ten 'sets' or tutorials by the Institute administration. In other words, the first student who was accepted for admission was placed in tutorial A, the second in tutorial B and so on until each tutorial had one student each. The 11th student was then placed in tutorial A, the 12th in tutorial B until each of the ten tutorials contained 16 students. The students would remain in these same tutorials for all their courses throughout their first year.

By the time writing classes had begun in the second week of term, the average number of students had dropped to 14 per tutorial. Some students had applied for, and received, course credit. Others, perhaps sensing that they had enrolled in the wrong program, dropped out of school or transferred to another program.

## Sample Population Assignments

These 10 tutorials for their first year writing classes were then assigned to two lecture instructors and one teaching assistant. Again the placement of students and instructors was an administrative decision based on student and instructor timetabling requirements. For the this reason, tutorials of students were assigned to instructors as follows:

### Instructor M - Treatment- Group M

- lectured in matrix analysis
- instructed in 5 writing tutorials

### Instructor T - Control- Group T

- lectured in traditional composition
- instructed in 2 writing tutorials

### Instructor X - teaching assistant

- no lecture responsibilities
- instructed
  - 2 writing tutorials in matrix analysis  
(Group M- treatment)
  - 1 writing tutorial in traditional  
composition (Group T- control).

Both lecture instructors were experienced at teaching technical writing and specifically at working with electrical engineering technology students.

Both lecture instructors worked from identical course outlines and had access to the same assignments, course materials and rooms. Both instructors were assigned by the administration to teach the same material on the same day but were given the freedom to teach as they wished.

The third instructor, a new and inexperienced teaching assistant, served as a neutral instructor in this study. Her teaching position required her to mirror the teaching methods of any instructor to whom she was assigned. Her presence in the classroom was a serendipitous event, and it was decided to use her to control for instructor bias. If the personality or the teaching ability of either the matrix analysis instructor or the tradition methodology instructor were to influence student scores or introduce unaccounted-for variables, student scores from the same neutral instructor should differ from the control and the experimental instructors. If instructor bias or characteristics were not a significant part in the experimental design, then student scores between the control or treatment instructors and the neutral instructor would not vary.

By instructional method, then, the tutorials were divided:

- Matrix instruction (Group M)
  - Instructors M and X taught seven tutorials
- Traditional instruction (Group T)
  - Instructors T and X taught three tutorials.



## Pretest and Posttest Questions

Pretest Questions: During the first meeting of the writing tutorials, the students in Group T responded to the question: "Why did you choose a science-oriented career?" Students in Group M responded to the question: "Why did you choose B.C.I.T?"

Two weeks after instruction, the posttest was administered to all students on a midterm examination. On this examination, the two pretest questions were reversed. Both groups were asked: "Please respond to the question below in your best technical style". Group T, responded to the question "Why did you choose B.C.I.T.?" while Group M answered the question, "Why did you choose a science-oriented career?"

In the midterm examination, students were treated as nearly alike as possible. The midterm examination was given at the same time to both groups; they sat in a large lecture hall with a sliding wall between them. They were given 60 minutes to respond to two questions: the experimental question and another question, "Please write a short, expanded definition (1 paragraph) on one of the topics listed below: winter, resistance, electrical parameters, physics, impedance, automobile, chemistry, book, hysteresis."

Although the pretest/posttest questions were designed to elicit a general-to-specific paragraph response and were judged to be of the same degree of complexity, reversing the questions was felt to eliminate any

inadvertent bias that might be inherent in one question or the other.

### Instructional Methods

Apart from the instructional method itself, both groups were treated as much alike as was possible in a classroom setting. Both Group M and T were given a single, one-hour lecture on paragraph instruction followed by a single, two-hour writing tutorial. Instructor X, the neutral instructor, attended both lectures but was unaware that she was part of a research study; she was merely given instructions at the beginning of the term to follow each instructor's methods, techniques and teaching style as closely as possible. Since B.C.I.T. was undergoing yet another internal engineering evaluation, it was easy to explain the additional procedures.

After the lecture, all students were given the same writing tutorial assignment to respond to: "Define one of these terms for me: history, electronics, spring, capacitance, mathematics."

The following table summarizes the teaching and testing schedule.

Table 1 Teaching and Testing Timetable

Week	Control	Treatment
1	Pretest Question	Pretest Question
2-5	Other Unrelated Instruction	Other Unrelated Instruction
6	Lecture + Writing Lab	Lecture + Writing Lab
7-8	Other Unrelated Instruction	Other Unrelated Instruction
9	Midterm Exam (posttest question)	Midterm Exam (posttest question)

#### Traditional Instruction

Instructor T taught traditional paragraph composition by lecturing on general-to-specific paragraph structure, stacked lists, topic sentences, transitions and unity. In the lecture he showed model paragraphs of general-to-specific paragraph development and analyzed each sentence in the paragraphs for its contribution to unity, coherence and emphasis.

In the single, two-hour writing tutorial, he or Instructor X showed and analyzed several more sample paragraphs. Students who asked questions were answered in terms of unity, coherence and emphasis. Students were then asked to write a paragraph responding to the writing tutorial assignment: "Define one of these terms for me: history, electronics, spring, capacitance,

mathematics."

This assignment was submitted for marking three days later. When these papers were handed in, Instructor T or Instructor X used identical marking sheets and commented on the student work in terms of unity, coherence and emphasis. The papers were marked and returned to the students.

Matrix Analysis Instruction

Instructor M also lectured for an hour. This lecture described the structural and functional characteristics of a general-to-specific paragraph and of a matrix, and explained the terms coordinate, subordinate and coordinate. The instructor then recalled the concept of general and specific terms, showed a good paragraph and drew the matrix that corresponded to it. From this matrix she interpreted the matrix as a simple circuit. (See Figure 6 below)

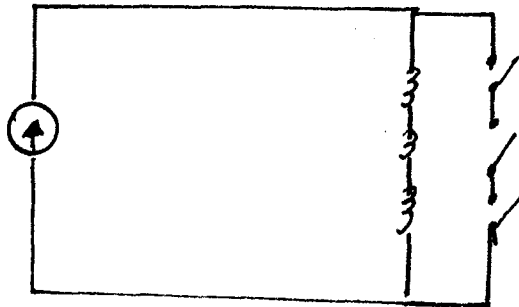


Figure 6 Discourse Matrix As A Simple Circuit

In the following single, two-hour writing lab, the students were given

poorly organized paragraphs and asked to use the matrix to draw these paragraphs' structures. When the poor structure was elucidated, the students were asked to add a sentence or two that completed the structure (and hence the matrix). During this process, the matrix was explained to students who asked for more information. When the instructors wanted to explain a term or show a student a particular relationship (coordination, subordination or superordination) in the student's own writing, they used a matrix drawing.

Students were then asked to respond to the same question the control group did: "Define one of these terms for me: history, electronics, spring, capacitance, mathematics." When the assignments were handed in, Instructor M and Instructor X marked and commented on the assignments using the terms coordinate, subordinate and superordinate. The instructors also drew matrices of the assigned paragraphs on the student's papers and commented on consistencies or inconsistencies in relationship to the matrix drawn for each paragraph. The papers were then returned to the students.

Two weeks after the paragraphs were returned, the posttest was given as part of a midterm examination. After the exams were collected, the posttest questions were photocopied, assigned numbers and given to the matrix analyst (see Introduction).

### Scoring

After the matrices were drawn, the analyst returned them to the author. The

author, working from the numbered matrix only, assigned a point for each of the requisite five characteristics. The data were entered directly into the university computer, together with other data, such as method, tutorial and instructor. (see Table 2)

Table 2 Sample Computer Data

Matrix #	Method	TS 1	IS 1	TU 1	MD 1	CL 1	TS 2	IS 2	TU 2	MD 2	CL 2	Set	Ins
54	1	0	1	0	0	0	1	0	1	0	1	4	1
119	2	1	0	0	0	0	0	0	1	0	1	10	3

Method-1=matrix analysis, 2=traditional instruction

TS 1-Topic sentence, pretest

IS 1-Idea string, pretest

TU 1-Presence of relevant T-units only, pretest

MD 1-Downward/downward + horizontal movement only, pretest

CL 1-No regeneration in the closing sentence, pretest

TS 2-Topic sentence, posttest

IS 2-Idea string, posttest

TU 2-Presence of relevant T-units only, posttest

MD 2-Downward/downward + horizontal movement only, posttest

CL 2-No regeneration in the closing sentence, posttest

Set-Tutorial/set the student was registered in

Ins-Tutorial instructor 1=matrix 2=traditional 3=neutral

### Statistical Procedures

The statistical procedures used were chosen to answer five questions:

- (1) Would the two pretest populations vary statistically from one another? If they did not, then they could be treated as an homogeneous population and changes in the posttest

scores could be attributed to methodology rather than population variance;

(2) Would the pretest and posttest scores vary at all? Presuming the experimental design admitted no other errors, differences in the pre- and posttest scores would reflect the result of instruction.

(3) Would the posttest scores from the control and treatment groups vary significantly from one another? If the project was properly designed, then changes in the total scores would reflect changes due to methodology;

(4) How would the scores vary (if they did)?

(5) On which of the five characteristics would matrix construction scores vary from traditional instruction scores (if they did)?

### Null Hypothesis

The null hypothesis for this study states that no significant difference would be noted between the posttest scores of the matrix analysis and traditional instruction groups. In other words, neither the total scores nor the individual characteristic scores could be significantly different between the control and the treatment groups. If significant differences were found between population means in the posttest scores, then the difference would not spring from a sampling error, and the null hypothesis could be

rejected.

