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UMI
Procedural Facilitation of Strategic Knowledge in ESL Writing: Longitudinal Case Studies of 9 Chinese-Background Freshman Students of Engineering

by

Susanna Yee-Ling Lo

A Thesis submitted in conformity with the requirements for the Degree of Doctor of Philosophy
Department of Curriculum, Teaching and Learning
Ontario Institute for Studies in Education
University of Toronto

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0-612-41461-2
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Abstract

This study analyzed the effects of procedural facilitation (Bereiter & Scardamalia, 1987a) of strategic knowledge -- in the form of five thinking prompts (from Cumming, 1995a) -- on second language academic writing development and knowledge-transforming behaviors while composing for participants who received tutoring over a period of four months. A longitudinal research design with a case study approach was used. Nine Chinese-background, ESL (English as a second language) engineering students participated in the strategy training, which was conducted in a one-to-one tutoring format, as a supplement to their other courses at the university. Each student wrote two compositions (technical description of a schematic diagram on a power plant and an argumentative writing task based on an engineering article) as pre-post writing samples prior to and then after the tutoring, as well as ten other compositions (2 technical reports, 2 technical descriptions, 2 letter tasks, 2 engineering definition tasks, and 2 non-engineering definition tasks) for ten tutoring sessions. Analyses assessed three aspects of their writing performance prior to and after the tutoring: (a) the quality of different aspects of compositions (global quality, communicative quality, argumentation/content, organization, language accuracy, and language appropriacy) produced, and while composing, (b) use of five heuristic search strategies (in the form of five thinking prompts) and (c) occurrences of
knowledge-transforming (a dialectic process between the content space and the rhetorical space).

In comparing performance on the pre-post writing tasks, students demonstrated significant improvement in the quality of their texts in the technical description task only, particularly in the categories of global quality, content, language accuracy and language appropriacy. They also demonstrated significant improvement in their strategic thinking while composing, devoting more attention to two aspects of writing that were highlighted in two of the thinking prompts, using more complex mental representations of composing tasks, and displaying more knowledge-transforming behaviors while composing. Individual differences were evident in all analyses. Task variables (i.e., argument vs. technical description task) exerted differing influences on students' writing performance. Additional case study profiles of each of the students showed, in addition to individual differences, common improvements in their evaluative, diagnostic and remedial capacities as the tutoring sessions proceeded. Findings are discussed in view of theories of procedural facilitation, second language writing development and instruction, task differences, and tutoring in the zone of proximal development (Vygotsky, 1978).
Acknowledgements

I would like to thank the many people whose help and support enabled me to complete this dissertation.

I am deeply indebted to my thesis supervisor, Dr. Alister Cumming. Without his invaluable assistance and unwavering support, the completion of this dissertation would not have been possible. I am grateful to him for giving me the opportunity to work in his second language writing research project, an opportunity which enabled me to develop theoretical insights and research ideas. Through all phases of the study, Alister encouraged and scaffolded me in ways that helped me to strive for deeper understanding. I am also grateful for his conceptual inputs and insightful comments on the many thesis drafts. In addition, his understanding, emotional support, and eager anticipation of the completion of the dissertation helped sustain me through difficult times.

I would like to express my gratitude to Dr. Carl Bereiter for his constructive criticisms to the dissertation. His perceptive and incisive comments helped me to clarify my arguments and to strengthen the thesis. His expertise in writing and in cognitive psychology will continue to be a source of inspiration for me.

I would also like to express my gratitude to Dr. Patrick Allen for his helpful suggestions, intellectual guidance, and warm encouragement. I benefited greatly from his expertise in the field of linguistics, not only at the stage of data analysis, but throughout the study.

My gratitude extends to members of the examination committee: Dr. Devon Woods, Dr. Sharon Lapkin, and Dr. Judy Wiener for their helpful advice.
Many other people have contributed to the completion of this dissertation. I would like to express my sincere thanks to those who graciously helped in the long tasks of rating and coding of the data, and text analyses: Doris Au, Xiaolei (Shirley) Wu, Carol Chan, Angel Lin, Ling Shi, Wing-yen Pong, and Tom Gregg. I would also like to express my deepest appreciation to Professor Hall and Professor Barham of the Engineering Department for rating the compositions. I would like to thank Sue Elgie for her helpful advice on the statistical analyses. I am grateful to the four ESL teachers who allowed me to observe their classes and to interview them. I likewise thank all the first year engineering course co-ordinators for the many interesting conversations and useful suggestions on designing writing tasks. Special thanks are due to Dolores Furlong who read and gave comments on my initial thesis draft. I also thank Hitomi Oketani, Sylvia Spielman, Louise Morrison, and Junko Tanaka for their kindness in letting me use the student office or the seminar room.

My sincere gratitude goes to the nine ESL first year engineering students who participated in the study. I thank them for generously giving me a lot of their time and for cheerfully sharing their personal thoughts and expectations with me.

I am appreciative of the support given me by friends in my life, either far away or close by, especially Sister Margaret Cheung, Doris Au, and Xiaolei (Shirley) Wu. Their friendship has always been a source of strength and comfort.

My parents have always been a source of support and patience. They deserve my heartfelt thanks.

Finally, and above all, I thank and praise the Lord who is my greatest source of strength. May He bless all those I love and care.
This thesis is dedicated

to

the Sacred Heart of Jesus

and

the Immaculate Heart of the Blessed Virgin Mary
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Chapter 1
Introduction

The present study aimed to describe how training in writing expertise through procedural facilitation (Bereiter & Scardamalia, 1987a) might help to improve both the written products and writing processes of inexpert ESL first year undergraduate students. Assuming it would, the research sought to document which aspects of the students’ written products (global quality, communicative quality, argumentation/content, discourse organization, language accuracy, and/or language appropriacy -- see Appendix A for Hamp-Lyons’ rating scheme) and their strategy use while writing (in the form of five heuristic search strategies) would be affected and to what extent. In particular, the research tried to see if tutoring in heuristic strategies would help students change their writing processes from knowledge-telling to knowledge-transforming behaviors (Bereiter & Scardamalia, 1987a). Also, I aimed to see if development in these knowledge-transforming behaviors produced better quality of texts.

The dissertation has seven chapters. This first chapter introduces the theoretical framework and rationale for the present study in view of related research on first and second language writing instruction as well as strategic knowledge in studies of expertise and writing. The rationale shows how and why the elements highlighted in the present study -- development in writing expertise, particularly knowledge-transforming -- are especially in need of systematic investigation. Three research questions were formulated to guide this investigation in respect to
(a) students' written texts, (b) the strategic knowledge students displayed in their thinking while composing, and (c) their knowledge-transforming cognitive behaviors. Ultimately, data related to these questions aimed to document what tutoring in procedural facilitation of strategic knowledge produced over a period of four months.

The second chapter documents the methods used in the research. First it describes the design of the study then reports results of preliminary studies, outlines the research procedures such as methods for data collection on the written products, writing processes, and contextual factors, and then describes the characteristics of participating students. It also introduces the tutoring sequences, documents the procedures for transcribing, coding, rating, and analyzing the data obtained, as well as describes the limitations of the study. The third, fourth, and fifth chapters present the results of both quantitative and qualitative analyses conducted to answer the three research questions. For each research question, findings from quantitative analyses are reported first. Then results of case study data are presented to illuminate unique changes among individual participants. The sixth chapter presents narrative accounts of students' progressions as nine individual profiles, focusing mainly on what went on in the tutoring sessions. It describes some possible effects of procedural facilitation by relating students' progressions to their post-tutoring thinking aloud while composing, and noting individual differences.

The final chapter discusses the significance and implications of the research. It first summarizes the findings in view of their contributions to theories and pedagogical practices of procedural facilitation. Then I speculate why the two sets of tasks, technical description and argumentative exposition, tended to produce quite different results for these students. Finally,
the chapter suggests implications for future research and second language instruction.

1.1. Educational Background

As English has increasingly become an international language employed in professional fields and academic studies, there is a widespread need for students from all parts of the world to learn to write in ESL (Huckin & Olsen, 1984; Swales, 1990). Both general ESL courses and courses for specific professional development are offered at many universities or colleges in English-speaking countries and around the world (Mackay & Mountford, 1978; Robinson, 1980). The university in which participants were solicited for this longitudinal study has provided general ESL writing courses for many years for its first-year engineering undergraduate students. Engineering was chosen as the field of study reported in this dissertation so as to confine the research to a specific, semantically rich domain and particular academic discipline.

1.1.1. Engineering Students and ESL Writing

Learning to write well is important for ESL engineering students because successful performance in academic courses and later in professional roles generally requires high levels of writing abilities in English (Bridgeman & Carlson, 1984; Horowitz, 1986; also see section 2.1.2. on engineering professors' interviews for this dissertation). For instance, one study found that professional engineers devoted fully 20% of their work time to writing (Faigley & Miller, 1982, p. 560). A survey of 367 practising engineers ranking the types of communication skills required on the job also showed that writing and speaking are the most important skills.
needed (Schiff, 1980). That is to say, there are strong instrumental reasons for engineering professionals to develop their writing abilities. In addition, Huckin and Olsen (1984) pointed out that what ESL engineering students most need from ESL courses are aspects of general English, especially the productive skills of speaking and writing. This was echoed in the interviews of engineering professors in Mendelsohn and Cumming (1987), Nelson (1988), and the present research. For example, in Nelson's study, one of the four engineering professors teaching a freshman writing course complained that engineering students do not have enough writing practice and consequently are often "output illiterate" (p. 60). He contended that it is important for students to master features of "competent writing" such as "complete sentences, spelling, and organization" as well as "content features" in their academic writing. Research on technical writing courses (e.g., Davis, 1977) has also found that clarity of expression, analyzing situations and producing communications to fit readers' needs, organizing reports, grammar and syntax, writing drafts and finishing documents are essential skills.

1.1.2. Engineering Students and Disciplinary Writing

Students entering academic disciplines must learn the genres and conventions of that particular disciplinary community (Berkenkotter, Huckin, & Ackerman, 1988; Freeman, Carey, & Miller, 1991). They have to be aware of what Bazerman (1980) called "the conversation of the discipline". Understanding the conventions of an academic discourse community constitute a special literacy that writers need to acquire (Herrington, 1985a, 1985b). Studies by Faigley and Hansen (1985) and Herrington (1985a, 1985b) have examined how disciplinary literacy is acquired, and what factors foster or hinder learning processes. However,
most such studies to date have focused on graduate or rhetoric courses (Berkenkotter, Huckin, & Ackerman, 1988). Those which focused on second language learners (e.g., Casanave & Hubbard, 1992; Currie, 1993; Riazi, 1995; Schmidt, 1981, Shaw, 1991; and three studies in Belcher & Braine, 1995) are few and restricted in the information they have documented. Visibly absent is research on how ESL first year engineering undergraduate students (who are both inexpert ESL writers and novice engineers) socialize into the effective practices of second language writing, and more importantly, develop relevant writing expertise, second language proficiency, and knowledge-transforming behaviors for their writing.

1.2. Approaches to Instruction in Second Language Writing

Undergraduate ESL learners need to develop their writing expertise, second language proficiency, and knowledge-transforming behaviors to cope with challenging and demanding academic writing in a second language. However, research and theories of second language writing have generally focused on fragmented issues rather than treated these issues in a holistic way. They are either product-focused, process-focused, or context-focused; consequently, they lack consensus on what and how to teach undergraduate students who are ESL learners in a new discourse community.

Approaches to instruction in second language writing have emanated from three theoretical orientations in first language writing research (for reviews, see Johns, 1990; Silva, 1990); they generally correspond to a cumulative paradigm shift (cf. Kroll, 1990) -- from a text-based view until the 1970s, then incorporating a cognitive view in the 1980s, then more recently incorporating a contextual view in the 1990s. This section reviews recent studies from these
three orientations to second language writing instruction, discussing their main concerns, strengths, limitations, and implications for the present study.

1.2.1. Product-oriented Instructional Orientations

A traditional, rhetorical approach has dominated second language writing instruction for many years. Not only is it still very much the focal attention in many ESL writing classrooms, but recently the text analyses informing this orientation have also been of renewed interest in some ESL writing research. Because ESL students' writing is typically evaluated on the basis of the written products they produce, analyses of qualities of such texts are important.

As an orientation to second language writing instruction, this perspective is mainly grounded on theories of behavioral psychologists and linguistic structuralists, emphasizing error-identification, evaluation, and mechanical correctness (Connor, 1985; Lalande, 1982; Robb et al., 1986). This orientation, for example, may aim to help students progress from controlled to free composition, study exemplary texts, or concentrate on prescriptive grammar such as pragmatic word order (Bardovi-Harlig, 1990) or article use (Master, 1995). Or it may focus on rhetorical usage, such as the teaching of Topical Structure Analysis (Lautamatti, 1978) for the revision subprocess of writing (Connor & Farmer, 1990). Similarly, some research has analyzed the use of vocabulary (Engber, 1995), metadiscourse (Intaraprawat & Steffensen, 1995), or cohesive devices (Reid, 1992) in relation to the quality of ESL students' texts.

A product orientation to instruction has been criticized by researchers for its strict emphasis on the correctness of form over ideas, its advocating a linear view of the writing process toward a final product, and because it lacks a sound conceptual theory of how writing
skills develop. In addition, other limitations are a concentration on teaching isolated, discrete language skills rather than writing as a whole activity, making the writing process fragmented instead of holistic; moreover, some text-linguistic, sentence-based approaches (cf. Connor, 1987), such as teaching pragmatic word order (Bardovi-Harlig, 1990), regard coherent writing simply as "a question of how sentences fit together to form a whole" (p. 43), thus reducing the act of composing to merely rhetorical concerns, and making it mechanical rather than semantically meaningful.

Three important implications can be drawn from this research on ESL writing for the instructional treatment used in the tutoring in the present study. First, instruction should avoid reducing the act of writing to the learning of discrete grammar skills; it should try to preserve its holistic complexity. Second, although sentence-based, text-linguistic analyses, such as the teaching of Topical Structure Analysis for revision looks promising, its training procedures might be too complicated for inexpert ESL freshman writers (see Connor & Farmer, 1990, or Witte's study for first language writers, 1983), or it might not be comprehensive enough for ESL writing instruction, since little attention is allocated to key aspects of language use, such as word choice or grammar. Third, and most obviously, it cannot be denied that knowledge of language form is useful, particularly for ESL inexpert writers in the revision subprocesses of writing. Instruction should, therefore, try to integrate attention to language form within students' writing processes (Coe, 1987; Connor, 1987; Raimes, 1985; Swales, 1990), by attending to both product and process, and teaching students not only heuristics on meaning, but also heuristics on rhetorical and linguistic forms (Raimes, 1991).
1.2.2. Process-oriented Instructional Orientations

This orientation, based on a cognitive view of first language writing, emphasizes the non-linear, goal-directed, and problem-solving nature of writing. Widely accepted generalizations about writing process are based on findings from first language studies, for example that first, writing involves planning (Flower & Hayes, 1980), revision (Faigley & Witte, 1981; Sommers, 1980), editing (Hull, 1987), and other subprocesses in a non-linear but recursive pattern; and second, there are distinct differences in the component behaviors of composing between skilled/expert and unskilled/novice writers (Flower, 1979; Hull, 1987; Sommers, 1980). Skilled writers intently plan (particularly in pre-writing time) to organize their texts and ideas, taking into account audience awareness and goals for writing (Burtis, Bereiter, Scardamalia, & Tetroe, 1983; Flower & Hayes, 1980). They also consistently engage in multiple drafting of texts and extensively revise their writing, making substantive ideational and rhetorical changes (Beach, 1976; Sommers, 1980). Overall, their decision making occurs at high levels of mental operations (Bereiter & Scardamalia, 1987a), demonstrating global concerns of text and complex mental representations of task (de Beaugrande, 1984; Flower & Hayes, 1984; Scardamalia & Paris, 1985). In other words, skilled writers control their own writing processes (Perl, 1980). In contrast, unskilled/novice writers seldom plan, nor do they have a clear notion of what to write and how to develop their texts. They may typically write only one draft, and they revise simply to make local changes (Faigley & Witte, 1981; Perl, 1979; Pianko, 1979).

Second-language studies have mirrored those of their English, first-language counterparts, largely focusing on the performance issue of skilled writers (Zamel, 1983), unskilled writers (Raimes, 1985, 1987), or comparisons of the two (Cumming, 1988) (for a review, see
Krapels, 1990). In general, studies have established similarities in composing behaviors between writers in their first and second languages (e.g., Silva, 1993); and suggested there is crosslinguistic interdependence in writing abilities (e.g., Cumming, 1989; Cumming, Rebuffot, & Ledwell, 1989; Jones & Tetroe, 1987).

Certainly, process-oriented studies have provided many insights into the unique nature of second language writing and its component skills (Silva, 1993). Nevertheless, scarcely any research has shown how instruction with this orientation might actually influence ESL writers' improvement in their composing processes and texts. There is a distinct need for research on second language writing instruction which documents and assesses exactly how unskilled or novice writers acquire the use of expert-like cognitive strategies while they compose, and how such development occurs in their writing over time. Although a process writing approach has been advocated and practised widely for about a decade in second language writing instruction, published empirical studies exploring the effectiveness of this approach have been sporadic and surprisingly few in number (for a review, see Susser, 1994). Such studies mainly focused on prewriting, the use of journals, or rewriting (cf. Susser, 1994, p. 37) with vague purposes such as teaching "the stage(s) of discovery" in the writing process. The fragmentation of the holistic, non-linear writing process into stages contradicts what this process-oriented approach advocates: the "recursiveness" of the writing process. Likewise, this process orientation has been criticized for dismissing the importance of language form, overemphasizing the importance of personal, expressive writing, and failing to reflect the social nature of writing (Horowitz, 1986). In addition, many such studies (e.g., Spack, 1984) fail to mention whether the instructional approach was effective in improving students' written texts, thus revealing another
One of the few process-oriented studies that has examined ESL writing instruction and learning over time is Cumming's (1986) case study of twenty ESL engineering undergraduate students, which found that cognitive modeling contributed to students' goal-setting and goal-achieving as well as development of their procedures to write and improvement in the quality of texts they produced. This study has important implications for the present study. First, it substantiates the claim that cognitive modeling, accompanied with goal-setting or metacognitive awareness, is a promising design for second language writing. Second, the variations in learning goals chosen by individual students in this study reveals the significance of individual differences among ESL inexpert writers, and thus, the need to devise some simple yet comprehensive strategies which can be tailored to individual differences. Third, the effectiveness of cognitive modeling highlights the importance of employing theoretically and empirically-based cognitive strategies which are informed by documentation of the actual processes that expert writers use in their second language writing (e.g., Cumming, 1989, 1995a).

1.2.3. Context-oriented Instructional Orientations

Many recent studies on second language writing pedagogy have emphasized how contextual factors impinge on the development of students as writers, especially in educational settings where writing performance contributes substantially to academic access, success, and later professional development (Huckin & Olsen, 1984; Horowitz, 1986; Mohan & Lo, 1985; Zamel, 1987). These studies have generated debate over whether writing instruction in academic and professional settings should be general or cater specifically to the genres and practices
associated with the disciplines students are learning in English. Whereas some researchers have maintained that specialized writing instruction is more cost-effective, relevant, and focused than "General English" instruction (Strevens, 1988, cited in Johns, 1991, p. 298), others (Huckin and Olsen, 1984) advocate a professionally oriented ESL instruction or some version of "specific purpose" instruction. Indeed, social constructionists advocate that adult ESL students need to gain an awareness of the rules of academic discourse and the unique strategies that successful writers in their discipline use (Johns, 1991; Swales, 1990).

Two studies that offer insights from this perspective for the present research are Johns (1995) and Jacoby, Leech, and Holten (1995), both genre-based approaches which integrated product and process orientations to ESL writing instruction. Johns taught academic genres (CGS) and authentic genres (AGS) to ESL students by using exemplary texts and the academic course instructor's texts for comparisons with the students'; she also employed portfolios as well as peer reviews to balance the focus on form/genre. Johns regarded this approach as "successful", but offered no particular findings to prove this. Jacoby et al.'s (1995) study was in the context of a developmental writing course for undergraduate ESL science-majors. They used model texts and criterion-referenced materials, teaching strategies used by skilled writers, such as prewriting, planning, and organizing, and emphasizing revision for meaning. Their main purposes were to familiarize students with the fundamentals of the genre of the experimental research report while simultaneously addressing their needs as ESL writers. However, no results were offered to demonstrate whether or not students had made any significant achievements in their writing.

These studies on academic writing in a second language show the influences of
academic discourse communities on writing tasks, learning, and instructional orientations. Nevertheless, other research has also shown the diversity of faculty expectations and reactions to students' essays (Hamp-Lyons, 1990; Leki, 1995; Mendelsohn & Cumming, 1987) as well as distinct variations in the performance of similar tasks among disciplines (Braine, 1995; Connor & Johns, 1989). A chief implication for the design of the present research, therefore, has been to situate it in one academic discipline, engineering, and to utilize writing tasks that are unique to this discipline as well as those, such as essays and letters, that are more general to university writing. A second implication has been to try to design an instructional approach subsuming not only a focus on the writing process (i.e., embedding the teaching of cognitive processes in the writing process), but also entailing an emphasis on the product (i.e., including heuristics on knowledge of form that shape the quality of students' texts) and the context (i.e., using writing tasks and topics pertinent to students' disciplinary knowledge and commensurate to their writing abilities).

1.2.4. Implications for This Research

In summary, research on second-language writing instruction thus far has been too scanty and partial to provide information on how instruction can facilitate the development of both writing processes and written products. Existing instructional approaches (product-, process-, or context-oriented) or models (linguistic-behavioral, cognitive, or social-constructionist) contain many discrepancies in theory and reveal many inadequacies in practice about conditions that would foster or hinder writing development in a second language. Therefore, it seems paramount to bring these discrepant approaches into alignment, to assess how they might
converge in practice, and to explore what effects they might have on ESL students' writing development. The optimal conditions for inquiry of this kind are longitudinal (to establish how learning happens over time) strategy training (to see the effects of specific approaches to instruction) on a case study basis (to observe individual trends and differences).

1.3. Strategies in Instruction

In addition to discrepancies over which theories and instructional approaches might account for expertise in writing in a second language, there is a dispute over what kinds of strategy relate to the development of competence or expertise in writing, can feasibly be learned, and should appropriately be taught. This section briefly outlines this intradisciplinary dispute and its implications for the present study.

The role of learner's knowledge and strategies in memory and development -- the theory of expertise -- has gained increasing prominence in the past decades. There are both interdisciplinary and intradisciplinary disputes over whether knowledge or strategies, as well as what kind of knowledge or strategies, might account for expertise. As some researchers (Alexander et al., 1991; Alexander & Judy, 1988; Peverly, 1991) have pointed out, the research literature has shown many different instantiations of the terms knowledge and strategy (for a comprehensive review, see Alexander et al., 1991). In the interdisciplinary dispute between knowledge-based and strategy-based instructional approaches, the term knowledge refers to prior knowledge or domain knowledge, whereas the term strategy generally involves problem solving skills or heuristics. Strategies are further categorized into domain-specific and domain-general strategies. Some researchers (e.g., Bereiter, 1985; Glaser & Chi, 1988) consider problem solving
strategies or heuristics as a kind of procedural knowledge or skill, thereby calling it strategic knowledge.

Notwithstanding the prevalence of knowledge on learning in the studies and theory of expertise, many cognitive psychologists believe that strategies, particularly problem solving skills or heuristics, can be learned and should be taught (Bereiter, 1985; Glaser & Chi, 1988; Simon, 1980); and there is converging evidence from studies to support such a contention. First, research has shown the effectiveness of cognitive control strategy training on different domains such as reading comprehension (Brown & Palincsar, 1987), writing (Bereiter & Scardamalia, 1987a; Stoddard & MacArthur, 1993), mathematics (Schoenfeld, 1987), and cognitive processing (Brown, Bransford, Ferrara, & Campione, 1983). Second, research has revealed that strategies can help to circumvent basic capacity limits (Ericsson & Charness, 1994) or lack of conceptual knowledge (Bereiter, 1985) in unfamiliar domains (McCutchen, 1986). Third, there is ample evidence from recent research showing the effectiveness of problem solving skills or heuristics in understanding and learning (Bereiter & Scardamalia, 1993; Chan, 1993). These researchers concur that instructional research needs to go beyond the stage of expert-novice analysis, to understand how expertise is acquired, how it can be taught, and how inexpert learners should be presented with appropriate learning experiences (Glaser & Chi, 1988).

The basic claim in this study is: expertise/writing expertise involves the coordination of knowledge and strategy variables -- a two-factor theory advocated by some researchers (Alexander & Judy, 1988; Carter, 1990; Perkins & Solomon, 1989; Peverly, 1991; Prawat, 1989; Smagorinsky & Smith, 1992). The present study did not endeavor to test the theoretical compatibility of these two variables. Instead, it attempted to assess if training in
strategic knowledge, an equivalent term for problem solving skills or heuristic search strategies, would help ESL inexpert writers produce better quality texts, promote greater use of strategic knowledge (i.e., heuristic search strategies), and develop knowledge-transforming behaviors in their writing.