To determine how large the difference should be to reject the null hypothesis, the significance level was set at 0.05 before the pretest questions were administered. "The test of statistical significance, then, permits the researcher to measure the difference between two samples and to make inferences about the populations from which they were drawn."(Borg and Gall, 1979). Another way to look at this is to say that at the 0.05 probability level, the researcher will mistake true difference for sampling error 5 times in 100.

A large difference between population means in the pretest samples would indicate a non-homogeneous population, and, therefore, no methodological difference could be inferred from a non-homogeneous population. If the pretest means were homogeneous, a large difference in posttest population means would allow the researcher to reject the null hypothesis and to conclude that the difference between sample means reflected a real difference between means.

The research hypothesis stated that matrix analysis (method M) was more effective than traditional instruction (method T). Only the positive difference between scores, rather than the positive and negative differences, need to be calculated. This narrows the location of the scores to be observed to the right-hand tail of the distribution curve, so the entire



$p=.05$  lies in the right-hand, or positive, tail. In other words, a one-tailed hypothesis only determines whether the experimental group is better than the control group, not better or worse. (This is important to note because a one-tailed hypothesis does not require as large a difference in mean scores as does a two-tailed hypothesis.) (Elzey, 1974) Choosing a one-tailed hypothesis leaves the researcher open to making Type I errors, rejecting the null hypothesis when it is, in fact, true. However, on the basis of two previous successful pilot studies, I felt justified in selecting a one-tailed hypothesis. Setting the  $p= 0.01$  or greater to compensate for Type I errors would leave the study open to Type II errors, accepting the null hypothesis when it was, in fact, false. Since matrix analysis instruction was a previously untested methodology, I chose a one-tailed hypothesis, aware of the implications of this choice.

### Statistical Analyses

A one-way analysis of variance (ANOVA), which contrasts groups on a single factor, was chosen to answer the questions posed at the beginning of the chapter. Although these were not classical interval data, a variety of rhetorical researchers have treated similar data in a similar fashion. (Fagan, 1981) (Hillocks, 1982) (Gorrell, 1983) This inferential technique allowed me to compare F probabilities, the probability that the variability among mean scores was large enough to reject the null hypothesis. It was used to compare the two pretest populations to determine if they were homogeneous (question 1 above). It also allowed me to contrast the posttest scores from the control and treatment groups (question 2 and 3 above), and

to contrast both the total scores and the individual item scores among groups.

Tests for homogeneity of variance were calculated using a contrast coefficient matrix which provided planned comparisons between two groups although more than two groups were present. This procedure produced, among others, a Bartlett-Box F score composed of an F value and an F probability. This F probability, when  $> 0.05$ , demonstrates homogeneity of variance, an implicit assumption of the T test.

The 0.05 significance level, was chosen for three reasons. First, the 0.05 level indicated only 1 chance in 20 exists that a large or larger difference in score would occur if there was no difference in sample population means, reducing the chance of a Type I error. Second, the 0.05 level is a common one in educational research. (Borg and Gall, 1979) (Elzey, 1974) Third, "statisticians conventionally use the cutoff probability of  $P= 0.05$  for rejecting the null hypothesis". (Elzey, 1974)

Two separate ANOVAs were performed. The first contrasted the effectiveness of the two instructional methods using the students' total scores, the sum of the characteristics successfully met (Analysis 1). The second contrasted the two methods characteristic by characteristic (Analysis 2). Both analyses included contrasts between the lecture instructor (M and T) and the neutral instructor (X).

## Analysis 1

One hundred thirty-six scores, totals of all five characteristics, were used in three contrasts. Sickness, absenteeism and attrition took their toll. By the time the posttest paragraphs were coded, only 136 pre- and posttest samples were available for study. The scores were analyzed by tutorial groups to compute the ANOVA.

- Contrast 1. The total scores, by tutorials, Group M students were contrasted with Group T. Group M contained 7 tutorials (98 students) while Group T contained 3 tutorials (38 students). (Method M, the experimental tutorials contrasted to Method T, the control tutorials.)

- Contrast 2. All the scores in this contrast were drawn from Group M's 7 tutorials. Scores from lecture instructor M's 5 tutorials (83 students) were contrasted to the scores from the neutral instructor X's 2 tutorials (15 students).

- Contrast 3. All scores in this contrast were drawn from the 3 tutorials (38 students) who received traditional instruction. Scores from instructor T's two tutorials (25 students) were contrasted with instructor X's single tutorial (13 students). In other words, contrast 3 replicates contrast 2 but

for the traditional instruction, not the matrix instruction.

### Analysis 2

The same 136 student scores were used in Analysis 2. All data in this analysis, however, represented contrasts in single item scores for each of the five characteristics. In other words, contrasts 1, 2 and 3 were replicated using individual item scores, such as T-unit relevance and topic sentence production, rather than total scores. These data were still grouped by method and tutorial instructors as in contrasts 1, 2 and 3, so the numbers in the groups remain the same. These contrasts were performed after the results of the first three contrasts were known to determine which of the specific characteristics the matrix analysis addressed.

- Contrast 4. Scores from each of the five characteristics were used to contrast matrix analysis instruction and traditional instruction (Method M and Method T).
- Contrast 5. Scores from each of the five characteristics were contrasted by matrix analysis instructor compared to the neutral instructor (Instructors M and X).
- Contrast 6. Scores from each of the five characteristics were contrasted by traditional instructor compared to the neutral instructor (Instructors T and X).

## CHAPTER III

### RESULTS

When the project was originally planned, a one-way ANOVA, using pre- and posttest total scores from the control and treatment groups seemed the most straightforward way to evaluate the data. When a teaching assistant was assigned to the two instructors in the project, three contrasts suggested themselves as a productive way to control for instructor bias, and a contrast coefficient matrix was added. When the results of the the first three contrasts (Analysis 1) demonstrated that matrix analysis instruction scores were significantly higher than the traditional scores, I continued to explore the data statistically in Analysis 2 by looking at the individual characteristic scores

Since the total scores were composed of five individual scores, the second analysis examined and contrasted the individual item scores. Although the second analysis was a post hoc procedure, the results are included here because they extend and clarify my major thesis.

#### Analysis 1 Pretest Scores

To demonstrate that the control and treatment groups were homogenous, that their group scores did not vary significantly from one another, F ratios were calculated on the results of the pretest questions (total scores). The ANOVA, a specialized version of the F test, was used to calculate the

probability of a significant difference at the 0.05 level between the matrix analysis (Group M) and the traditional instruction (Group T) groups' writing scores. If significant differences existed between the control and treatment groups on the pretest question scores, then no comparison could be made of posttest scores because the population would not be homogeneous.

F ratios were carried out by first calculating the mean scores within each group and then comparing them with the estimate obtained from the mean scores of each group to see if they differed significantly. (see Table 3) In this project, the F ratio was 1.424, giving an F probability of 0.1844. This probability (p) is greater than 0.05, indicating that the population was homogeneous and that differences in scores were not the result of sampling error.

Table 3 Pretest F Ratios and Probabilities

Source	Degrees of Freedom	F Ratio	F Probability
Between Groups	9	1.424	0.1844
Within Groups	126		

The variance of the group scores was calculated by first calculating the mean scores for each group (see Table 4 below) and then finding the deviation of each group from the mean. The group deviations were next squared, summed and divided by the total number of groups (the degrees of

freedom plus 1). Next the group and total standard deviations, the measure of variability based on the square root of the squared deviations, were calculated. (The standard deviation is the square root of the squared deviances.) (Elzey, 1974)

Table 4 Total Pretest Score Data

Group	Lecture/Tutorial Instructor	Students per Group	Mean Score	Standard Deviation
1	M/M	15	1.8000	1.2071
2	M/M	12	2.0833	1.4434
3	M/M	13	1.3846	0.8697
4	M/M	18	1.8333	0.7859
5	M/M	14	2.2143	1.1217
6	M/X	11	2.1818	1.0787
7	M/X	15	2.1333	0.9155
8	T/T	13	1.1538	1.0682
9	T/T	11	1.8182	0.9816
10	T/X	14	2.0714	1.2067
Total		136	1.0876	1.0874

Last, the between-group and within-group variance, the F ratio, was calculated. Its reflection in the F probability of 0.1844 was not statistically significant because it was larger than 0.05. Since the differences in the pretest sample scores by group were not significant, Groups M and T were considered to be homogeneous.

The pretest contrasts, listed below, also demonstrated that the populations were homogeneous:

- Contrast 1-Method M (matrix analysis) compared to Method T (traditional)

- Contrast 2-Instructor M compared to Instructor X  
(matrix analysis only)
- Contrast 3-Instructor T compared to Instructor X  
(traditional method only)

In the three pretest contrasts, the T probabilities were all greater than 0.05, demonstrating that the populations involved in the contrasts were homogeneous (an implicit assumption of the T test) as Table 5 below demonstrates. This is exemplified by the F values of .827 and the F probability of .592 in the Bartlett-Box F. (T values and T probabilities from pooled variance estimates were reported when the results demonstrated homogeneity of variance. T values and probabilities from separate variance estimates were reported when the results did not demonstrate homogeneity of variance because of method in which the computer calculated the data.)

Table 5 Pretest Contrast Coefficient Matrix

Contrast	T Value	T Probability
1	1.290	0.200
2	-1.1878	0.238
3	-1.621	0.107
Bartlett-Box F	.827	.592

#### Analysis 1 Posttest Scores

The data suggest that matrix analysis is a useful method for teaching para-



graph organization to electrical engineering technology students. The posttest scores demonstrate a statistically significant difference created by instruction. The F probability was 0.0233, less than 0.05. This indicates that the probability of such a change occurring randomly between pretest and posttest scores was only 2.33 in 100. The populations were no longer homogeneous, and clearly the next step was to assess which contrasts were significant. (see Table 6 below)

Table 6 Posttest Ratios and Probabilities

Source	Degrees of Freedom	F Ratio	F Probability
Between Groups	9	2.243	0.0233
Within Groups	126		

The variance of the posttest scores below in groups M and T demonstrates both a significant change in the Group M scores and in the amount of change present. Clearly then, both groups changed their writing scores as the result of instruction.