1.3.1. Intradisciplinary Disputes over Strategies in Learning

Specific strategies pertain to domain-specific strategies which are less transferable between domains, whereas general strategies refer to domain-independent control strategies (such as planning, monitoring, and revising), including heuristic techniques and problem solving skills, which Glaser and Chi (1988) and Scardamalia and Bereiter (1985) regard as part of people's knowledge base. Many researchers in cognitive science (Pressley, 1986; Scardamalia & Bereiter, 1985; Schoenfeld, 1987) suggest that teaching domain-general strategies is the most efficient approach for acquiring executive control strategy and problem solving skills. There is evidence from research showing the effectiveness of domain-general strategies, for example, in the three cognitive apprenticeship programs orchestrated by Palincsar and Brown (1984) on reading, Schoenfeld (1987) on mathematics, as well as Bereiter and Scardamalia (1987a) on writing. As Prawat (1989) and Carter (1990) have noted, those who espouse the teaching of domain-general strategies hold beliefs that experts have available more effective general strategies than novices, and general strategies can be transferred from one domain to another. Nonetheless, those who advocate the teaching of domain-specific strategies (e.g., Glaser, 1984) contest that "the more general the method, the weaker the method" (Perkins & Solomon, 1989, p. 19). The central contention of the dispute is the issue of transferability: To what extent can general strategies be
transferred from one context to another? Are they useful for problem solving in a variety of domains?

Research on training has often shown acquisition of either specific or general strategies is insufficient to prompt and sustain their effective use, so researchers have suggested that monitoring or self-regulation, an intentional and metacognitive strategy along the general executive strategy continuum, is crucial to continued effective strategy use (Bereiter & Scardamalia, 1989; Ericsson & Charness, 1994; Peverly, 1991; Prawat, 1989; Zimmerman, 1990). The ability to monitor or regulate cognitive behavior is crucial to cognitive competence. Research is replete with evidence that self-regulation and self-monitoring strategies enhance learning in different domains such as statistics (Lan, 1995), reading comprehension (Pressley & Ghatala, 1990) and writing (Graham & Harris, 1993; Scardamalia & Bereiter, 1984; Zimmerman & Bandura, 1994). Even knowledge-based researchers (Glaser, 1984; Glaser & Chi, 1988) have suggested integrating knowledge and general self-regulatory strategies in the acquisition of domain-related knowledge.

1.3.2. Intradisciplinary Disputes over Strategies in First Language Writing

There is a similar intradisciplinary debate over general strategies and specific strategies in research on first language writing (for reviews, see Carter, 1990; Smagorinsky & Smith, 1992), with these two kinds of strategies further subdivided into different positions, in accord with the three different theoretical views of writing instruction discussed in preceding sections of this chapter.

The general strategy position is divided into three distinct trends. According to
Smagorinsky and Smith (1992), the primary trend corresponds to the textual view of writing instruction and involves the teaching of text structure, that is, general composition knowledge. It was largely supplanted in the 1980s by the general procedural knowledge position under the influence of cognitive writing process research with its reliance on heuristics -- general probes in the form of questions. As Smagorinsky and Smith (1992) have noted, despite some design flaws, Hillocks (1986) in his meta-analysis of composition studies found research on general procedural knowledge "encouraging" (p. 180). Nevertheless, this interest in general procedural knowledge was later superseded by another trend -- general composing procedures -- which espouses teaching writing processes such as brainstorming and freewriting, that is, teaching writing as a process (Murray, 1980) or the natural writing process (Hillocks, 1986). Overall, in spite of their different foci on product versus process, these two views hold the same underlying assumptions that general strategies will suffice and can be transferred from one context to another.

As the general writing process position failed to prepare students for academic writing tasks (Applebee, 1986; Hillocks, 1986), the specific strategy position replaced it in popularity. There are two different positions which emerged from the teaching of specific strategies -- task-specific strategies and community-specific strategies (see Smagorinsky & Smith, 1992). The task-specific position represents the genre approach, teaching different aspects of classical discourse such as narration, description, exposition, and argumentation. It is actually an old product-oriented instructional approach focusing on exemplary texts. The other specific strategy position -- the community-specific strategy position -- stems from the socio-cultural view of writing instruction, suggesting strategic knowledge is contextual, thereby advocating strategy
teaching pertinent to specific discourse communities.

Similar to the strategy debate in research on learning, the main dispute in writing research also focuses on the issues of transferability and durability of general strategies. Likewise, some composition researchers (Carter, 1990; Smagorinsky & Smith, 1992) suggest that the various strategy positions need not be incompatible, so they postulate a pluralistic and balanced view of writing expertise that embraces both general and specific strategic knowledge. In addition, some (Carter, 1990; Flower, 1989; Smorgorinsky & Smith, 1992; Walker, 1987) suggest teaching general strategies contextually, or situately, as a requisite and powerful means for acquiring specific strategies; that is to say, with general strategies at the beginning of, and specific strategies at the end of, the same developmental continuum.

Overall, regarding strategy training, research on first language writing has focused on the issue of self-monitoring and self-regulation, that is, metacognitive strategy training (e.g., Bereiter & Scardamalia, 1987a; Graham & Harris, 1993; Zimmerman & Bandura, 1994; see also procedural facilitation studies reviewed below in section 1.4.3.). In contrast, second language writing research has lagged behind its first language research counterparts in having neglected training on metacognitive strategies or metacognition (see section 1.4.5.). It is, therefore, imperative to investigate this issue. The present study did not aim to assess distinctions between general and specific strategies, however. My basic assumption is: whereas domain-specific strategies may be necessary in advanced stages of learning, domain-general strategies are particularly valuable in initial stages of learning when domain-specific knowledge is lacking. A major implication for the design of the present research, therefore, has been to teach general strategies such as heuristic search strategies in writing contextually or situatedly.
1.3.3. Implications for This Research

In summary, research on strategy training in second-language writing has been minimal. It is necessary to explore this issue to help guide pedagogical approaches and curriculum decisions in ESL writing instruction. The obvious way to conduct inquiry of this kind is through cognitive apprenticeship (Collins, Brown, & Newman, 1989), modeling cognitive, metacognitive and self-regulatory processes in routinized procedures and with external supports.

1.4. Some Key Concepts

This section introduces the theoretical premise for the present study: Bereiter and Scardamalia’s (1987a) concepts of procedural facilitation and knowledge-transforming. These relate to Flavell’s (1976, 1979) views on metacognition and Vygotsky’s (1978) idea of the zone of proximal development. These concepts explain "how" strategy instruction in the present study was designed and implemented.

1.4.1. Procedural Facilitation

Procedural facilitation (Bereiter & Scardamalia, 1987a) is one successful model of cognitive apprenticeship (Collins, Brown, & Newman, 1989) in which, "the skills a student will acquire in an instructional interaction are those required by the student’s role in the joint cognitive process" (Bereiter & Scardamalia, 1989, p. 383). Procedural facilitation involves modeling cognitive, metacognitive, and self-regulatory processes, not only for the identification and resolution of composition problems, but also for composing and text evaluation, by providing
students with cues (e.g., cue cards) and through practice making the procedures for task performance routinized. If procedural facilitation is carried out under the guidance of a teacher or tutor, it involves guided and scaffolded cooperative learning (Brown & Palinscar, 1989) with progressive turnovers of higher level parts of instructional processes to students and gradual "fading" of a teacher's prompting.

According to Bereiter and Scardamalia (1987a), the four main steps in designing a procedural facilitation are: (1) identify a self-regulation function that appears to go on in expert performance; (2) describe the self-regulatory function as explicitly as possible in terms of mental operations or functions; (3) design a way of cuing or routinizing the onset and offset of the process that makes minimal demands on mental resources (e.g., the CDO process: compare, diagnose, operate); and (4) design external supports or teachable routines for reducing the information-processing burden of mental operations, for example, by presenting sets of alternative evaluations on cards or in lists (p. 255). In other words, in the context of writing, this kind of instruction aims to facilitate inexpert writers' writing processes through supportive procedures which minimize the cognitive demands made on their attention but which enhance self-monitoring and the quality of their thinking (Bereiter & Scardamalia, 1987a; Cumming, 1986).

Bereiter and Scardamalia (1987a, p. 254) pointed out that one of their reasons for exploring procedural facilitation was that children in their studies might have appropriate self-regulatory mechanisms available, and even realize the benefits of using these procedures, but fail to employ them because they are unable to place these self-regulatory procedures within the executive control continuum. This question at issue can also be applied to inexpert ESL adult writers. Procedural facilitation consists of the aforementioned "special supportive procedures"
(Bereiter & Scardamalia, 1987a, p. 254) to help immature writers with this monitoring deficiency, that is, the lack of spontaneous application of strategies or procedural knowledge, or the problem of "access failure" (Prawat, 1989), so that they would be able to self-regulate their writing -- to derive and use strategy-effectiveness information when necessary, to sustain strategy use, and to become fully self-regulated writers. Most importantly, the ultimate goal of procedural facilitation is to make strategic changes in immature or inexpert writers' writing processes -- to move from a knowledge-telling to a knowledge-transforming approach (see definitions of these terms in section 1.4.2. below) -- that is, to acquire a problem-solving executive control structure that does not initially exist (Bereiter & Scardamalia, 1987a).

1.4.2. Knowledge-telling and Knowledge-transforming

To conceptualize this procedural facilitation, I have utilized Bereiter and Scardamalia's empirical research (1987a) for English native writers, which postulated two distinct writing models -- inexpert writers' knowledge-telling and expert writers' knowledge-transforming. These two writing models appear germane to exploring and explaining the relationships between second language writing instruction and learners' development of writing expertise in their second language.

These two models, taken together, are developmental writing models of cognitive processing while composing, distinguishing two different kinds of mental operations performed on content knowledge as people write; they depict how inexpert writers may develop from knowledge-telling to knowledge-transforming in their writing processes. Knowledge-telling is "simply telling the knowledge", without any conscious, effortful, or reflective application of
strategies and attention given to knowledge and audience. It is a writer-based approach (Flower, 1979). In contrast, knowledge-transforming is a complex cognitive process -- "a dialectic process between the content space and the rhetorical space" (Bereiter & Scardamalia, 1987a, p. 303, see quotation below) -- with knowledge-telling as a subprocess in it. It is a goal-directed and reader-based problem-solving approach. Because there is a complex mental representation of content and rhetorical knowledge in the knowledge-transforming writing model, problem solving in either space might lead to changes in the other one, producing ideational changes and constructing new knowledge. As Bereiter and Scardamalia (1987a) pointed out,

For instance, a writer might be working in the rhetorical space on a problem of clarity and might arrive at the decision that she needs to define the concept of responsibility as she is building her argument around. This is a content problem, however, and so one might imagine a message going from the rhetorical problem space to the content problem space, saying "What do I really mean by responsibility?" Work on this problem within the content space might lead to determining that responsibility is not really the central issue after all but that the issue is, let us say, competence to judge. This decision, transcribed to the rhetorical space, might initiate work on problems of modifying the text already written so as to accommodate the change in central issue. This work might give rise to further content problems, which might lead to further changes in the writer’s beliefs, and so on until a text is finally created that successfully embodies the writer’s latest thinking on the subject (p. 11).

These two writing models are representative of the cognitive-developmental nature of writing as well as the interactive realities of knowledge and rhetorical concerns in the writing process, not mere generalizations of the writing process or expert-novice differences. They were empirically found and tested in the thinking processes among writers of different levels of skills (Bereiter & Scardamalia, 1987a, p. 179) -- from immature writers (basically elementary school children) to mature writers (adult graduate students).
These two cognitive-developmental writing models which Bereiter and Scardamalia (1987a) put forward make concrete the evident need to provide immature or inexpert writers with some kind of strategy training (e.g., cognitive and metacognitive strategy training) which would trigger more complex mental representations of, and operations between, the content/knowledge and the rhetorical space, thereby combating the problem of inert knowledge (Bereiter & Scardamalia, 1987a, p. 180), leading to a goal-directed, effortful problem-solving approach in writing and fostering knowledge transformation. Both first and second language writing researchers have regarded this as requisite for effective writing performance (e.g., Belcher, 1995; Bereiter & Scardamalia, 1987a; Cumming, 1995a; Zellermayer et al., 1991).

1.4.3. Previous Studies of Procedural Facilitation

Numerous empirical studies have used Bereiter and Scardamalia's (1987a) procedural facilitation as an instructional model (e.g., De La Paz & Graham, 1995; Englert et al., 1991; Graham et al., 1991; 1993; Kozma, 1991; Zellermayer et al., 1991; among others). Some employed computerized procedural facilitation tools (e.g., Kozma, 1991; Zellermayer et al., 1991), while others used cue statements or think sheets (on cue cards). The duration of these studies varied from a few session (e.g., most of the above studies) to 5 months (e.g., Englert et al., 1991). And the number of participants differed from 3 (e.g., De La Paz & Graham, 1995) to 183 (e.g., Englert et al., 1991).

All these procedural facilitation studies used English native speakers as their subjects. They concentrated either on elementary school LD (learning disabled) students (Graham et al., 1991; 1993; Zellermayer et al., 1991), regular elementary school students (Scardamalia &
Bereiter, 1983, 1985), college undergraduate students (Kozma, 1991), or comparisons between elementary school LD and regular students (Englert et al., 1991) as well as between regular elementary and college graduate students (Bereiter & Scardamalia, 1987a). Apart from Cumming and So’s (1996) research conducted at the same time as the present study, no attempts have been made to study ESL writers using procedural facilitation.

Many of these studies focused on certain writing subprocesses such as revising (Graham et al., 1993; Scardamalia & Bereiter, 1983) or planning (Burtis, Bereiter, & Scardamalia, 1983; Kozma, 1991). The majority of these studies showed that procedural facilitation helped to improve students’ written texts and their metacognitive knowledge. Only a few studies yielded equivocal or inconclusive findings (De La Paz & Graham, 1995; Kozma, 1991; Scardamalia & Bereiter, 1983), for example, that more planning and/or revision of text, as results of intervention using procedural facilitation, had little impact on the quality of text or the kind of revisions made. When this happened, the researchers concluded that these could be attributed to immature writers’ difficulties in choosing or responding to the appropriate cue statements and the impossibility of making dramatic improvement in writing quality within short periods of time. Thus these studies imply that the use of simple cue questions, rather than more detailed cue statements, might be more desirable for and easily internalized by inexpert writers, and I might suggest for the present purposes, particularly ESL learners. For example, Kozma (1991) found that novice college (L1) writers wrote best when using a simple outliner with prompts rather than a detailed organizer with prompts for planning; and in Englert et al.’s (1991) multicomponent research the procedural facilitation of "think sheets" (in the form of cue questions) successfully made the cognitive strategies into self-talk and text structures for
performing writing processes "visible" to students.

Bereiter and Scardamalia (1987a, p. 246) suggested that the indicators of fundamental change after training in procedural facilitation of strategies are: signs of problem solving effort (i.e., an indicator of greater writing expertise), internalization of a new feedback loop or strategies explicitly taught, and evidence of cognitive change (including self-regulation). Nevertheless, very few of the procedural facilitation studies, to date, have attempted to explore these important issues by analyzing students' writing processes through think-aloud data. The use of students' self-report or self-recall (in questionnaires) for measuring metacognitive or cognitive change in many of these studies seems dubious because, unlike concurrent think-aloud data, such self-reporting or self-recalling after the termination of training can only be tangentially related to people's writing and thinking processes, and cannot be considered as direct evidence of their actual cognitive, metacognitive changes or internalization of strategies while composing. Importantly, Graham et al. (1991) suggested that future research should carefully investigate what students internalize as a result of employing procedural facilitators, and how these procedures are utilized and modified in the absence of physical cues or supportive procedures. As most of these procedural facilitation studies mainly focused on the written text or on overt behavior, and there was no evidence of cognitive or metacognitive changes from analysis of think-aloud data, research is needed to testify and substantiate whether procedural facilitation of strategies helps students develop and internalize an executive structure for applying cognitive resources, as evidenced in their think-aloud data of the writing process.

Overall, in spite of the methodological limitations mentioned above, most of these procedural facilitation studies employed highly controlled but naturalistic experimental
approaches, endeavored to balance both product (e.g., text structure analysis) and process (e.g., teacher modeling the writing process). They contribute to our understanding of procedural facilitation as an effective writing instructional model only to the extent that most of the issues brought to light, thus far, require more thorough study. Although similar research on ESL writing has yet to be conducted, procedural facilitation would seem to have the potential to affect ESL inexpert writers' writing performance, given the similarity of their difficulties in writing to their English as first language counterparts. As such, whether procedural facilitation would be a viable instructional model for second language writing merits attention and investigation.

1.4.4. Procedural Facilitation Used in the Present Study

The five procedural facilitation prompts used in this study were:

1. **Word** - to choose appropriate words or phrases
2. **L1-L2** - to switch between or to compare equivalent expressions in students' first and second languages
3. **Goals** - to set and monitor goals to accomplish specific purposes and to accommodate readers of their writing
4. **Fit** - to assess the fit (or coherence) between parts of their compositions
5. **Rules** - to use relevant grammar and spelling rules

These five thinking prompts are derived from Cumming's (1995a; Cumming & So, 1996) research on writing expertise in second languages, particularly the heuristic search strategies frequently used by more expert writers. Prior to outlining the use of these five prompts through procedural facilitation, I will first define each of the prompts and explain their importance in relation to previous research on ESL writing or second language learning.

The prompt **word** refers to retrieving, generating, and assessing alternative or appropriate choices of words or expressions. Professors in academic disciplines typically regard
vocabulary errors as the most weighty issue affecting their impressions of the quality of students’ texts (e.g., Santos, 1988). Considerable research has revealed the relationship of vocabulary use to the quality of second language written texts (Engber, 1995). Collectively, these studies point out that lexical correctness and lexical richness are crucial components in conveying a meaningful second language text, thus echoing the suggestion of some second language acquisition models to equate vocabulary learning with second language learning (see Gass, 1987). Some second language writing research has also investigated this issue through analyses of cognitive processes, observing that inadequate vocabulary is a problem in ESL writing (Raimes, 1985). ESL writers spend much of their time thinking how to express their intended meanings as words (Cumming, 1989, 1990a; Jones, 1985; Raimes, 1987), and expert bilingual writers often use their first language to search for cross-linguistic equivalents of words (Cumming, 1989, 1990a; Cumming et al., 1989).

The prompt L1-L2 refers to code-switching between two linguistic codes to access mental resources or generating and comparing linguistic equivalents through direct translation. The study of code-switching in second language writing has focused mainly on the effects of a first language on writing in a second or foreign language (Friedlander, 1990; Ringbom, 1987), that is, language transfer (Carson et al., 1990; Faerch & Kasper, 1987). Findings have showed significant effects of cognitive models of first language writing on second language writing (Devine, Railey, & Boshoff, 1993) and that ESL writers transfer planning skills across languages (Cumming, 1989; Jones & Tetroe, 1987) for generating content (Cumming, 1989; Friedlander, 1990), developing ideas, and producing text content and its organization (Kobayashi & Rinnert, 1994; Lay, 1982; Uzawa & Cumming, 1989). Findings have also indicated that in code-
switching between the two linguistic codes, first language knowledge provides useful resources for decision making, revising and problem solving in second language writing (Carson & Kuehn, 1994; Cumming, 1989, 1990a; Cumming et al., 1989; Uzawa, 1996; Uzawa & Cumming, 1989).

The prompt goals involves a writer setting objectives to achieve specific purposes of the writing task, adhering to these local and global goals to guide decision making by working forward or backward with them in the writing process, and/or making modifications to accommodate the anticipated readers’ needs. Both first and second language cognitive process writing studies have observed the importance of setting and adhering to goals in writing, that a goal-directed problem solving approach is requisite for effective writing performance (Bereiter & Scardamalia, 1987a; Belcher, 1995; Cumming, 1989, 1990a, 1995a; Flower, 1989; Flower & Hayes, 1984; Zellermayer et al., 1991). Studies have also indicated the importance of reader awareness (Bereiter & Scardamalia, 1987a; Cumming, 1989, 1990a, 1995a; Flower, 1979; Johns, 1993; Kroll, 1978; Raimes, 1987) and showed that because of problems of perceiving a real reader in their writing and revision processes (Roen & Willey, 1988), inexpert writers (e.g., in Bereiter & Scardamalia, 1987a; Nystrand, 1990) tend to produce only writer-based prose (Flower, 1979). Furthermore, studies have conspicuously pointed out the importance of planning or goal-setting in writing (Burtis, Bereiter, Scardamalia & Tetroe, 1983; Cumming, 1989; De La Paz & Graham, 1995; Flower & Hayes, 1984; Jones & Tetroe, 1987) and have consistently observed that inexpert writers plan little (Cumming, 1989; Perl, 1979; Raimes, 1985; Zamel, 1983), whereas expert or advanced writers have demonstrated complex mental representations in their planning and writing (de Beaugrande, 1984; Flower & Hayes, 1984; Scardamalia & Paris, 1985).

The prompt fit involves checking the coherence of a text by comparing and relating
parts of the composition, either structurally or semantically, to the whole. Much second language writing research has concentrated on the cohesive view of textual coherence derived from Halliday and Hasan (1976) and advocated the teaching of cohesive devices (articles, pronouns, conjunctions) (e.g., Reid, 1984). Nevertheless, thus far, research on coherence and academic writing has been sporadic (e.g., Johns, 1986), and little is known about learners’ attention to this aspect of writing while composing (but see Whalen & Menard, 1995).

The prompt rules refers to assessing an element or elements with reference to grammar, punctuation, or spelling conventions. This concern for linguistic accuracy has been the focal point of most second language formal instruction (for a review, see Ellis, 1994) or constrained training studies (for a review, see Mellow, 1992), and its importance has been voiced in faculty interviews in the field of engineering (e.g., Bogdanowicz, 1983; Mendelsohn & Cumming, 1987; Nelson, 1988; the present study). Obviously, linguistic accuracy is of primary importance to effective writing in ESL, as it is considered as an indicator of second language proficiency (Cumming & Mellow, 1996) and recognized in virtually all ESL analytic rating scales (Cumming, in press).

The present study set out to explore and establish the teachability and impacts of these heuristic search strategies on writing in a second language. In this study, these five aspects of writing were developed into five very simple cue questions or general probes (with modifications for different phases in tutoring sessions) to guide students’ thinking while they composed individually and independently in writing sessions, or when I provided mentoring discussions for text revision and evaluation during tutoring sessions, or to be used as external supports or teachable routines for reducing the information-processing load of ESL inexpert
writers' mental operations:

(1) for students' independent thinking while composing (in writing sessions); or self-initiated text revision in tutoring sessions:

Word - Is this the right word or expression? Are there any possible words or expressions?
L1-L2 - How do I say this in my language? Does it make sense in English?
Goals - Will people understand this? What do I want to tell my reader?
Fit - Does this part fit with the other parts?
Rules - Do I know a grammar or spelling rule for this?

(2) for tutor-prompted text revision in tutoring sessions:

Word - Do you think this is the right word or expression? Can you think of any possible words or expressions?
L1-L2 - How do you say this in your language? Do you think it makes sense in English?
Goals - I don't understand this. What do you want to tell your reader?
Fit - Do you think this part fits with the other parts?
Rules - Do you know a grammar or spelling rule for this?

(3) for text analysis toward the end of tutoring sessions:

Goals - What are the main goals and subgoals of this writing? Does the introductory paragraph clearly set the main goals and subgoals? And are they relevant to the topic and adjusted to the reader?

Fit - Do different parts (e.g., thesis statement, topic sentences, specific sentences or paragraphs, elaboration of ideas) of the writing fit the whole and the goals?

Word - Is there any redundancy or irrelevancy in word choices? Are changes already made more appropriate and better choices which fit the whole and the goals?

Rules - Are there any more grammatical or spelling errors not yet identified and resolved?
L1-L2 - Is there any use of direct translation from L1 (e.g., in the planning, the content, sentence structure, or word choices)?

and (4) for an open discussion at the end of tutoring sessions (for detailed procedures, see section 2.2.2.4.):

How can the written text be improved by using the five thinking prompts as a guide?

Procedural facilitation of the five thinking prompts in the present study was conducted in a sequence of tutoring sessions. Documented below is a specific example from a verbatim transcription of one of the tutoring sessions, demonstrating how the prompts were used for text analysis toward the end of one tutoring session (originally spoken in Cantonese):

T: How's the first paragraph? You can refer to the topic, the goals and then analyze.
S: I think the last sentence is not needed.
T: Aha
S: Because the usefulness and uniqueness have been mentioned in the previous sentence.
T: Right, aha
S: But for the part "can be applied in my own field", I still can't think of anything.
T: Aha, if you look at this sentence again, these characteristics, that means here you have already had a paragraph. That is, the first paragraph has already mentioned the characteristics. Right?
S: Aha
T: But usually, is it fit to describe the characteristics in details in the first paragraph?
S: Usually we briefly mention the characteristics, and then every characteristic will be described in the following paragraphs.
T: Um, okay, the same here. You said it's unique and useful. Do you mean you will mention all these below?
S: Umm
T: Okay, so besides deleting the last sentence in the introductory paragraph, are you going to add the sentence you just mentioned? (Read the sentence)
S: Yeah
T: Why do you need this sentence?
S: Because I need to say it's unique and useful from the ...
T: Okay, good, finish (analyzing) the first paragraph. If the first paragraph is like this (i.e., after the changes were made), now let’s take a look at the whole piece of writing, does every paragraph fit the goals?
S: Um, then it doesn’t fit very well.
T: Aha, why?
S: Because it means no longer need to mention its usefulness, only its uniqueness and how to apply to its own field. I’ve only mentioned the basic structure, functions of the internal structure. So, if I am going to make changes, it should be: just mention the structure, functions of the internal structure, and the relationship with its usefulness.
T: If so, you mean its structure has something to do with its uniqueness? Then how are you going to start your second paragraph?
S: Um, probably I’ll say it’s unique. Another point is, I’ll talk about why it is unique. And here I’ll mention its structure, and then say how unique this structure is, to explain bla, bla, bla, and quote the above. Conclude, the concluding sentence will say due to the above unique structure, this thing is useful and ...
T: You’ve mentioned its usefulness. When you talk about its uniqueness, what would you do?
S: Well, I’ll elaborate more.
T: Ah, okay. What does this word "others" refers to?
S: Ah, the other kinds of Walkman.
T: Okay, so uniqueness refers to the structure.
S: Yeah
T: Any other changes?
S: I’ll start another paragraph to talk about its (?).
T: Um, here, because you just mentioned its features, will you include this in its uniqueness?
S: Features, yes
T: You think so?
[They continued analyzing the content: on applications of the new device and the profits, and discussing what elements to be included in the next paragraph.]
T: Just now you said you need to convince your boss and colleagues by mentioning about its uniqueness. What words or expressions would you use to persuade them?
S: Like those mentioned before.
T: Okay
S: Like: I strongly believe, recommend, etc.
T: What other comments do you have?
S: Word choice. For word choice, I’ll use more useful and better
ones -- how handy, etc. Also rules, and we have already analyzed that. And then fit and goals.
T: Fit and goals together?
S: Fit and goal, and LI-L2.
T: Aha
S: LI-L2 is ---
[Then the discussion shifted back to the third paragraph.]
S: Actually the third paragraph has mentioned its average (?). So, it means I need to change what’s entailed in the second paragraph. This will be better. Not to say too much about the basic structure, but to talk about its particulars, why it is unique.
T: Do you mean you will add something to illustrate the specific structure?
S: Actually I’ve mentioned it in the third paragraph. But it seems I haven’t talked about its (?). But I’ll mention it in the first paragraph.
T: So, you will add this?
S: Yeah, not in details, though, because similar kinds of Walkman have similar structures. There’s a lot to write, my changeable current too, to convince its, to convince the colleagues to use mine because it’s useful and will gain more profits.
[They continued on this issue. Then they discussed the concluding paragraph.]
T: Did you add something new to the conclusion? Fit or not?
S: Fit
T: You think so?
S: Yeah. Though this conclusion doesn’t point out this, point out how useful, how unique it is, you know how unique, useful, and can get profits when you read this paragraph. I also mentioned how it can be modeled. I have rephrased the introduction. So, I think it’s okay.