Table 7 Total Posttest Score Data

Group	Lecture/Tutorial Instructor	Students per Group	Mean Score	Standard Deviat.
1	M/M	15	2.7333	1.8310
2	M/M	12	3.3333	1.7233
3	M/M	13	3.3846	1.5021
4	M/M	18	3.1667	1.2948
5	M/M	14	2.7143	1.6376
6	M/X	11	3.0909	1.7003
7	M/X	15	3.5333	1.0601
8	T/T	13	1.7692	1.1658
9	T/T	11	2.1818	1.1677
10	T/X	14	2.1243	1.1883
Total		136	2.8309	1.5034

The posttest contrast coefficient matrix presented interesting data. If the null hypothesis was to be refuted, then the probability of the higher scores from the experimental group compared to the control group (contrast 1) would be the result of the treatment and not a random phenomenon. A T value of 3.891 and a T probability of 0.000 demonstrated that the values were significant at both the 0.05 and the 0.001 level. (see Table 8 below) Homogeneity of variance was demonstrated in the F scores as well.

Table 8 Posttest Contrast Coefficient Matrix

Contrast	T Value	T Probability
1	3.891	0.000
2	-0.735	0.464
3	-0.491	0.624
Bartlett-Box F	.961	0.470

Contrast 2, Instructor M compared to Instructor X (both matrix analysis instructors, presented relevant data as well. If only the instructor rather than the teaching method was responsible for the change between the treatment and the control groups rather than the teaching method, then the two different instructors would influence groups in different ways. In other words, T probability scores between the two instructors would be low if the populations scored differently (heterogeneous populations) and high if the populations scored alike (homogeneous populations). The T probability of 0.464 was non significant; the populations were an homogeneous group.

Contrast 3's results were much like those of Contrast 2. This contrast compared the scores from instructor T and instructor X. A similar T value and T probability demonstrated that these populations, too, could be considered homogeneous between these two instructors.

#### Analysis 2 Pre- and Posttest Scores

Analysis 1 affirmatively answered the question, "Does matrix analysis help students write 'better formed' technical paragraphs than traditional pedagogy?" Analysis 2 investigated the number and kinds of changes that both matrix analysis and traditional instruction produced in students.

Again a one-way ANOVA and a contrast coefficient matrix were used to compare group scores on each of the five criteria. This created five sets of comparisons, one for each criterion.

The same three contrasts were used for Analysis 2:

- Contrast 4-Method M (matrix analysis) compared to Method T (traditional)
- Contrast 5-Instructor M compared to Instructor X (matrix only)
- Contrast 6-Instructor T compared to Instructor X (traditional only)

### Topic Sentence

#### Pretest

The pretest data demonstrate that the sample populations were homogeneous, as in Analysis 1. (see Table 9 and 10 below) F probabilities of greater than 0.05 demonstrated that differences in scores were not significant. As well, all the variance estimates from the three contrasts were non-significant. As in Analysis 1, Bartlett-Box F probabilities demonstrated homogeneity of variance.

Table 9 Pretest Topic Sentence Values

Source	F Ratio	F Probability
Between Groups	1.754	0.0836

Table 10 Pretest Topic Sentence Contrast Coefficient Matrix

Contrast	T Value	T Probability
4	0.123	0.902
5	-1.319	0.190
6	-0.977	0.320
Bartlett-Box F	0.070	p=1.000

Pretest and posttest student scores appear below in Table 11 below.

Table 11 Pre-and Posttest Topic Sentence Scores

Group	Lecture/Tut. Instructor	Pretest Mean + Std. Dev.	Posttest Mean + Std. Dev.
1	M/M	0.4000/0.5071	0.6667/0.4880
2	M/M	0.5833/0.5149	0.8333/0.3892
3	M/M	0.3077/0.4804	0.7692/0.4385
4	M/M	0.7222/0.4609	0.8889/0.3234
5	M/M	0.5000/0.5189	0.5714/0.5136
6	M/X	0.6364/0.5045	0.6364/0/5045
7	M/X	0.6667/0.4880	0.8667/0.3519
8	T/T	0.2308/0.4385	0.4615/0.5189
9	T/T	0.7273/0.4671	0.7273/0.4688
10	T/X	0.6429/0.4972	0.7143/0.4688
TOTAL		0.5441/0.4999	0.7206/0.4504

## Posttest

Comparison of the pre- and posttest total scores above demonstrate that instruction in topic sentences did produce results, a reassuring note for all writing teachers. The contrasts demonstrate that both methods increase topic sentence production. (see Table 12 below).

Table 12 Posttest Topic Sentence Coefficient Contrast Matrix

Contrast	T Value	T Probability
4	1.328	0.190
5	-0.054	0.957
6	-0.798	0.426
Bartlett-Box F	0.697	p=.712

The T probability of 0.190 ( $>0.05$ ) indicates that the differences between the groups were not significant. Combined with the increase in total mean scores, this indicated that both the matrix analysis and traditional groups produced more topic sentences after instruction. The Bartlett-Box F probability of  $> 0.05$  indicated that there is still homogeneity of variance.

## Idea Strings

### Pretest

The pretest data again demonstrated that the populations were homogeneous with respect to this characteristic as well. The F probabilities and Bartlett-Box F values (Tables 13 and 14) were all  $>0.05$ .

Table 13 Pretest Idea String Values

Source	F Ratio	F Probability
Between Groups	0.953	0.4825

Table 14 Pretest Idea String Contrast Coefficient Matrix

Contrast	T Value	T Probability
4	-0.297	0.767
5	0.587	0.558
6	-1.229	0.221
Bartlett-Box F	1.346	p= .216

## Pretest

Pre- and posttest mean scores appear below in Table 15.

Table 15 Pre- and Posttest Idea String Scores

Group	Lecture/Tut. Instructor	Pretest Mean + Std. Dev.	Posttest Mean + Std. Dev.
1	M/M	0.0667/0.2582	0.2667/0.4577
2	M/M	0.2500/0.4523	0.5000/0.5222
3	M/M	0.0769/0.2774	0.6154/0.5064
4	M/M	0.0/0.0	0.2222/0.4278
5	M/M	0.2143/0.4258	0.4286/0.5136
6	M/X	0.0909/0.3015	0.4545/0.5222
7	M/X	0.0667/0.2582	0.4667/0.5164
8	T/T	0.0769/0.2774	0.0769/0.2774
9	T/T	0.0909/0.3015	0.0/0.0
10	T/X	0.2143/0.4258	0.2857/0.4688
TOTAL		0.1103/0.3144	0.3309/0.4723

## Posttest

Comparison of pre- and posttest scores indicated that matrix analysis instruction in idea strings did change the total score, and the contrast demonstrate in which group the changes were significant (see Table 16 below).



Table 16 Posttest Idea String Contrast Coefficient Matrix

Contrast	T Value	T Probability
4	3.459	0.001
5	-0.516	0.607
6	-1.623	0.107
Bartlett-Box F	.760	p= .638

Relevant T-Units

Pretest

The pretest data indicated that the populations were homogeneous (see Table 17 below) between groups.

Table 17 Pretest T-Unit Values

Source	F ratio	F probabilities
Between	1.613	0.1131

However, the pretest contrast coefficient matrix indicated that the matrix analysis group was significantly different than the treatment group as shown by the T probability of 0.018 in Table 18 below.

Table 18 Pretest T-Unit Contrast Coefficient Matrix

Contrast	T Value	T Probability
4	2.403	0.018
5	-1.658	0.100
6	-1.687	0.094
Bartlett-Box F	.912	p= .513

The T probability of 0.018 ( $< 0.05$ ) was significant since it represented groups who already wrote many relevant T-units in their paragraphs. The probabilities, therefore, from contrasts 5 and 6 were not significant. Contrast 5 and 6 represent the comparison between instructors M and X and T and X respectively.

Pretest and posttest mean scores and standard deviations appear in Table 19 below.

Table 19 Pre- and Posttest T-Unit Scores

Group	Lecture/Tut. Instructor	Pretest Mean + Std. Dev.	Posttest Mean + Std. Dev.
1	M/M	0.8000/0.4140	0.8000/0.4140
2	M/M	0.6667/0.4924	0.8333/0.3892
3	M/M	0.5385/0.5189	1.0000/0.0
4	M/M	0.7222/0.4609	0.9444/0.2357
5	M/M	0.7857/0.4258	0.8571/0.3631
6	M/X	0.8182/0.4045	0.9091/0.3015
7	M/X	0.9333/0.2582	0.8667/0.3519
8	T/T	0.4615/0.5189	0.7692/0.4385
9	T/T	0.4545/0.5222	0.9091/0.3015
10	T/X	0.7143/0.4688	0.7857/0.4258
TOTAL		0.6985/0.4606	0.8676/0.3401

Posttest

The table above demonstrates that student total posttest scores improved. The data from Table 20 below, however, show that none of the contrasts were significant. Contrast 4, Method M compared Method T, with a probability of 0.322 indicates that both groups improved equally, the groups were homogeneous still.

Table 20 Posttest T-Unit Contrast Coefficient Matrix

Contrast	T Value	T Probability
4	0.944	0.322
5	-0.011	0.991
6	0.461	0.646
Bartlett-Box F	1.026	p= .413

Again the contrasts between Instructor M and X and between T and X are not significant, demonstrating uniformity of method between instructors. The Bartlett-Box F of .413 demonstrated homogeneity of variance.

Movement Downward

Pretest

Pretest data demonstrated (Table 21) that the populations were homogeneous between groups.