Key qualities of these five thinking prompts and the discourse associated with them in the tutoring sessions are their simplicity, integratedness, and theoretical foundations. Succinctness is a characteristic of the five thinking prompts when compared with the procedural facilitation prompts (e.g., in Bereiter & Scardamalia, 1987a; Kozma, 1991) or strategies (e.g., in Jacoby et al., 1995) in other studies. However, researchers such as Peverly (1991) have suggested that success is closely related to learners’ mastery and consolidation of the most
effective strategies, and their abandonment of less adequate ones. Thus the conciseness of the five thinking prompts should help inexpert ESL writers remember the strategies, effectively model specific procedures for thinking while composing, and productively incorporate them into their writing processes or revisions during tutoring. In short, the benefits of this simplicity are in accord with Kozma’s (1991) findings that simple prompts or strategies best fit novice writers’ zone of proximal development (Vygotsky, 1978).

Second, the five thinking prompts contrast with conventional approaches to teaching grammar, purposes of writing, vocabulary, and rhetorical organization individually in separate lessons, as done in many training studies in second language education (for a review, see Mellow, 1992). However, the crucial difference is like between holding all the loose threads in one’s hands (teaching discrete skills), and tying all these loose threads together to make it a whole (employing all five thinking prompts). That is, the whole of the prompts preserves the holistic complexity of composing. Furthermore, these five simple procedural facilitation prompts were used in a routinized and comprehensive way in the present study. The five thinking prompts embrace both global and local concerns of composing and are likely to facilitate interactions between the form/rhetorical space and the knowledge/content space in ESL inexpert writers’ writing processes. Bereiter and Scardamalia (1987b) described four types of higher-order skills and strategies that distinguish more from less competent writers: (1) problem-solving strategies, (2) self-regulatory procedures, (3) executive control structures, and (4) intentional learning procedures. The present five thinking prompts, in the form of cue questions or general probes, represent problem solving and self-regulatory strategies. They were used not only as a checklist for revisions but also as heuristics for text evaluation and composing; that is, heuristics
which mark the low end of, as well as interact with points along, the executive control continuum -- planning, checking, monitoring, revising, knowledge-telling, and knowledge-transforming. Their ultimate goal is to foster intentional writing (Bereiter & Scardamalia, 1989) so that students adopt a more problem-oriented/problem solving approach to composing, treating writing as a goal, not an activity.

Thirdly, these five procedural facilitation prompts were derived from previous research on the thinking processes that ESL students with high levels of writing expertise use frequently when they write in their second language (Cumming, 1989, 1990a, 1995a; Cumming, Rebuffot, & Ledwell, 1989; Cumming & So, 1996). Their value is based on the premise that cognitive modeling in writing instruction, which involves demonstrating and practising cognitive processes of expert writers, can make inexpert or novice writers aware of and practise these complex, expert-like mental activities while they compose (Bereiter & Scardamalia, 1987a; Cumming, 1986). Importantly, these "learning to write" procedural skills are developmentally appropriate for ESL inexpert writers, that is, during tutoring they were pitched intuitively to be within their "zone of proximal development" (Vygotsky, 1978). Additionally, they should help to foster knowledge-transforming behaviors so that inexpert writers may approach writing tasks in a second language holistically -- addressing both content and rhetorical concerns in a dynamic and interactive manner (Bereiter & Scardamalia, 1987a; Cumming, 1989, 1990a, 1995a).

1.4.5. Metacognition and Strategic Knowledge

The theoretical premise for procedural facilitation follows general concepts of metacognition. In cognitive psychology, metacognition is usually defined as either knowledge
about cognition or the regulation of cognition. Metacognition in this study refers to the latter, that is, monitoring and regulation of one's own learning and cognitive behavior, though both are requisite for acquiring competence in learning (Brown & Palincsar, 1982; Flavell, 1976, 1979). According to Flavell, "Metacognition refers, among other things, to the active monitoring and consequent regulation and orchestration of these processes ... usually in the service of some concrete goals or objectives" (Flavell, 1976, p. 232). There are different components of metacognition. Flavell (1979) subdivided metacognition into knowledge of self, knowledge of task, and knowledge of strategy. In the view of Paris and Winograd (1990), metacognition involves two primary aspects: (a) knowledge and control of self-commitment, attitude, and attention; and (b) knowledge and control processes. The three kinds of knowledge are declarative (the "what" or "that"), procedural (the "how"), and conditional (the "when" and "why") knowledge. In addition, some researchers have suggested a combination of cognitive, metacognitive, and motivational aspects of academic learning. For instance, Pressley, Borkowski, and O'Sullivan (1985, cited in Borkowski, Carr, & Pressley, 1987) combined different aspects of metacognition into an integrated system which includes strategic knowledge about how to select, monitor, and revise strategies and general knowledge about strategies. Borkowski, Johnson, and Reid (1987) added a motivational component to metacognition. The motivational aspects of metacognition include self-esteem, success and failure (e.g., effort versus ability) and are hypothesized to determine the efficacy of strategies. The various components of metacognition interact to produce spontaneous strategy use (Borkowski, Carr, & Pressley, 1987). For the purposes of the present research, I have assumed that the student participants are, like their peers in their classes who did not participate in the research, all similarly motivated to learn
to write effectively in English for their English courses and for their future careers as engineers.

There are various interpretations of the terms domain-specific and strategic knowledge in the literature (e.g., Garner & Alexander, 1989; Greeno, 1980; for a comprehensive review on the different terminologies of knowledge, see Alexander et al., 1991). In this study, domain-specific knowledge is defined as the declarative, procedural, and conditional knowledge ESL students possessed relative to writing in their particular field of study, engineering. However, because the participating engineering students were first year undergraduate students who do not possess sophisticated domain-specific knowledge (see interviews of engineering professors in section 2.1.3.), domain-specific knowledge here simply refers to engineering knowledge in general. Admittedly, this definition is tautological, but it was the only assumption I could make in these circumstances.

Strategic knowledge is a special kind of procedural knowledge which can exist separately from specific domains. Pressley, Goodchild, Fleet, Zejchowski, and Evans (1989) have described a hierarchy of strategies: task-limited that are dependent on a specific domain (i.e., domain-specific strategies); across-domain (i.e., domain-general) strategies that are applicable to different areas (already discussed in section 1.3.). The five thinking prompts in this study refer to general or across-domain strategies.

Strategies are conscious, goal-directed, and intentional. They represent high-order skills which control and regulate some task-specific or practical skills. They constitute self-regulation and self-monitoring. Research has provided evidence that those who monitor and regulate their cognitive processing appropriately during task performance do better than those who do not engage in such strategic processing (e.g., Pressley, & Ghatala, 1990; Zimmerman &
The value of teaching cognitive processes or reflective awareness has been endorsed by many researchers in cognitive psychology (e.g., Carter, 1990; Frederiksen, 1984; Peverly, 1991; Prawat, 1989).

The teaching and learning of strategies in second language writing can be justified by Cummins’ (1984) model of language proficiency. Cummins presents language tasks along one continuum from context-embedded to context-reduced, and on another continuum from cognitively undemanding to cognitively demanding, thus distinguishing between basic interpersonal communication skills (BICS) and cognitive/academic language proficiency (CALP) (Cummins, 1980). Since academic tasks like writing are context-reduced and cognitively demanding, acquiring appropriate strategies is indispensable and beneficial for students.

Despite this need, surprisingly little research has evaluated self-regulation in second language writing. Devine, Railey, & Boshoff (1993) described some implications of cognitive models for instruction in second language writing. Wenden’s (1991) study on the use of metacognitive strategies in the regulation of ESL composing found that three students used a variety of metacognitive strategies: planning, evaluation, and monitoring. Raphael, Englert, and Kirschner’s (1989) training study on upper elementary students’ metacognitive knowledge about writing yielded improvement in their writing and metacognitive awareness. However, as Lantolf and Appel (1994) pointed out, consciousness merits scrutiny in cognitive psychology research because it is more than awareness of one’s cognitive abilities; it comprises the self-regulatory mechanisms employed in problem solving: "What was required, according to Vygotsky, was to discover the appropriate unit of analysis of consciousness, the theoretical principle to explain its formation and operation, as well as a methodological paradigm to carry out the necessary
research" (p. 3).

1.4.6. Zone of Proximal Development

Learners' transitions from inter- to intra-psychological functioning takes place in the "zone of proximal development" which is the:

difference between the child's developmental level as determined by independent problem solving and the higher level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers (Vygotsky, 1978, p. 85).

Procedural facilitation of strategic knowledge fits generally into Vygotsky's concept of the "zone of proximal development". It is goal-directed and tool-mediated. The particular approach I adopted aims at developing in ESL students behaviors that expert writers display in either first or second languages; that is, "learning that is in advance of development" (Vygotsky, 1978, p. 89). ESL students in this longitudinal research collaborated with a more capable adult (the tutor in tutoring sessions) and were expected to internalize the strategic knowledge transacted through assisted performance and be able to apply procedural strategic knowledge while composing on their own. As Vygotsky pointed out, "The zone of proximal development defines these functions that have not yet been matured but are currently in the embryonic state" (Vygotsky, 1978, p. 86).

The training in strategic knowledge through procedural facilitation in this study also meets three characteristics of the zone, that the zone is: (1) setting a level of difficulty -- "good learning is that which is in advance of development" (Vygotsky, 1978, p. 89); (2) providing assistance in performance -- that the transition from inter-psychological to intra-
psychological takes place "in the zone of proximal development" and "under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 85); and (3) fostering independent performance -- that expert-like problem solving behavior will be "matured tomorrow" and needs to be transferred to the learner "in a definite system" (Vygotsky, 1978, p. 169). In other words, procedural facilitation of the five thinking prompts, in the form of expert-led and scaffolded cooperative learning, should be an impetus for developmental change in students' writing performance -- that they will appropriate the use of strategic knowledge, and advance their writing development from social learning (in a tutoring context) to self-directed and self-regulated learning (as independent composing).

In recognition of these matters, there has been a spurt of interest in second language studies espousing the value of a Vygotskian framework for second language acquisition (SLA) theory and research (see Moll, 1989; Schinko-Llano, 1993). Nevertheless, these studies have mostly addressed speaking or inner speech (for a comprehensive review, see Lantolf & Pavlenko, 1995). Very little research has been done on writing in a second language, though Aljaafreh and Lantolf's (1994) study of tutoring ESL writing is a notable exception. Nevertheless, their study sought to teach only discrete, separate grammatical skills and subskills, a kind of "part-to-whole" lesson in which a student worked with bits and pieces of language instead of with full texts (Freeman & Freeman, 1989; Moll, 1989).

1.5. Rationale for the Present Research Design

The purpose of the present research arose out of the issues discussed in the preceding sections. It addressed the evident need for an in-depth empirical study exploring the
effects of procedural facilitation of strategic knowledge on the development of writing expertise in a second language, particularly development of knowledge-transforming behaviors. The research investigated the strategy learning of first year ESL engineering students in academic writing in a second language, with respect to: (1) the qualities of language use, discourse organization, and content in the students' texts, (2) the strategic knowledge students displayed in their thinking processes while composing, that is, the content and complexity of thinking in reference to the five thinking prompts and the aspects of writing they represent, and (3) the students' development of knowledge-transforming in their writing processes.