Table 21 Pretest Movement Downward Values

Source	F Ratio	F Probability
Between Groups	1.526	0.1456

Homogeneity of variance was present, and the pretest contrasts were not

significant as Table 22 show.

Table 22 Pretest Movement Downward Contrast Coefficient Matrix

Contrast	T Value	T Probability
4	-0.450	0.653
5	0.078	0.935
6	-0.931	0.364
Bartlett-Box F	.956	p= .469

Pretest and posttest mean scores and standard deviations are shown in Table 23 below.

Table 23 Pre/Posttest Movement Mean Scores and Standard Dev.

Group	Lecture/Tut. Instructor	Pretest Mean + Std. Dev.	Posttest Mean + Std. Dev.
1	M/M	0.1338/0.3519	0.4667/0.5164
2	M/M	0.1667/0.3892	0.5000/0.5222
3	M/M	0.1538/0.3755	0.4615/0.5189
4	M/M	0.0.0/0.0	0.4444/0.5113
5	M/M	0.4286/0.5136	0.3571/0.4972
6	M/X	0.2727/0.4671	0.5455/0.5222
7	M/X	0.0667/0.2582	0.5333/0.5164
8	T/T	0.1538/0.3755	0.1538/0.3755
9	T/T	0.1818/0.4045	0.0909/0.3015
10	T/X	0.2857/0.4688	0.2143/0.4258
TOTAL		0.1765/0.3826	0.3824/0.4878

### Posttest

The posttest data demonstrated that, although the mean total was increased, only the change between Group M and T was significant. (Table 24 below)

Table 24 Posttest Movement Contrast Coefficient Matrix

Contrast	T Value	T Probability
4	3.465	0.001
5	-0.841	0.402
6	-0.569	0.571
Bartlett-Box F	.624	p= .778

Contrast 4 demonstrated that the score differences between Group M and T was 0.001, significant at the 0.05 level. Contrasts 5 and 6 indicated that the differences between Instructor M and X and Instructor T and X were not significant. Again homogeneity of variance was maintained.

Closing

### Pretest

The pretest data indicated that no significant differences appeared. Table 25 and 26 demonstrate that the pretest populations were homogeneous and that homogeneity of variance was present.

Table 25 Pretest Closing Values

Source Between Groups	F Ratio 0.312	F Probability 0.9697
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Table 26 Pretest Closing Contrast Coefficient Matrix

Contrast	T Value	T Probability
4	1.032	0.304
5	-0.196	0.845
6	0.507	0.613
Bartlett-Box F	0.104	p= 1.000

Pretest and posttest mean scores and standard deviations are listed below in Table 27.

Table 27 Pre- and Posttest Closing Mean Scores and Std. Dev.

Group	Lecture/Tut. Instructor	Pretest Mean + Std. Dev.	Posttest Mean + Std. Dev.
1	M/M	0.4000/0.5071	0.5333/0.5164
2	M/M	0.4167/0.5149	0.6667/0.4924
3	M/M	0.3077/0.4804	0.5385/0.5189
4	M/M	0.3889/0.5016	0.6667/0.4851
5	M/M	0.2857/0.4688	0.5000/0.5189
6	M/X	0.3636/0.5045	0.5455/0.5222
7	M/X	0.4000/0.5471	0.8000/0.4140
8	T/T	0.2308/0.4385	0.3077/0.4804
9	T/T	0.3636/0.5045	0.4545/0.5222
10	T/X	0.2143/0.4258	0.2143/0.4258
TOTAL		0.3382/0.4749	0.5294/0.5010

## Posttest

Table 27 above demonstrated that posttest mean scores were higher than pretest scores. Table 28 below indicates that the T probability of 0.003 in Contrast 4, Group M versus Group T, showing significant difference. Again, both Contrast 5 and 6 probabilities were not significant, and homogeneity of variance was present.

Table 28 Posttest Closing Contrast Coefficient Matrix

Contrast	T Value	T Probability
4	2.995	0.003
5	-.0811	0.419
6	1.013	0.313
Bartlett-Box F	0.174	p= .997

## Improvements

The table below demonstrates that Group M students, the matrix analysis groups, scored higher in all five characteristics than did Group T, the traditional instruction students. In three characteristics, idea string production, movement downward and non-generalized closing, the differences were statistically significant. In topic sentence production, the increase was not statistically significant. In the production of relevant T-units, the pretest populations were not homogeneous, so no statistical comparisons could be made.



Table 29 Comparison of Groups M and T Mean Scores and Std. Dev.

Charact.	Groups M Mean/ + Std. Dev.	Group T Mean/ + Std. Dev.	Posttest Mean Differen.
TS pre	0.5452/0.4284	0.5336/0.4676	M>T 0.2626
TS post	0.7475/0.4298	0.5849/0.4816	
IS pre	0.2262/0.2819	0.1273/0.2977	M>T 0.3012
IS post	0.4220/0.4952	0.1208/0.2487	
TU pre	0.7520/0.4250	0.5434/0.5033	M>T 0.0659
TU post	0.8872/0.2936	0.8213/0.3886	
MD pre	0.1745/0.3365	0.2071/0.4162	M/T 0.5896
MD post	0.7426/0.4412	0.1530/0.3676	
CL pre	0.3661/0.4977	0.2696/0.4563	M>T 0.2817
CL post	0.6072/0.4954	0.3255/0.4761	

### Refuting the Null Hypothesis

#### Analysis 1

The results of Analysis 1, based on total scores, indicate that the null hypothesis should be rejected and the research hypothesis tentatively accepted. In contrast 1, matrix analysis versus traditional methodology, the matrix analysis groups' scores were significant at the  $p=0.05$  level. The probability that such a difference in scores resulted from a sampling error was 0.001.

Contrasts 2 and 3 were designed to determine if changes in scores resulted from the differences in methods rather than the difference in instructors. The pre- and posttest mean scores in Contrast 2 (Instructor M compared to Instructor X) and Contrast 3 (Instructor T compared to Instruc-

tor X) were not significant. In other words, the pre- and posttest scores from the neutral instructor fell close to those of the matrix analysis instructor in Contrast 2 and close to those of the traditional instructor in Contrast 3. This is an important finding because the results were shown to depend on the method used rather than on any special characteristic of the instructor. Because the neutral instructor was a young, beautiful woman teaching an all-male group close to her age, it is a strong indication of the power of the matrix analysis instruction that not even her powerfully attractive presence affected any of the variance scores, all groups maintaining homogeneity of variance in all pre- and posttest results.

#### Analysis 2

Analysis 2 compared scores on the individual characteristics. Throughout Analysis 2, Instructor X's scores were not significantly different than either lecture instructor's scores. In other words, as in Analysis 1, her tutorials' mean scores agreed significantly with those of Instructor M in Contrast 5 and with those of Instructor T in Contrast 6. The importance of these findings is clear. Both matrix analysis and traditional practices were taught effectively by an inexperienced instructor with no training or assistance from the lecture instructors. The fact that her scores were consistent with those of the lecture instructors demonstrated that, even in inexperienced hands, both matrix analysis and traditional instruction created reproducible changes in writing behavior.

Since the results of Contrasts 5 and 6 are not significant and the neutral instructor's scores are significantly like those of her two lecture instructors, the data from Contrasts 5 and 6 will be subsumed in a broader discussion of Contrast 4.

In topic sentence production, Groups M and T were not different before instruction. After instruction, Group M's tutorials had achieved higher mean scores than had Group T (mean M=0.7475; mean T=0.4849). However, when the pre- and posttest scores were compared, the difference was not significant. Both groups had improved their ability to write relevant topic sentences at the beginning of a paragraph.

In idea string production, the groups were homogeneous before instruction. After instruction, Group M achieved higher mean scores, and this difference was significant (mean M=0.4220; mean T=0.1208). In fact, Group T's score declined slightly from pretest means of 0.1273 to the posttest mean above, and this difference was significant. Only Group M wrote more idea strings; the traditional group actually wrote fewer.

In the production of relevant T-units, the pretest population was non-homogeneous (pretest mean M = 0.7502; pretest mean T = 0.5434) so the ANOVA was not valid. Group M scored significantly higher on the pretest, demonstrating that they could already produce either many relevant T-units. Although Group M group achieved slightly higher posttest scores (mean M = 0.8872; mean T = 0.8213) no posttest comparisons were possible because of

pretest sampling error. Clearly, however, both groups could produce more relevant T-units after instruction.

Both the pretest and posttest populations were homogeneous for the downward movement characteristic. After instruction, Group M achieved significantly higher scores than Group T (mean M = 0.7426; mean T = 0.1530). Group M were successful in explaining, exemplifying or continuing their ideas. Not only were Group T unsuccessful in explaining, exemplifying or continuing their ideas, but they wrote fewer coordinate or subordinate T-units after instruction than they did before (pretest mean = 0.2071; posttest mean = 0.1530).

In analyzing the requisite closing characteristic, Groups M and T were homogeneous before and after instruction. Group M's score was significantly higher (mean M = 0.6072; mean T = 0.3255) after instruction. Group M was able to reproduce the characteristic non-generalized closing of a technical paragraph while Group T was not.

Students in Group M improved their scores and scored higher than those in Group T on all characteristics tested for and significantly higher scores on three of these: idea string production, downward movement and characteristic closing. Students in Group T improved their scores on topic sentence production, relevant T-units and characteristic closing. On idea string production and downward movement their posttest scores were lower than their pretest ones.

## CHAPTER IV

### Discussion

This small study, using a unique student population, poses several questions. Does discourse matrix instruction significantly change the way students write? If so, how do these changes compare to those created by traditional instruction? And insofar as there are changes, why might they occur?

First, does matrix analysis change the way students write and help them write paragraphs closer to the desired pattern than does traditional instruction? Based on both total score and the individual characteristic ANOVAs, the answer would be that it does.

In the total-score ANOVA (Analysis 1), the three groups were not significantly different before instruction, and the neutral instructor's scores were not significantly different from the lecturers' scores. In Analysis 1, the matrix analysis group improved its scores from a pretest mean of 2.0900 to posttest mean of 3.1366 while the traditional group's scores changed from a pretest mean of 1.6811 to a posttest mean of 2.0817. The probability of this change occurring through random sampling error was 0.000. Clearly, both methods produced improvement, but the change in the matrix analysis group was far greater. Analysis 2 helped further explain the kinds of changes that created the higher scores.

In the individual-characteristic ANOVA (Analysis 2), each characteristic of the desired paragraph structure was examined separately. Matrix analysis instruction was contrasted with traditional instruction by characteristic. The neutral instructor's pre- and posttest scores were not significantly different in this part of the study from those of the lecturers, so her groups' scores were reported as part of either the matrix analysis or traditional group scores.

All pretest groups were homogeneous, except in the relevant T-unit characteristic. The matrix analysis group's pretest scores indicated that they could already produce many relevant T-units, and, therefore, no comparisons could be carried out for this characteristic. Nevertheless, the matrix analysis group improved their posttest mean scores.

The remainder of the individual comparison scores demonstrates that matrix analysis instruction does indeed help students write better-formed paragraphs than does traditional instruction. In the production of idea strings and the production of idea strings by coordination and subordination only, the matrix analysis group's scores improved significantly: idea string production, 0.4220 (matrix) compared to 0.1207 (traditional); the production of idea strings by coordination and subordination only, 0.7426 (matrix) compared to 0.1502 (traditional). One especially interesting finding was that the traditional group scores declined after instruction from 0.1273 to 0.1207 for the production of idea strings and from 0.2071 to 0.1503 for the production of idea strings by coordination and subordination only.

In producing a final sentence without a regeneralization or summary statement, the matrix analysis group demonstrated significant improvement over the traditional method group. In relevant topic sentences, the matrix analysis group again improved their scores, though both groups improved their scores in this area, and the improvement of the matrix analysis group was not significantly better than the traditional instruction group. In other words, both groups wrote more relevant topic sentences after instruction.

In matrix analysis pedagogy, interactions between the student and the matrix with its attendant concepts, vocabulary, structure and cues undoubtedly produced most of the learning. The resulting change was not due to teaching expertise since the scores did not vary significantly between Instructor M and X and between Instructors T and X. Matrix analysis methodology, therefore, must have been responsible. In this study, matrix analysis was a powerful technique that produced significant changes in student writing, even in the hands of an inexperienced instructor.

I believe matrix analysis instruction helps students write better formed paragraphs because it is an imaginative and sophisticated reconceptualization of dispositio, a department of rhetoric that has been in virtual eclipse since Peter Ramus and Francis Bacon (Corbett, 1971) and because it provides active rather than passive learning during writing instruction.

## Theoretical Soundness

The discourse matrix has both theoretical and empirical roots in the New Rhetoric, the process approach to the development of writing abilities and in recent work in the psycholinguistics of reading. From Christensen's work on patterns of modification in the sentence and the paragraph (Christensen, 1963, 1965 through the analysis of cognitive processing by Kintsch and Vipond (1975), rhetoricians have explored the structure of large units of discourse to explain how writers structure the material within paragraphs and how readers make sense of the propositions in these larger units.

Recent applications of frame theory help explain the connection between the ways readers process text and the way writers, in their texts, can facilitate this processing. Readers read most efficiently when they consciously or subliminally recognize textual patterns (Kintsch and Vipond, 1975). The crucial construct from both empirical and theoretical work is that readers must in some way mentally represent the gist of the semantic structure of the text.

Kintsch (1975) argues that the knowledge that readers need to comprehend a text functions like a frame or scaffold to create the conceptual framework. This frame may be considered as the conceptual counterpart of what Smith (1978) calls "nonvisual information", the prior knowledge behind the reader's eyes that reduces uncertainty in advance and thus permits identification decisions with less visual information. Ausubel subsumed this



concept in his "advance organizers" that provide both the structure and the relationships within it (Ausubel, 1968). All of these appear to be the embodiments of Burke's definition of form.

Recently, Witte (1983) found student writers who, during revision, could not separate sentences that supported the gist from those that did not support the gist. He hypothesized that these students were unable to recognize the semantic hierarchy of the text, and thus perhaps tended to either revise only at the word and sentence level or failed to evaluate the semantic structure against their intentions. In either case, these students would seem to have lacked a frame necessary for comprehension.

In original composition as well, writers should provide frames for their readers so textual material can be understood immediately. The data from the relevant T-unit characteristic demonstrate that discourse matrix analysis allowed students simultaneously to visualize the hierarchical relationships and to support or extend their topic sentence with relevant T-units. This allowed them more nearly to match the pattern they wished to create and to discard supporting ideas, that did not support the semantic gist of their texts. The matrix diagrams students created formed both a conceptual and a visual frame for the creation and revision of text.

### Flexible, Visible Analogies

Matrix analysis instruction provides teachers with the opportunity to com-

pare the relationships within a paragraph to a concept or model students already know. In other words, the pedagogy provides a built-in, analogy-generating model that teachers of various disciplines can adapt. By providing an "analogy bridge" between what students know and what they have to learn, matrix analysis puts information about composition in a familiar frame and decreases the number of new concepts students must learn.

For instance, I wrote a good technical paragraph and drew the corresponding matrix as a circuit with a current supply, resistors, capacitors and inductors so on. I then compared the reader's progress through that paragraph to the flow of current through a circuit if the path was interrupted. Irrelevant T-units became unintended short circuits, increasing specificity, represented as downward movement on the matrix, became current levels; the upward movement from a lower-level T-unit to a higher one became a switch and so on. Thus the characteristics of components and circuits, with all their concomittant concepts, were represented in the matrix and its corresponding paragraph. As well, the idea of changing components in a circuit, which would alter the circuit, extended the idea of audience and revision. Students came to look on different types of audiences as resistors and silicon-controlled rectifiers, and revision became routine troubleshooting. Paragraph structure became simple circuitry; its composition and structure were reduced to understandable, 'moveable' subunits that had some connection both with the concept previously learned of rhetorical situation and with the principles of electrical circuitry.

One of the author's colleagues taught matrix analysis to nursing students, comparing the matrix to the nursing hierarchy in a large hospital ward or a suite of operating rooms. The author, lecturing a group of mechanical engineering students, explained a matrix by analogy with the hydraulic system on a ship. With both groups, the analogies drawn from their own disciplines were readily accepted by the students. After it was explained that a matrix diagram traces the readers' path through a paragraph as a nurse would follow a routine procedure or as a technologist would investigate a system, explaining paragraph patterns and revision proved to be a relatively simple task. Part of the power of matrix analysis here lay in its potential to clarify paragraph organization and structure for audiences of widely different backgrounds and from widely different disciplines in ways they could easily recognize and understand. In other words, the analogy provided an adaptable cognitive link between what students already knew and what they were to learn.

Students were also able to "see" why the structures taught were easier for the audience to understand: fewer switches or unintended grounds, fewer confrontations with a grumpy head nurse, fewer pressure blockages. Now the length and number of particular idea strings and the length of a paragraph for a particular audiences were clear for students.

This coincides with Kintsch and Vipond's (1975) work on readability of different types of text. They suggest that the load placed on short term memory is inversely proportional to a text's readability, and that the load

is greater when the reader goes from one new topic or subtopic to another new one than when he stays within a topic or sub-topic. In other words, when a reader reads 'down' an idea string, a smaller load is placed on short term memory than when he changes topics in a regeneration (or presumably in a non-sequitur). Since the structure of the technical paragraph that was taught is list-like, contained only three or four sub-topics as idea strings and used few upward-moving generalizations, these paragraphs that put little load on short term memory made 'visual sense' to students.

### Visual and Visible Involvement

Matrix analysis instruction involves the student in a new writing/seeing/listening/doing pedagogy. Specifically, matrix analysis instruction provides a visual/spatial, symbolic pattern that the student can follow or use to generate new information, sets out "rules" for the pattern and provides a flexible, visible analogy for students from many disciplines.

Most composition instructors have had the experience when teaching traditional methodology that some students simply intuited the right information and produced excellent work. Those same instructors have also worked with students who went through writing classes "AWKing and FRAGing", as Andrea Lunsford said in a B.C.I.T. seminar in 1982. In my heart of hearts, I attributed my students' successes to my superior teaching skills and good choice of techniques. My poorer students I filed away in my mind as uncaring, dyslexic, lazy or stupid. Their lack of success, when their peers succeeded so brilliantly, was never the fault of the method or the

instructor. Matrix analysis now appears to provide some possible explanations, other than those offered above, for the poor performance from the less able group of writers.

Matrix analysis may have some inherent advantage or appeal for many students who have not intuited the highly auditory, traditional methodology, if only by adding more visible information to the auditory information of traditional instruction. By their own reports, the physical matrix on the page allows students to "see" the paragraph as they want it or have written it. This "seeing", however, may be a different kind of reading, a type of pattern recognition rather than simply word recognition.<sup>1</sup>

For these outspoken writers, and perhaps for other less vocal ones, the matrix may be a symbolic, visual/spatial representation. In this context, visual/spatial and symbolic are distinctly different. The matrix is a visual representation on paper of a rhetorical concept, the patterns of sentences within a text. The visual aspect is novel in rhetoric since traditional instruction has depended exclusively on intuition, on memory, or on the abstract representations of paragraph shape such as a pyramid or keyhole to describe the relationships within a paragraph. Since traditional instruction has no way, either graphically or conceptually, to represent the relationships among T-units either on paper or in students' minds, students usually learn by intuition or not learn at all.