1.5.1. A Longitudinal Research Study

The present study assumed students' generalized use of the strategies encoded in five procedural facilitation prompts in their second language writing is a product of a long, complex, developmental process. Therefore, a training program had to be extensive in order for ESL students in this study to acquire and be able to use this specific strategic knowledge; only a longitudinal study may give a clear picture of how the use of this specific strategic knowledge is an important factor contributing to more "expert-like", spontaneous writing performance and knowledge-transforming. In addition, various researchers (Bereiter, 1985; Brown & Palincsar, 1989) have pointed out that, thus far, there is little understanding of internalization within the zone of proximal development as a prime mechanism of conceptual/cognitive change; the most viable way of reaching such an understanding is to study how internalization takes place within individuals over time. To this end, I considered it necessary to conduct a longitudinal study with a case study approach and a training component.
1.5.2. A Training Study

Bereiter and Scardamalia (1989) proposed that the need to conduct strategy training is justified by the manifestation of its immediate effects; such research can show how learners overcome a strategy deficiency. In this way, research thus far has shown that training and practice are necessary for attaining high levels of competence or performance improvement in various domains, such as chess playing (Chase & Simon, 1973; Simon, 1980), reading (Carrell, Pharis, & Liberto, 1989), second language acquisition (O'Malley & Chamot, 1990), comprehension (Palincsar & Brown, 1984), composition planning (De La Paz & Graham, 1995; Scardamalia & Bereiter, 1984) and so forth. Ericsson and Charness (1994) also found that extended, focused training together with deliberate practice are crucial for exceptional performance and achievement.

In empirical research, a training study allows one to assess the effects of strategies directly (Peverly, 1991). The present training study consisted of an explicit instructional procedure leading students to independent learning and practice, based on components of instruction that research has revealed to be important for acquiring expertise: (1) teacher modeling (ESL teacher in individual tutoring sessions), (2) scaffolded practice (in tutoring sessions), (3) independent practice (while composing), (4) consolidation (teacher or tutor feedback), and (5) application or transfer (to various writing tasks). The present study involved a tutor (myself) conducting strategy training in tutoring sessions with individual students.

1.5.3. The Dimensions of Performance Studied

1.5.3.1. Quality of Compositions. Research question 1 compared the quality of
compositions students produced before and after the training in procedural facilitation of strategic knowledge:

What aspects of the quality of the compositions written by ESL engineering students improve after the training in procedural facilitation of strategic knowledge in second language writing?

As Cumming (1988) has pointed out, much previous research on both first and second language writing assessment has showed that substantive content, discourse organization, and language use are the three aspects of writing that "figure most predominantly in judgements of the qualities of students' compositions" (p. 34). I set out to assess the quality of these three aspects of writing before and after the training in procedural facilitation of strategic knowledge. The purpose was to evaluate what improvements the students made in their written texts after the procedural facilitation tutoring. Two rating schemes were employed to rate a set of two comparable tasks written at the beginning then at the end of the tutoring sessions. One scheme comprised six categories (global quality, communicative quality, organization, argumentation/content, language accuracy, and language appropriacy) (Hamp-Lyons, 1991; Hamp-Lyons & Henning, 1991) rated by ESL teachers. The other involved three categories (language use, content, and organization) rated by engineering professors. In addition to text ratings, I used Lautamatti's topical progression and topical structure analyses for analyzing topical depth and syntactic complexity in the students' texts before and after the tutoring. These analyses were expected to provide multiple, convergent evidence of changes in students' written products.

1.5.3.2. Use of Strategies as Attention to Five Aspects of Writing. Research question 2 compared the attention that students devoted to the five aspects of writing represented in the procedural facilitation prompts -- word, L1-L2, goals, fit, and rules -- before and after the
training study. Think-aloud protocols from two writing tasks, administered at the beginning then at the end of the tutoring were transcribed, segmented, and coded for the content and complexity of students' thinking while composing in reference to these five aspects of writing:

Do ESL engineering students make greater use of strategic knowledge in their writing processes after the training in procedural facilitation of strategic knowledge in second language writing?

This question compared the content and complexity of students' thinking while they wrote before and after the training study, investigating whether more references or more complex references to the five aspects of writing were more prevalent in students' thinking processes immediately after the strategy training than before it. These included behaviors such as goal-setting and planning (Cumming, 1988, 1989, 1995a; Jones & Tetroe, 1987), L1-L2 transfer (Carson et al., 1990; Cumming, 1989, 1995a), audience awareness (Cumming, 1989, 1995a; Nystrand, 1990; Roen & Willey, 1988), and word choices (Cumming, 1988, 1989, 1995a). Study of this question is also based on the tentative hypothesis that the application of domain-general strategies would produce heuristic problem-solving -- as indicative of writing expertise -- in students' thinking while writing.

1.5.3.3. Use of Knowledge-transforming. Research question 3 assessed whether students made the leap from knowledge-telling to knowledge-transforming, or at least, made greater use of knowledge-transforming, in their writing processes over the period of the research:

Do ESL engineering students make greater use of knowledge-transforming behaviors in their writing processes after the training in procedural facilitation of strategic knowledge in second language writing?

Study of this question is based on Bereiter and Scardamalia's (1987a) cognitive developmental
writing models: knowledge-telling and knowledge-transforming. They contend that immature or inexpert writers can change from knowledge-tellers to knowledge-transformers after training in procedural facilitation of strategies. As Bereiter (1990) indicated, to date, there has been no longitudinal research documenting this acquisition.

1.5.4. Methodological Issues

1.5.4.1. Task Variables. Different kinds of writing were collected for the present research to assess the extent of consistency and variation in students' writing performance across tasks before and after the strategy training study. The tasks were selected mostly to represent the kind of academic writing pertinent to the students' discourse community, that is, most of the writing tasks and topics were related to studying engineering. The selection of domain-related topics and tasks was based on the assumption that by placing writing practice in academic contexts (that is, situated writing), there is the maximum possibility of writing skill or strategy transfer (although as noted earlier this is a debated assumption). Moreover, the use of domain-related topic and tasks is well supported by research findings. Tedick and Mathison (1995) found that the most effectively framed ESL essays they analyzed were mostly written on domain-specific rather than general topics. Walker (1987) suggested assessing cognitive skills in a familiar rather than in an unfamiliar domain because it can provide more accurate indications of individuals' cognition. Kroll's (1979) survey on the writing needs of foreign and American college freshmen and Peyton et al.'s (1990) study of ESL children writing also found that when writing tasks were less related to experience and knowledge, students tended to find them most difficult and their writing was less elaborate. Kroll and Reid's (1994) guidelines for designing
ESL writing prompts suggest that writing prompts must be carefully prepared, considering six variables -- contextual, content, linguistic, task, rhetorical, and evaluation variables -- in the context of specific knowledge domains. Similarly, strategy instruction should consider teaching strategies within learners' prior knowledge or domain-specific content rather than teaching strategies in new knowledge domains because domain-specific knowledge can assist learners in monitoring their writing and learning.

This study also included a few non-domain-related tasks in the tutoring sessions because writing in a variety of contexts is important to ESL students' writing development (Peyton et al., 1990). As pointed out by many researchers, valid assessment of writing ability should include different writing samples of different writing tasks, topics, purposes, and audiences.

The various dimensions of performance studied provided multiple converging data on the results of the training study. The goal was to explore the effects of procedural facilitation of strategic knowledge -- through five thinking prompts -- on writing performance in a second language. I sought to balance process and product variables in light of individual differences as well as exploring their relations in reference to the development of writing expertise and knowledge-transforming behaviors in a second language.

1.5.4.2. Individual Differences and Social Contexts and Writing. Case study profiles of each of the students were undertaken to supplement the analyses conducted to answer the three main research questions. These case studies documented individual students' progressions over time to investigate possible effects of procedural facilitation. I expected that individual differences would play a pivotal role in strategy learning processes and outcomes.
instance, research has indicated that goal-setting and self-evaluation influence learning approaches and achievement (Schunk, 1995). Second language writing research (e.g., Arndt, 1987) has revealed evidence of great varieties among second language writers. Nonetheless, past studies on expert versus novice performance have concentrated mainly on learners or writers as a group; no studies on individual differences among members of the same group have been conducted (Alexander & Judy, 1988; Peverly, 1991). Studies are needed to uncover variations in individuals' writing processes and growth (Freeman et al., 1987), including engineering students (Herrington, 1985a, 1985b).

Writing research has also indicated that it is important to explore the relationships between the formal features of a text and its social and rhetorical situations, pointing out that language processes must be understood in terms of language contexts (Freeman et al., 1987; Herrington, 1985a, 1985b; McCarthy, 1987; Mosenthal, 1983; Nystrand, 1989; Prior, 1991). The nine case study profiles conducted in the present study focused mainly on what went on in the tutoring sessions. The purpose is to study the effects of procedural facilitation -- how it was carried out under the individuals' zone of proximal development, and whether students internalized and appropriated the use of the five heuristic strategies and advanced their writing development from social learning to self-directed learning.
Chapter 2

Methods

This chapter documents the research methods employed in the study. It has eight sections. After introducing the chapter and the design of the research, the first section documents preliminary studies I undertook to develop the methods of training in procedural facilitation of strategic knowledge, to interview engineering professors and course co-ordinators about their expectations for ESL writing in this context, as well as to pilot-test writing tasks and topics and other instruments. The second section outlines the procedures for data collection in the main study. The third section describes characteristics of the ESL engineering students who participated in the main study. The fourth section describes the ESL learning context in the main study. The fifth section documents the procedures for transcribing the think-aloud data and the tutoring data obtained. The sixth section presents the schemes used to rate compositions and to code the use of strategic knowledge and knowledge-transforming in the think-aloud protocols, providing operational definitions and examples of individual coded categories. The seventh section describes the procedures for conducting both quantitative and qualitative analyses to address the research issues reported in subsequent chapters. The final section discusses some assumptions and limitations of the design of the study.

The goal of this study was to trace the procedural facilitation of strategic knowledge in writing in a second language among ESL engineering first-year undergraduate
students -- to determine how their writing expertise (use of heuristic searches and problem solving behaviors), text production, and knowledge-transforming behaviors developed in the context of this strategy training. The study was originally designed as a longitudinal research with a quasi-experimental design and a training component. However, because no control group subjects could be solicited (see section 2.2.1. below), I adapted the research design to become a longitudinal study with a case-study approach and a training component. The three main research questions introduced in the first chapter and forming the basis of my analyses were:

1. What aspects of the quality of the compositions written by ESL engineering students improve after the training in procedural facilitation of strategic knowledge in second language writing?

2. Do ESL engineering students make greater use of strategic knowledge in their writing processes after the training in procedural facilitation of strategic knowledge in second language writing?

3. Do ESL engineering students make greater use of knowledge-transforming behaviors in their writing processes after the training in procedural facilitation of strategic knowledge in second language writing?

A combination of both quantitative and qualitative methods was applied. Process-tracing methods (think-aloud reports of decision making while composing) and text analyses were employed to study the different aspects of writing performance. Case studies profiles of students supplement these analyses.

2.1. Preliminary Studies

Several preliminary studies were conducted prior to the main study. These preliminary studies attempted to establish and refine appropriate procedures for the tutoring using procedural facilitation, to develop and modify instruments for data collection, as well as to search
for and field-test suitable writing tasks and topics.

2.1.1. Initial Case Studies

The issues to be addressed in the main study were investigated through initial case studies of tutoring and the writing processes of ten ESL engineering students (of different nationalities), then more specifically with four of them who volunteered to participate in the field-testing of writing tasks and topics for the main study. At the end of the preliminary study, each of the four students produced a composition on an engineering definition task, with topics of their own choices, together with a concurrent think-aloud protocol. I coded their protocols impressionistically, using the five thinking prompts as indicators of aspects of writing they had attended to while composing, to form the basis for the strategic-knowledge coding scheme described later in this chapter. Results, documented in a pilot study report, showed little change in either the content or the complexity of the students' thinking processes after a single training study. This indicated that the design of the research would have to involve tutoring over a lengthy period of time in a series of tutoring sessions.

A second methodological issue was that an approach I had initially conceived -- of counting the number of engineering lexical items used technically (in reference to Godman & Payne, 1981) in the think-aloud protocols -- was insufficient to account realistically for domain-specific knowledge in participants' writing performance (through their verbal report data). So I dropped this idea and replaced it by a new coding scheme related to knowledge-transforming behaviors, as described at the end of this chapter. Second, it happened that only one participant used his mother tongue in his think-aloud protocol, though all had been informed clearly that they
should think aloud in whatever language they were actually thinking in. For this reason being unsure of my initial methods, I decided to provide a more thorough thinking-aloud training session preceding the writing session in the full study. Several instruments to be used in the main study were refined, modified, or developed after being field-tested in the case studies. The student questionnaire to gather profile information on individual participants was adopted from Cumming (1988).