The symbolic, right-brain nature of the matrix makes conspicuous the hierarchical relations between T-units, seen on the up/down and right/left axis

of the matrix. Since the students in the study use symbols routinely and well, this kind of a tool appears to be a powerful and long lasting one and one that can be recreated quickly. The posttest data on the movement downward characteristic demonstrated that the downward or horizontal movement of T-units was significantly increased in the matrix analysis group.

The symbolic structure of the matrix helped students generate and explain technical data in greater depth, as the significant data from the idea string section in Analysis 2 demonstrated. This may have occurred because students simply recognized that, after they had written a paragraph and drawn a matrix, part of the structure was missing. In this way, the matrix may have acted as a heuristic that said, "Finish that!" or "Fix that!"

The visual/spatial aspect of the matrix is harder to explain within the discipline of rhetoric, but cognitive psychology and neurology provide some answers since propositional relations parallel logical structures. "The main theme to emerge...is that there appear to be two modes of thinking, verbal and non-verbal, represented rather separately in left and right hemispheres, respectively, and that our educational system, as well as science in general, tends to neglect the non-verbal form of intellect." (Sperry, 1973)

These two modes of thinking are commonly represented by the two sides of the brain. The left hemisphere is the "...analytical, verbal, figuring-out, sequential, symbolic, linear mode." (Edwards, 1979) The right hemi-

sphere is the visual, spacial, perceptual, creative side of the brain. (Edwards, 1979) The visual/spacial and symbolic characteristic of the matrix may then accesses both the verbal and the non-verbal sides of the brain, making the highly verbal task of technical writing more easily processed by students who may have a stronger visual/perceptual learning mode than an analytical/verbal one. Indeed, this student who does not learn in the traditional left brain way may have, and in the author's experience does have, great problems with the spare prose and highly structured forms of technical writing.

Traditional instruction does not have a structure to represent an idea string and has only a limited way of expressing the concept of development. As teachers, we all know what we mean by adequate paragraph development, but that concept is hard to explain and teach using the look-and-analyze method. Students really can only examine and analyze models and draft their own text. They must rely on an instructor's feedback to check how successful their experiments with patterns and techniques have been. Traditional methods do not go beyond asking the student to support a statement or simply naming conventional methods of development. It was at best a fragmentary methodology.

Disourse matrix analysis, on the other hand, unifies many concepts and techniques. It allowed teachers to discuss and exemplify the cognitive structures and tasks involved in reading, writing and thinking in one overarching concept. Matrix analysis lets students generate form and content, as

they did in this study. Beyond this study, the author's students have been led by a discourse matrix through the levels of generality to create their own generalities for summaries. They have used the same matrix and identical texts to write summaries focused on different audiences and have written conclusions based on inferences they drew from the information in a discourse matrix. They have used the discourse matrix to extend not only what they thought but how they thought it.

### Rule Generating

A discourse matrix may also have acted in "...some manner of taking an original theme and copying it by an isomorphism or information-preserving transformation". (Hofstadter, 1980). This isomorphism produces/creates what Hofstadter calls "a recursively enumerable set", a set of rules that can be generated from a set of starting points (axioms), by repeated application of the rules of inference. "Recursive enumeration is a process in which new things emerge from old things by fixed rules". (Hofstadter, 1980) In Godel, Escher, Bach: An Eternal Golden Braid, he used Fibonacci and Lucas numbers and simple, sentence-level text as examples. In this study, the information-preserving transformations allowed students to generate the axioms for the patterns they wished to produce or revise.

The student may draw a matrix on paper before he writes the paragraph and use this skeleton matrix to guide him through the writing task as students in this study did in their writing labs. (Students referred to this



task as "writing through" a paragraph.) In this way the matrix also acted as a heuristic, causing students to generate, change, delete or move related or unrelated data. In that sense, the visual matrix acted as both an aid to invention and ad hoc troubleshooting tool when an instructor or a student "felt something was wrong" with a paragraph or something has been left unfinished as Instructors M and X did in this project.

In the technical paragraph taught, the five characteristics of the study provided the visible axioms for this recursive enumeration to function: the topic-sentence-first order; the depth of the idea strings; the movement downward or horizontally; the inclusion of only relevant T-units; the non-generalized closing. Here the discourse matrix acted to let form function as an invention or revision heuristic.

### Complete Vocabulary

The complete vocabulary of coordination, subordination and superordination, shared between teachers and students, named the hierarchial relationships between propositions (as T-units), a task not possible in traditional instruction. Although it is somewhat outside the scope of this study, personal comments from students and faculty may explain some of the classroom 'power' of this enlarged vocabulary. One of the author's colleagues mentioned that merely naming the new relationship, simply knowing that superordination existed as a relationship with a name made it easier to explain certain kinds of poor paragraph structure.

Students themselves commented that the three relationships are similar to equal to (=) (coordination), less than (<) (subordination) and greater than (>) (superordination) in a mathematical sentence, the same ones used at the junior high school level in Project Literacy . Since many engineering technology students are more comfortable with mathematical abstractions and their associated symbols, this was immediately useful because it came with its own built-in analogy. The expanded vocabulary, then, was not only shared between students and teachers but between disciplines. As well, it may have been far more readily accepted because it appeared linear and logical to an audience that prizes linear, logical thinking.

Without words or ways to display them, students had found these concepts and the relationships implicit in them ephemeral. In this study, the propositional relationship of superordination appeared to be crucial to the concept of idea strings and closing generalization, as the individual contrasts ANOVA indicated. All three concepts were needed to successfully produce all five characteristics in a 'technical' paragraph. Without subordination, students could not define idea strings or relate them to the topic sentence, Without the three relationships--coordination, subordination and superordination--the traditional instruction group's scores declined. With all the relationships, the matrix analysis group's scores improved significantly.

Students who knew superordination existed and were able to use it fared better in this study, and this has significant implications. First, students

met an important relationship that obviously existed and had not been named and discussed in traditional instruction; second, students and teachers could confidently discuss this new concept using a common vocabulary that extended the discussion of traditional relationships between T-units. The results from the last characteristic studied, producing a closing sentence without a regeneration or a summary, indicated that the matrix group avoided inappropriate superordinate last sentences significantly more often than did the traditional group. As well, the matrix group's improvement in topic sentence production could be partially accounted for in this way.

Unfortunately, the scores for producing more relevant relationships were not appropriate for statistical analysis because the matrix and the traditional groups were not homogeneous before instruction. Although the matrix group wrote more relevant T-units than the traditional group before instruction, they did still improve their scores after instruction. In the most general sense, explaining and demonstrating relevance and irrelevance is important in understanding part of the rhetorical situation. Specifically in the classroom, being able to explain why a given T-unit should not follow another helps confirm the boundaries of the paragraph and the relation of the T-unit in question to the topic sentence. In a job situation, writing irrelevant sentences might destroy the potential of a proposal or confuse an already complex report or paper.

## Relation to Rhetorical Situation

All the traditional texts surveyed (and the instructor of the traditional group) discussed audience and purpose, but none of them connected the different types of audiences or the different purposes with particular paragraph structures. None of them provided techniques for analyzing the needs of a particular audience within the larger framework of cause and effect, description, narration and so on.

This focus on a preordained general form of a paragraph rather than on the specific needs of an audience (i.e., the relations of number and type of propositions to specific audiences and purposes) might have caused the traditional group to score poorly in producing idea strings and producing idea strings by coordination and subordination only. They could not understand and reproduce the structures that were appropriate for their audiences because they could neither characterize their audiences (i.e., the type of propositions appropriate for those audiences) nor manipulate the type of T-units that would fulfill their audiences' expectations.

## Markers of Propositional Relationships

The traditional methodology instructor used one further technique, one that the matrix analysis instructors did not use, instruction in the use of transitional words, phrases and sentences as surface markers of relational change. Traditional instruction students were given a list of transitions

and told to use them where they were appropriate. And, by in large, where a change in relationships was obvious, this technique worked.

However, every practicing composition instructor has experienced the basic writer's or second-language student's misuse of transitions, the random scattering of words and phrases throughout a paragraph. Students do not mark changes in levels of generality accurately because they do not recognize them. (Berthoff, 1984) And obviously the presence of surface markers does not guarantee the marker and the propositional relation will match.

Matrix analysis students did not receive instruction in the use of transitions, because technical and semitechnical texts use transitions sparingly, and yet the matrix analysis group's texts were well formed and read smoothly. Without instruction in the use of transitions, they were able to focus on the interrelationships of meaning and their audiences' expectations and produce them. Marking surface change became less important than producing relational change. These students certainly did not simply "forget" to use transitions.; they learned the relation of transitions to the underlying pattern of meaning, indicating the potential of the matrix to unify the discussion of pattern of meaning and of conjuncts.

The matrix pedagogy allowed students to ignore the common injunction to "include transitions" and to concentrate on the relationships within their texts. In creating meaning, students could use the structure of the matrix

as a physical frame to be completed or a circuit design to be implemented. A matrix became a heuristic to generate and revise text, thereby letting form motivate the search for information. In fact, the traditional group's focus on transitions may have impeded them in learning about idea strings since their scores on this characteristic declined dramatically

### Use of Previously-learned Material

The most universal concept that traditional instruction teaches is the topic sentence. From grade 4 through secondary school, students are adjured to write or imply at least one sentence per paragraph that contains an inclusive generality expressing the topic to be explicated or discussed. Possibly, traditional pedagogy is successful in teaching topic sentences because they are so easy to create and explain. The writer does not even need to relate a topic sentence, when he first writes it, to any other statement. Even on revision, he needs only a sentence that names the topic in some general way. When a writer had to respond to a simple question such as "Why did you come to B.C.I.T.?", the task became even simpler. After students have been taught often and well what constitutes an acceptable topic sentence and roughly how general it should be, much of that concept undoubtedly will be "remembered" and applied. Therefore, it was not surprising that the traditional group scored well in the topic sentence characteristic.

Matrix analysis instruction might well have been successful for pre-

cisely the same reason. In addition, the lecture information on levels of generality and specificity undoubtedly clarified the level of generality appropriate for a topic sentence. Both the concept of superordination and the visible relation of the topic sentence to other sentences in the paragraph might have reinforced the traditional instruction all the students received before.

### Physical Involvement

Matrix analysis went further than simply providing the interior structure of a paragraph. Besides demonstrating the heuristic value of form, it involved students in testing or inspecting the relationships within their own prose even if they did not add, move, delete or rephrase material. Furthermore, it guided a student when he originated or changed his text. In the study, the students actually drew the matrix, explained why certain relationships existed, revised the matrix he had drawn and wrote the accompanying paragraph. These activities of drawing, explaining and problem solving indicated students were actively involved; matrix analysis changed the passive process of listening to a lecture on paragraph structure into the active one of looking, listening, writing, drawing and questioning and, as the test scores from both the ANOVAs demonstrated, problem solving. The old saying "I hear and I forget, I see and I remember, I do and I understand" is nowhere more applicable than here.

## Implications

The significance of the discourse matrix for teaching becomes clear in the different effectiveness of traditional and matrix analysis methods in the tutorials taught by the teaching assistant. Pedagogy, not teaching expertise, produced most of the learning, since the scores did not vary significantly between the experienced instructor and the teaching assistant. In other words, in both cases, the experienced and the inexperienced instructor produced statistically comparable results, so methodology must have been responsible for the results.

Beyond the classroom, does this study have any practical implications? Both ANOVAs demonstrated that electrical engineering technology students in the matrix analysis groups produced significantly more well-formed paragraphs than those in the traditional groups, given the same teaching resources and time. Clearly, students who write better paragraphs, and all other things being equal, write better overall, are potentially better employees since good writers are more useful and promotable than poor ones. (See Appendix A)

Why then has traditional instruction remained in place in the face of pragmatic concerns and other successful studies of process-oriented writing? Why has product-oriented writing instruction persisted when process-oriented writing techniques are more successful?



## Impediments

The answers, I believe, lie in the historic development of rhetoric, the nature of the paradigm that surrounds writing instruction and the type of literacy that meets current economic needs.

### Historical Development of Rhetoric

Corbett (1971) classified rhetorical practice in the early 16th century in three schools:

(1) the Traditionalists--those who taught a full-fledged rhetoric, with attention given to the five parts: invention, arrangement, style, memory, and delivery; (2) the Ramists--those who assigned invention and arrangement to the province of logic and allocated only style and delivery to rhetoric; (3) the Figurists--those whose primary, if not exclusive, interest centered on the study of the schemes and tropes.

Ramist thought was accepted in England before the beginnings of the Royal Society in London, leaving rhetoric with style and delivery--the faculties of the imagination. As Francis Bacon and the Royal Society began to influence thought in the late 16th and early 17th century, logic came under the domination of "science", further dividing invention and arrangement from style and delivery. "By viewing the imagination and reason as definitely distinct faculties, Bacon laid the groundwork for the great amount of subsequent discussion about the separate provinces and the separate cultivation of these faculties; and of course he thereby fostered the Ramist dichotomy between logic and rhetoric." (Corbett, 1971)

Through Blair, Campbell and Kames, extensions of this rhetorical tradition were transmitted to Britain and North America. (Corbett, 1971) The emphasis on imagination, style and rules, on form rather than process

reinforced the Vitalist assumptions, inherited from the Romantics, that underlie many of its overt features. The overt features, however, are obvious enough: the emphasis on the composed product rather than on the composing process; the analysis of discourse into words, sentences, and paragraphs; the classification of discourse into description, narration, exposition, and argument; the strong concern with usage (syntax, spelling, punctuation) and with style (economy, clarity, emphasis); the preoccupation with the informal essay and the research paper; and so on. (Young, 1978)

With such a history and with so much experience behind them, is it little wonder that the proponents of traditional methodology resist New Rhetoric's methodology. They have both Blair and Vitalism:

Vitalism, with its stress on the natural powers of the mind and the uniqueness of the creative act, leads to the repudiation of the possibility of teaching the composing process, hence the tendency of current-traditional rhetoric to become a critical study of the products of composing and an art of editing. (Young, 1971)

### The Nature of Paradigms

The second part of the answer, I believe, lies in what Thomas Kuhn calls the structure of scientific paradigms. Although Kuhn cautions his readers not to attempt to transfer the exact idea of a scientific paradigm holus-bolus to other disciplines, I believe his definition of a paradigm and theoretical

implications are broadly applicable here. A paradigm, on one hand, is

the entire constellation of beliefs, values, techniques and so on shared by the members of a given community. On the other hand, it denotes one sort of element in that constellation, the concrete puzzle-solutions which, employed as models or examples, can replace explicit rules as a basis for that solution of the remaining puzzles of normal science. (Kuhn, 1970)

Berlin (1982) points out that the different schools of rhetorical theory really are separate views of reality in that each conceives of the roles of reader, audience, and language as different entities achieved in different ways.

Current-Traditional and Neo-Platonic Rhetoric deny the place of invention in rhetoric because for both truth is considered external and self-evident, accessible to anyone who seeks it in the proper spirit. Like Neo-Aristotelian Rhetoric, the New Rhetoric sees truth as probabilistic, and it provides students with techniques--heuristics--for discovering it, or what might more accurately be called creating it. This does not mean, however, that arrangement and style are regarded as unimportant, as in Neo-Platonic Rhetoric. In fact, the attention paid to these matters in the New Rhetoric rivals that paid in Current-Traditional Rhetoric, but not because they are the only teachable part of the process. Structure and language are a part of the formation of meaning, are at the center of the discovery of truth, not simply the dress of thought. From the point of view of pedagogy, New Rhetoric thus treats in depth all the offices of classical rhetoric that apply to written language--invention, arrangement and style--and does so by calling upon the best that has been thought and said about them by contemporary observers. (Berlin, 1982)

Like this study, the tendencies Berlin calls Neo-Aristotelian, Neo-

Platonic/Expressionist and New Rhetorical are responses to the Current-Traditional paradigm's inability to create effective writers and effective thinkers.

Although the Neo-Aristotelian and the Expressionist traditions do not play a large part in the teaching of technical writing, they are included here because they are represented in texts that are available.

Like competing scientific paradigms, rhetorical paradigms allow their adherents to make sense of the world in different ways, and discourse matrix analysis is simply the embodiment of one of those ways. Like scientific paradigms that can be related to the physical world, rhetorical paradigms can be validated, at least in part, by the kinds of processes they foster in students' writing. If rhetoric behaves as science has, a new paradigm will be accepted when the ablest and most productive members of the writing community are persuaded, as evidenced by a restructuring of group commitment. The mere fact that an older paradigm does not subsume new information or findings, or cannot produce better empirical products, is not sufficient. However, writing teachers have not yet behaved as scientists.

Ostensibly, the ablest and most productive, at least in British Columbia, are the university and college composition instructors who are educated and/or are publishing their theories and research in the discipline of composition, but they represent only a small percentage of practicing writing teachers in the province. The majority of writing teachers, who are

still teaching and working within the traditional paradigm, are neither educated nor active in the discipline. (Hairston, 1982) These teachers, however hardworking and well-intended, do not function as would a scientific community. They are not following the lead of "the ablest and most productive", though I do not believe this discontinuity springs from any unwillingness to teach students to write better or more effectively.

Many of these teachers do not see themselves as writing teachers. They do not see themselves as part of the writing community partly because they teach literature and writing, but more importantly, because they were not trained to be teachers of writing. They do not share the theoretical background and methodologies of composition instructors because they have never learned them. They, like my colleagues and the writing teachers I know, were trained in literary criticism. Many of them do as I did: teach writing as writing and literary criticism were taught to me, by discussion and inspection, by following a well-known older text, and by floundering. They were not trained by writing to write as Kuhn's science students were trained by "sciencing" to "science".

### Economic Needs

Kuhn discussed the relatively closed and self-contained scientific community, but writing teachers are far more open to outside influences. So publishers, university funding committees, entrance examinations and various provincial educational departments and ministries too temper the rate at

which a new paradigm will be accepted. If the beginnings of the paradigm shift can be dated from D. Gordon Rohman's Pre-Writing: The Stage of Discovery in the Writing Process in 1965, then it has taken over two decades, rather a long time for a successful methodology not to have become clearly dominant.

The issues of training and the educational bureaucracy aside, are there other reasons why has New Rhetoric taken so long to become a viable paradigm, particularly in Canada? Is it only because we do not have a National Writing Project as does the United States?

Perhaps the answer may lie in the fact that all the tendencies for New Rhetoric named by Berlin are part of humanist educational tradition that does not necessarily produce a graduate who will fit smoothly into the present socioeconomic pattern. As more and more graduates work with information and computers rather than with goods and machines

the principles of 'scientific' management are being applied to information workers. As the division of labor becomes increasingly hierarchial, decisionmakers are increasingly removed from the point of production and the 'raw' information. Only if they have subordinates who can write accurate reports will these decisionmakers have the information they need to make effective decisions. They also need subordinates who can read accurately and make decisions regarding implementation within the bounds set by written instructions and guidelines.