2.1.2. Interviews with Engineering Professors

I interviewed nine engineering professors and first-year course co-ordinators and the first-year engineering faculty advisor to prepare the writing tasks and topics. My purpose was to seek advice from them on writing tasks and topics to be administered in the present study. The findings from these interviews can be summarized as five main points:

1. Engineering Academic Assignments. Most first-year engineering academic assignments at this university require very little English writing, or virtually none, but rather focus on mathematical calculations. However, they elicit high levels of domain-specific knowledge -- either "technical knowledge" or "first-year undergraduate level domain-specific knowledge". The ability to organize content, to structure grammatically correct sentences, and to convey meanings to expected audiences are the necessary basic writing skills required (e.g., for lab reports). Usually instructors provide guidelines on formats required.
2. Perception of Students' Roles as Writers. Overall, the abilities "to structure highly organized content and information" and "to communicate ideas correctly to other students, professors or potential employers" are considered to be of the greatest importance in engineering students' future roles as writers, according to these engineering professors and their teaching assistants.

3. The Importance of Acquiring English Writing Skills for ESL Engineering Students. The writing abilities (described above in item 2) expected from first-year engineering students (in the writing tasks described in item 1 above) are also perceived to be the major writing problems of many ESL first-year engineering students. These writing problems are considered to be an impediment to successful performance in academic studies. Thus the acquisition of high levels of ESL writing abilities is vital not only for ESL engineering students' academic success at the present but also for their personal and professional advancement in the future.

4. Consultation on Writing Tasks and Topics. Each professor recommended certain tasks and topics. They all ardently reminded me that engineering students do not possess high levels of domain-specific knowledge until they are in their third year. Some
professors suggested choosing topics for writing tasks that have something to do with technology, or some prescriptive, broad social topics of particular interest to engineering students. Overall, the majority of them contended that the study should focus on writing, not engineering knowledge, because first-year students have only a low level of engineering knowledge.

5. Requests for Assistance Rating Students' Writing. Two engineering professors agreed to help in rating all 124 pieces of writing in the full study. One professor teaches chemical engineering and the other teaches humanities courses in the engineering faculty.

2.1.3. Pilot-testing of Writing Tasks and Topics

Five phases of piloting-testing of writing tasks and topics for the present research were conducted with four, then later two, ESL first-year engineering students and three non-engineering graduate students. In addition to testing the feasibility and comparability of writing tasks and topics, and to see if they would elicit specific instances of engineering knowledge (despite item 4 above), my purpose was to determine the task formats to be used in the full study. This pilot-testing started in the spring semester of 1992, then continued through the summer and fall semesters to end in the spring of 1993. Whereas the first phase of pilot-testing involved students' free choices of topics, the second phase was on tasks and topics devised in reference to Ruth and Murphy (1988) and the book Technically-write (Blicq, 1987) used as a text
book in some of the ESL writing courses. The third phase involved interviewing engineering professors, as described above, the fourth phase was on tasks and topics suggested by the engineering professors, and the fifth phase involved trying out tasks and topics suggested by some ESL first-year engineering students participating in the pilot-testing.

In brief, findings from these five phases of pilot-testing of tasks and topics were:

First, the topics administered would have to be controlled carefully (through selection, piloting and analyses) to ensure they are truly comparable, feasible, and relevant. Second, some topics (e.g., evaluating two building sites, or describing how an electrical appliance works) did not necessarily require engineering knowledge, as one non-engineering student in the pilot-testing produced better writing than the engineering students (see point five below). Third, it was found that differences in students' writing would be more distinct if prescribed formats were not provided, so I decided to use relatively open-ended topics in the main study. Fourth, students liked to write on certain creative topics such as designing a technologically manufactured machine or material. Fifth, as suggested by the engineering professors, topics administered in the full study should not demand sophisticated engineering knowledge, because engineering students do not typically have this in their first academic year. Sixth, as recommended by some engineering professors, topics concerning technology, or tasks involving reading scientific journals were worthwhile. Seventh, some tasks suggested by the engineering professors (e.g., evaluation report of the Challenger Accident and Air Ontario Accident technical reports, which I tried out in the fourth phase of pilot-testing) proved to have problems of both feasibility and comparability and so had to be abandoned. Eighth, some tasks -- describing how a simple device works (e.g., how a stapler or a hole-punch works), which some engineering professors considered
to be interesting and manageable topics for first-year engineering students -- were found to be very difficult for the participating ESL first-year engineering students. Ninth, tasks and topics suggested by the participating ESL first-year engineering students -- argumentative writing, based on articles taken from a first-year engineering course, and technical description of a figure or diagram -- produced feasible, comparable topics, and did elicit some engineering knowledge.

2.2. Data Collection

Data collection for the main analyses started in mid-February, 1993, and ended by the end of July. The total period for all data collection was therefore five and a half months.

2.2.1. Solicitation of Participants

Prior to the solicitation of participants in mid February, consent for conducting the research was obtained from the ESL program co-ordinator, ESL teachers, the Engineering Department, as well as from individual first-year engineering professors and course co-ordinators. Then first-year ESL engineering students were invited to participate in the research through a letter (describing the study in both English and Chinese) which was distributed in four engineering ESL writing classes (but see the circumstances mentioned below). I focused on Cantonese learners of English because I speak this language and therefore could understand it in their think-aloud protocols, and because students in these courses included large numbers of people from Hong Kong. I aimed to control for cultural and linguistic diversity, and its possible effects on the results of the research, in this way. My initial plans for the research were to solicit students from: an experimental class with its teacher receiving a small stipend and agreeing to
incorporate instruction in learning strategies into her regular classroom presentations; a second experimental class with its teacher not involved in the strategy training in her regular classroom teaching; and a third class acting as a control group. However, when only one student in the potential control class volunteered for the research, the letter was then distributed in one more engineering ESL writing class to solicit participants for a control group. The letter distributed to the two "experimental" classes informed potential participants of the research study and offered individual tutoring in second language writing, utilizing procedural facilitation of strategic knowledge, whereas the letter distributed to the two "control" classes informed potential participants of the research study and design but offered them tutoring sessions with error corrections only.

Eight students (five males and three females) from the first experimental class initially volunteered for the research. But two female students withdrew before the pre-tutoring writing sessions started, one male student withdrew after writing one composition, and another male student's data, mainly his four pre-post writing tasks, had to be finally discarded because he did not participate in any tutoring session. Three students (all males) from the second experimental class volunteered to participate. In the two classes designed as control groups, only four students, two from each class, volunteered. This was probably due to engineering students being overloaded with course work and not having any particular incentive to be control-group participants in the study. Moreover, one control-group participant withdrew prior to the pre-tutoring writing sessions; and another -- the only non-Chinese participant -- had to be rejected so that cultural and linguistic homogeneity would be controlled for in the study.

In sum, nine students participated in the research and tutoring. They were solicited
from four ESL writing classes. There was not an equivalent distribution of males and females; there was only one female among the nine participants. It was obvious that neither the number of participants from the second experimental class nor those in the control classes was sufficient to make valid the quasi-experimental research design originally conceived for this study, particularly to investigate and compare the effects of different treatments across groups. As a result, the quasi-experimental design was abandoned and changed to a case-study approach with a strategy training component.

2.2.2. Meetings with Participants

After receiving the consent forms and completed student profile questionnaires from potential participants, I telephoned individual students to schedule an initial meeting for reviewing and verifying their responses. In addition, I informed the participants in greater detail of arrangements for subsequent meetings. Altogether there were twenty-eight meetings for each student, including the initial meeting, four pre- and post-program writing sessions, three interview sessions, ten other writing sessions, and ten subsequent tutoring sessions. All meetings were scheduled at times convenient for the participants. Eight participants, except one, wrote all fourteen compositions and attended all ten tutoring sessions. The other student participated in nine writing sessions (including pre-post writing sessions) and four tutoring sessions.

2.2.2.1. Think-aloud Training. I gave a think-aloud demonstration and training session preceding the first writing session for the pre-program tasks. These involved three small demonstrations by me (in whatever languages I was actually thinking in, including Cantonese and English) and three subsequent practise opportunities by individual participants. First, I
demonstrated how to think-aloud while solving an arithmetic problem (following Ericsson & Simon 1984 pp. 375-379, and Cumming 1988, pp. 59-60); and participants practised this by performing two other similar arithmetic problems, talking aloud in whichever languages (Cantonese or English) they were currently thinking in. Then I gave further think-aloud practice by stating the number of windows in my home; and participants repeated this practise by referring to their own homes. At end of the session, I asked each participant to think aloud in no more than six sentences on the topic of "my major (study)". I encouraged participants to think aloud in whatever languages they were actually thinking in; it is common for Chinese ESL students from Hong Kong to code-switch between their L1 and L2 while talking about their academic studies, which are mostly taught in their second language, English. I did not provide any training in thinking aloud while writing (prior to the first tutoring session), so as not to bias the behaviors of the participants in regards to behaviors I might personally have displayed while writing.

2.2.2.2. Writing Sessions. In total, there were fourteen writing sessions for individual participants: two pre-tutoring writing sessions, ten individual writing sessions preceding ten individual tutoring sessions, and two post-tutoring writing sessions. Two kinds of data were collected from these sessions, compositions and concurrent think-aloud protocols. Participants wrote one composition at each session in a seminar room. Each session lasted two to two and a half hours. Apart from the four pre-post writing sessions, each of the other ten writing sessions involved provision of procedural facilitation using the five thinking prompts in the form of short cue questions (see section 1.4.4. during their composing and generating of think-aloud protocols). Dictionaries, including one for synonyms, were provided in all fourteen writing sessions.
Participants’ thinking aloud while composing was tape-recorded.

2.2.2.3. Writing Tasks. The fourteen pieces of writing in English by individual participants involved seven pairs of topics for seven different writing tasks -- technical description of chemical processes and argumentative writing based on engineering readings (in the pre-post sessions) then in the tutoring sessions technical reports on environmental issues, technical descriptions of technological products, engineering-related letter writing, engineering definition writing, and non-engineering definition writing. They were counterbalanced in the order of presentation on the pre-post tasks and within the pairs of topics by using a table of random numbers so that effects of order of presentation would be avoided. However, the order of presentation for the writing tasks in the tutoring sessions followed a fixed sequence (see Table 2-1) so that all participants received similar strategy training. It was anticipated that different knowledge demands from the various tasks might exert an influence on and elicit different writing performance from participants. In addition, four of five tasks for the tutoring sessions demanded different levels of engineering knowledge (high or low). My major concern, however, was to determine whether the students displayed differences in their second language writing, in respect to text quality, strategy use, and knowledge-transforming behaviors, before and after the strategy training.
Table 2-1: Writing Tasks (for Pre-Post and Tutoring)

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Kinds of Writing</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Post</td>
<td>Technical Description</td>
<td>on (A) an advanced pulverized coal plant with an advanced flue-gas desulphurization system, or (B) an advanced coal plant with integrated gasification combined-cycle technology</td>
</tr>
<tr>
<td></td>
<td>(counterbalanced)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Argumentative Writing</td>
<td>based on a reading article on (A) Otto Engine, or (B) Diesel Engine</td>
</tr>
<tr>
<td>1/10</td>
<td>Technical Report</td>
<td>in relation to the (A) Greenhouse Effect, or (B) Ozone Depletion</td>
</tr>
<tr>
<td>2/9</td>
<td>Technical Description</td>
<td>on (A) A Technologically Manufactured Machine, or (B) A Technologically Manufactured Material</td>
</tr>
<tr>
<td>3/8</td>
<td>Letter</td>
<td>to (A) an Engineer, or (B) an Engineering Student</td>
</tr>
<tr>
<td>4/7</td>
<td>Engineering Definition</td>
<td>on (A) Calculus, or (B) Statics</td>
</tr>
<tr>
<td>5/6</td>
<td>Non-engineering Definition</td>
<td>on (A) Youth, or (B) Happiness</td>
</tr>
</tbody>
</table>

The two pre- and post-tutoring writing tasks involved (a) technical description and (b) argumentative writing based on reading an engineering article. They were randomly counterbalanced for each student in either the pre- and post-tutoring sessions. There were various reasons for choosing these two tasks. First, both tasks had been suggested by a few engineering course coordinators during interviews. Second, both these tasks and topics were strongly recommended by first-year engineering students participating in the pilot-testing of the writing tasks and topics. Third, these two tasks seemed representative of the engineering mode of writing as determined by a survey among various engineering departments in universities with high foreign enrolments across North America (Bridgeman & Carlson, 1984). Fourth, the knowledge variable would be controlled for since topics chosen for these two tasks entailed relatively sophisticated engineering knowledge. Participants had neither performed these tasks previously, nor had they studied them during the spring semester of data collection. Fifth, the pilot-testing showed that these topics and tasks were feasible, comparable, and would elicit some
engineering knowledge from first-year engineering students, though not necessarily sophisticated technical knowledge.