What this increasingly hierarchial division of labor requires is many workers who can read for information, follow instructions, and (perhaps) write occasional short reports clearly and accurately, some workers with specialized read-

ing, writing, and thinking abilities to write longer reports and handle the decentralized implementation decisions (which require the ability to make low-level inferences correctly); and a few real professionals with genuinely critical reading, writing, and thinking abilities to serve in (and educate) the centralized managerial elite." (Coe, 1981)

Maintaining the traditional paradigm has some distinct advantages for "scientific management". (see Appendix A) Since traditional methodology teaches students to emulate models, it is unimportant whether the models are essays or mechanism descriptions. Students do not need to understand texts structures as long as they can produce them. They can be trained to produce only the kind of writing that is required for their jobs without the expense of a broad, general education or the danger that graduates may be too well educated for their jobs. New Rhetoric can provide specialized writing skills too, as this study demonstrates, but it is expensive and may create workers not content to obey within the hierarchy. (Coe, in Luke, de Castell and Egan)

Traditional instruction with its strong emphasis on the rules of spelling, grammar and punctuation, exerts powerful forces to restrict the upward mobility of writers and speakers of non-standard Canadian English or to force them to adopt the socially acceptable norms before they may rise. The Genuine Education Movement in British Columbia, with its emphasis on "values schools" and "back to the basics" schooling typified the conformity that traditional methodology enforce. Insofar as this is the case, it is not surprising that New Rhetoric is slow in winning approval, particularly in more conservative areas of North America. (Coe, 1981)

## Future Directions For Matrix Analysis Instruction

First, there are procedural questions that need to be answered. A limited study like this one has obvious limitations. The study should be repeated to determine whether other researchers can replicate these results on other technical writing students in other schools. Next, the study should be repeated with a changed variables: time, instruction, populations and instructors as the first variables. If the study can be replicated on technical writing students, it would be appropriate to inspect how long the learning lasts by examining students at varying time periods, probably up to two years.

Is the method used in this study the most appropriate method of matrix instruction? Coe and Chen (Coe et al) have used other methods successfully, so perhaps this only one way to teach matrix analysis. It would be useful to investigate several methods in parallel with different groups of students. Perhaps different types of students would benefit from these, or other yet untested methods. Certainly other instructors could bring rich experience to this new methodology.

One of the most interesting questions that needs to be investigated if matrix analysis is to become part of New Rhetoric is its transmutability. Can this promising new methodology be adapted for a variety of instructors in a variety of classrooms? Can this technique, or others like it, be used



as a writing curriculum? The study demonstrated that an untrained instructor was as successful as an experienced instructor at the post-secondary level. Further studies are needed to confirm this and to investigate how much instruction is needed to help instructors learn matrix analysis instruction. training in composition?

This study was carried out with lectures and writing laboratory practice, an entirely paper-based process. Studies need to be carried out to see if this methodology can be adapted for composition software? The precise, linear structure of the matrix and its vocabulary seems would be easy to program into software and display on a computer screen. Would this be a useful addition to expert composition software? I intend to investigate at least one aspect of this interesting area of investigation.

This study seemed natural for me; the discourse matrix was so simple and elegant that I felt students would understand it and use it well. But simple classroom pragmatism is only one part of rhetoric. This study only investigated the results of a certain type of matrix analysis instruction and put forth some tentative reasons why the results were achieved. If the method is as powerful as the results of this study suggests, other issues need to be studied.

However, there remains the issue of ambiguity since language is, by its very nature, more or less ambiguous. Because the interplay between generality and specificity, and therefore its coded representation, is tied

to meaning, the final decision of a text's meaning always lies in the interpretation of the reader or coder. Intercoder reliability and ambiguity seem destined to be an issue.

Beyond ambiguity, this study should be replicated with many types of student writers and at many level in the curriculum. Students enrolled in technical writing courses at B.C.I.T. are atypical, with a mix of English-speaking basic writers, second-language basic writers, learning-disabled students with varying degrees of writing ability from all cultures and transfer students from college and university engineering programs. Clearly they are not a homogeneous population, and if this methodology is to be investigated in more depth, homogeneous populations would allow researchers and teachers to describe their results more precisely. It would be interesting to determine if this methodology works well with the learning-disabled or the second-language speaker, or perhaps transcends cultural groups and learning styles.

Is this methodology useful for other-- perhaps younger or more sophisticated--groups of people? Secondary school students should surely benefit from matrix analysis instructions. This might be a successful method with employees in communications upgrading courses or adults in literacy courses. Since none of these question have been addressed, all need to be investigated.

This study did not address the rhetorical backgrounds of this heterogeneous group of learners. How much must learners know about grammar to use this methodology? Would it help both younger and older second language students? What correlations exist between the states of cognitive development and success with matrix analysis instruction? It would appear that students should be able to manipulate the abstract representations in the matrix. This would seem to indicate that students should be in the stage of formal operations. All the students in the study were successful in dealing with mathematical abstraction. Is this necessary?

Any future studies should proceed over a longer time. It would be most interesting both to teach matrix analysis for a longer period of time and to assess students at varying time intervals. This might answer questions about the permanence of the learning. It would be appropriate to teach matrix analysis throughout a semester- or year long-long writing course, for a one-week long instruction period is scarcely long enough to teach anyone anything of real import. Ideally, students should be followed and tested after a minimum of a term or semester of instruction for one or two years. Since B.C.I.T. students go out into the workforce after two to three year's training, a five-year longitudinal study is not out of the question. Since matrix analysis students in this study were able to write well for one type of audience, it would also be interesting to see if this made any change in their abilities to analyze other types of audiences at varying time intervals. Other protocols, such as speak and write, should be combined with

matrix analysis instruction to determine if students create text in a different way with matrix analysis than with traditional instruction.

The underlying cognitive processes involved in matrix analysis instruction were not formally studied. The most interesting studies might use matrix analysis as the major theoretical framework from which to teach other cognitive tasks. Here I am thinking about students writing summaries and conclusions. My preliminary observations lead me to believe that discourse matrix analysis helps students recognize and create the general statements that are included in "executive summaries" and draw the inferences that are a part of certain types of conclusions.

This study literally stopped at the end of the paper page. Further afield, other researchers should determine if students who understand and use the discourse matrix learn to write other texts better or write better text on a computer screen or write it more quickly than students taught with other methods. My experience teaching basic writers to create and revise on-screen is that they have problems creating on-screen text because they must attend to too many things at once: audience, purpose, meaning, form, typing and word processor commands. Moreover, they cannot look backwards and forwards to orient themselves as well on-screen as they can on paper, so they tend to forget where they were going with their writing or to spend a great deal of time scrolling up and down through their texts to reorient themselves. Will matrix analysis help "on-screen" writers to form "better paragraphs"? Will the information from a discourse matrix lower the cognitive

demands for basic writers or lower the load on their short term memory? Does the discourse matrix, then, have value as a research instrument in the investigation of cognitive processing?

The discourse matrix has already proved its worth in cross-cultural studies. Work by Sun-i Chen (Chen, M.A. Thesis) and Jia Shan and Zhu Weifang (Coe et al., unpublished paper) suggests that the discourse matrix is a valuable tool for explaining the structure of different types of English prose to non-native speakers. In a school system that fairly bulges with non-native speakers during a time of severe economic restraint in the educational system, any research and methodology that might help those who teach English as a second language or who must learn English is most welcome.

More immediately, the question of coding reliability needs to be addressed more closely. Because matrix coding is new itself and depends on a coder's interpretation of a particular text, more people need to learn how to code and researchers need to determine intercoder reliability. In this study, the experienced coder had previously worked with many texts: the author's pilot study, the more difficult coding task of Sun-I Chen's cross-cultural study of Chinese texts, and texts of the author's senior supervisor, R. Coe. Chen and the coder achieved 71.5% concordance on her texts, and 75% is considered highly accurate in cross-cultural studies. (Chen, M.A. thesis) In addition, the coder checked his interpretation of any ambiguous passages with the author's senior supervisor, Dr. Coe, and they

resolved them. Ellen Nold and her coders were able to achieve 80-90% inter-coder reliability on well-structured texts, but only 60% on poorly-structured or ambiguous ones. (personal communication) However, if this study has a design flaw, it may well be here, and intercoder reliability needs to be addressed for any future work.

Outside of the socioeconomic and political implications lie the basic rhetorical questions that this study highlights. Can we create that "grammar of passages" that Shaughnessy (1977) sought? I believe that this work and that of Coe, Witte and others demonstrate that we are on the way to that goal.

APPENDIX A

A 1979 Canada Manpower survey of employers of B.C.I.T. graduates addressed this point by asking this question:

"In what areas can B.C.I.T. ( or other) graduates' skills be improved?" (A summary of the industry responses appears in Table 30)

Table 30 Industry Responses

RESPON- DERS	CONSUL- TANTS	GOV'T.	INDUSTRY	UTIL.	TOTAL
	26	24	4	2	56
1. Commun- ications	7	12	3	-	22
2. Drafting	10	6	2	-	18
3. Practic- al Lab	4	2	-	1	7
4. Business Managmt	2	4	-	-	6
5. Human Behav.	4	6	-	-	6
6. Maths.	4	-	1	-	5
7. Scient. Theory	2	-	-	-	2
8. Trade & Labour	1	1	-	-	2
9. Prof. Practices	-	1	-	-	1

Other surveys demonstrated that employers prize writing skill more highly than other seemingly more technical ones. In a study from the United States,

- "1. Employers emphasized the importance of effective oral and written communication.
2. Technicians' opportunities to move upward in the company are largely dependent on their writing skills.
3. The technicians' reports are important criteria for evaluation of job performance.
4. Writing ability is especially important for supervisors, and the chances to be promoted to supervisory positions are limited.
5. Most reports are read by different types of people, most of whom are higher in rank than the writers.
6. Those in health occupations have a greater need for reading and speaking skills.
7. Employers understand the importance of skill in reading, because technicians must read specifications, instruction manuals, company rules, trade journals, and product releases. About 62 percent of employers find that further training in reading is often necessary." (Skelton, 1977)



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