The **pre-post technical description task** asked participants to describe the technical processes of a newly devised power plant and to explain why it is an efficient way for controlling carbon dioxide emissions. The two figures and one short paragraph of information (for each figure) are from chapter 8, "The likely roles of fossil fuels in the next 15, 50, and 100 years, with or without active controls on greenhouse-gas emissions" (Kane & South, 1992), of an engineering book *Limiting greenhouse effects: Controlling carbon dioxide emissions: Report of the Dahlem Workshop* (Pearman, 1992). The title of the first Figure (Figure 8.11, on page 215 of this book) is: Principal component of a power plant with advanced flue gas cleanup. The title of the second Figure (Figure 8.12, on page 218 of this book) is: Principal components of a power plant with integrated gasification combined-cycle technology. Both figures originated from DOE (the U.S. Department of Energy) (1987a & 1987b). The instructions for one version of this technical description task were:

You are working as an engineer in an electric power research institute. Research into greenhouse-gas emissions and more advanced fossil-energy technology are under development. The CEO asks you to write a technical description on this schematic of an advanced pulverized coal plant with an advanced flue-gas desulphurization system, to explain how it works and why it is an efficient way for controlling CO₂ emissions. Your technical description will be published in the institute’s journal. Your readers for this technical description are your boss and colleagues. Your boss will already be aware of much of this information, but some of your colleagues may know little about it.

The instructions for the second version of this task were:

You are working as an engineer in an electric power research institute. Research into greenhouse-gas emissions and more
advanced fossil-energy technology are under development. The CEO asks you to write a technical description on this schematic of an advanced pulverized coal plant with an integrated combined-cycle technology, to explain how it works and why it is an efficient way for controlling CO₂ emissions. Your technical description will be published in the institute’s journal. Your readers for this technical description are your boss and colleagues. Your boss will already be aware of much of this information, but some of your colleagues may know little about it.

As Bridgeman and Carlson (1984) pointed out in their survey, "The topic describe and interpret a graph or chart was a clear favorite among the engineering and science departments". I devised this task to represent conventional engineering writing, a technical process description, where participants could compose by following the figure as a framework and using their engineering skills (though not expecting sophisticated technical knowledge from these first-year students).

Both versions of the pre-post argument task asked participants to read a chapter - a ten-page article from the History of technology and engineering since the industrial revolution first year engineering course book (Hall, 1992, pp. 96-105 and pp. 106-115) -- then to write an argumentative essay based on their understanding of the particular theory and engine from the reading. These writing tasks seemed comparable, feasible and would elicit engineering knowledge, because both chapters were originally published in the same magazine Scientific American (March 1967 and August 1969) and were written by the same author (Bryant, 1967, 1969), consisted of the same number of pages, were illustrated clearly with diagrams, and most importantly, were textbook materials for first-year engineering students in this Ontario university. In addition, the knowledge variable was controlled for, as the students participating in the full study were not enrolled in this engineering course (History of technology and engineering) during the semester for data collection. The instructions for one version of this argument task were:
You are taking Professor Hall's *History of Technology and Engineering* course. You have to do an argumentative writing task on "Otto's engine and theory" with respect to Lynwood Bryant's article. In your paper, you will argue whether the success of Otto's engine meant or did not mean the success of the theory that guided him. Your paper will be presented in class (to your professor and about one hundred students in your class).

The instructions for the second version were:

You are taking Professor Hall's *History of Technology and Engineering* course. You have to do an argumentative writing task on "Diesel's engine and theory" with respect to Lynwood Bryant's article. In your paper, you will argue whether the success of Diesel's engine meant or did not mean the success of the theory that guided him. Your paper will be presented in class (to your professor and about one hundred students in your class).

"Argumentation with audience designation" was considered by many engineering faculties in North America with high foreign enrolments as "1 - acceptable/good" according to Bridgeman & Carlson's survey (1984, p. 271). Similarly, according to one engineering professor I interviewed, articles from *Scientific American* were "scientific in content and reasonably general" and were texts that "worked well at a professional level". Thus, I devised this argument task to be representative of a demanding, intellectual academic assignment, commonly required of students in engineering humanity courses which involved an integration of reading and writing. The reading material was given to participants one week preceding the writing session; I presumed they had read the article thoroughly before performing the writing task.

In addition to the pre-post technical description and argument tasks, five other writing tasks with comparable topics (according to engineering professors' and some students' suggestions and comments) were chosen for the ten tutoring sessions. Each pair of topics on these first and tenth (last), second and ninth, third and eighth, fourth and seventh, fifth and sixth
writing tasks were counterbalanced in the order of presentation. These additional tasks provided the context for the tutoring and for writing practice. Informally, I intended to further assess whether participants demonstrated changes in their written texts over different periods of time, which aspects of the qualities of their writing improved, and whether task and knowledge variation would affect changes in participants' writing performance. However, the research was not designed to assess these matters rigorously and its design could not do so systematically.

Most of these writing tasks and topics were either suggested or approved by engineering professors during interviews. The first/tenth task was technical report writing, recommended by some of the engineering professors. Prior to the writing session, students were provided with two pages of information on topics from an engineering book *Responding to global warming* (Eastwood, 1991). This short reading was included just in case some participants had no knowledge of these environmental issues at all. The instructions for two versions of this task were:

You are an engineer working in a company which is in the business of producing some materials that have something to do with the issue of greenhouse effect/ozone depletion. There is a concern that the government will tighten the regulations on these things. The CEO asks you to write a technical report to discuss the issue of greenhouse effect/ozone depletion, how it would affect the operations of your company, and what measures can be taken. Your report will be presented and discussed in the company's meeting with your boss and colleagues.

The second/ninth task was technical description. The topics had been pilot-tested and were strongly recommended by two first-year ESL engineering students who performed the tasks. They were also endorsed by some of the engineering professors interviewed. One professor commented on this task, "That's what they do after they graduate;
to some extent what they write here. And it shouldn't be too difficult for them. I think they
don't have to use sophisticated technical knowledge." The instructions for the two versions of
this task were:

Technologically manufactured machine/material -- Either choose one already manufactured machine/material to the best of your
knowledge as your new design or have a completely new design of
your own, write a technical description to the boss and some senior
colleagues of your company, to convince them that your new
design of the machine/material is unique and useful, and describe
how it can be applied in your particular field.

The third/eighth task was engineering-related letter writing, as recommended
by one engineering professor who emphasized, "The issue is not writing as engineers, the issue
is writing". According to most of the engineering professors interviewed, the majority of
engineering students would work in the management field after graduation, and they would
routinely have to write letters. Therefore, this task was devised as informal but conventional
writing commonly required of students, not only in ESL composition classes but also in the
engineering field. The instructions for this task, slightly modified from a rubric suggested by one
engineering professor, were:

Write a letter to an engineering student/an engineer who does not
work hard.

The fourth/seventh task was engineering definition writing. The two topics,
"Calculus" and "Statics", were recommended by the two first-year engineering students
participating in the pilot-testing of writing tasks and topics. According to them, first-year
engineering students should be able to write on these two topics based on knowledge they
acquired from high school and first-year engineering courses in the fall semester; no sophisticated
knowledge would be required for completing this task. As one engineering professor said,
"Choose prescriptive, broad topics because first-year students have only a low level of engineering knowledge". This task (i.e., to define calculus or statics, respectively) was selected to be representative of academic writing relevant to participants in their level of domain-specific knowledge.

The fifth/sixth task involved non-engineering definition writing. The two topics were "Happiness" and "Youth" which presumably participants would have thought of or discussed previously. This task (i.e., to define happiness or youth, respectively) was chosen to represent academic writing usually assigned to students in composition courses; it was utilized to see whether there were any obvious differences in participants' writing performance in a non-engineering topic.

2.2.2.4. Tutoring Sessions. Prior to the first tutoring session, I held an introductory session of about twenty-five minutes with each person. First, I (the tutor) explained what the five thinking prompts were (see section 1.4.4). Then I told the person that these five thinking prompts represented aspects of writing derived from previous research on the thinking processes that ESL writers with high levels of writing expertise use when they write in their second language, and practising these should help them become more aware of and practise complex, expert-like mental activities while composing. After that, I did a short think-aloud demonstration, showing the student how to use the five thinking prompts while composing (i.e., on-line revision) and for evaluation (i.e., revision afterwards) by using some cue questions (see section 1.4.4). I also answered any queries from participants regarding the five thinking prompts.

I (the tutor) and an individual participant worked on a piece of writing completed in a writing session that preceded every tutoring session. The students used the five thinking
prompts as independent cues while they composed. In each tutoring session, the use of five thinking prompts was routinized in various procedures, for example, for student-initiated editing or revisions and tutor-prompted editing or revisions (by referring to the five procedural facilitation prompts in the form of simple cue questions), then text analysis (using cue questions in a more elaborated form), and finally discussion on how to improve the text based on these five aspects of writing.

At first, the participant read the text sentence by sentence, and made self-corrections or changes simultaneously, by (a) referring to the five cuing questions; (b) indicating the existence of a problem; and (c) pinpointing whether it corresponded to the prompts, word, L1-L2, goals, fit, rules or a combination of more than one of them. (Usually participants applied only the last step after getting familiar with the five thinking prompts or aspects of writing.) Whenever changes suggested by the participant were not relevant, I used questions to help the person to diagnose the problem, compare different possibilities, and reach appropriate choices, instead of providing immediate answers, unless the person really could not retrieve any appropriate choices. Then the participant made corrections on a photocopy of his/her text and wrote down the specific problem(s) (i.e., word, L1-L2, goals, fit, and/or rules) on the left margin of the text. At the same time, I wrote down the change(s) on another photocopy of the text, and recorded them separately as student-initiated revisions.

After the participant finished making self-initiated revisions for the whole piece of text, the person read it again sentence by sentence. This time I prompted the student whenever I perceived a problematic phrase undetected in the previous revision and editing, "Do you find a problem/any problems here? What problem(s) is it/are they?" If the person could not
identify the problem(s), I used some tutor-prompted cue questions to guide the person.

Again, instead of suggesting immediate resolutions to the participant after identifying the problems, I tried to use questions to lead the participant in diagnosing the problems, comparing alternatives, and resolving the problems. The purpose of these questions was to apply the three major steps in procedural facilitation (Bereiter & Scardamalia, 1987a) — to diagnose, compare, then operate — and to let students take the initiative as much as possible (so the tutor’s role would "fade" gradually as students became more self-regulatory). Then both the participant and I wrote down the appropriate revisions on the photocopies of the text, and circled indications of specific problems written on the left margin of the text, distinguishing them from changes made without provision of prompts or my prompting. I also recorded them separately as tutor-prompted revisions on another sheet of paper.

After finishing tutor-prompted error revisions on the whole piece of writing, the participant reread the text a third time to check whether there were any leftover issues needing resolution (by using the same preceding procedures) and to get ready for the next text analysis phase. In the text analysis phase, I led the participant to analyze the written text by using the five thinking prompts as a guide (see section 1.4.4).

After analyzing the written text, I posed an open question, "How can the written text be improved by using the five thinking prompts as a guide?" The participant then discussed what main goals and subgoals should be entailed, how to reorganize different parts of content or paragraphs to fit the goals and the whole; how L1-L2 comparisons might help in the planning, writing, and revising phases; and how to improve the quality of the text by paying more attention to better word choices or grammar or spelling rules. By comparing the revised text with the
previously written one, the person could pinpoint the strongest and weakest points of the written
text and which aspect of the five thinking prompts the person thought needed further work. Emphases on these matters varied according to individual needs.

At the end of the tutoring session, I documented on a summary checklist the participant’s expressed perception of the usefulness of the five prompts for that particular piece of writing. I discussed this with each person as well. In addition, the participant might review or compare changes in her/his use of the five thinking prompts and the written texts over time.

2.3. Characteristics of Participants

Nine ESL first-year engineering students participated in the study. Their ESL writing classes focused on the study of different aspects of rhetorical discourse such as comparisons, argumentation, definition writing, and so on. All participants had to enrol in this writing course because they failed the Engineering Department’s English writing test after admission to the university even though they had achieved TOEFL scores of at least 580 as a condition of admission to the University or had completed high school in Canada. Prior to this accredited course, most of them had taken a non-credited writing course, focusing on syntactic rules and discourse organization. In the thesis, I have given all participants pseudonyms (that preserve gender) to maintain their confidentiality.

2.3.1. Backgrounds and Motivations

All participants were Chinese and could speak fluent Cantonese, except one who was born and educated in Indonesia. All but one came from Hong Kong, and most of them were
new immigrants to Canada. Their length of residence in Canada varied from 1.5 to 10 years, with six of them being here for less than 3 years, and three residing here for longer periods of time (4, 7, and 10 years, respectively). Six were in their late teens, and three in their early twenties. The majority of them had been studying English for 14 or 15 years, except the one from Indonesia who had been studying English for 8 years. Although their age, education, and culture variables were controlled for in the full study, participants were males with the exception of one female. All of them were highly motivated to learn English, either for their present engineering academic studies or future careers in industrial, electrical, or chemical engineering.

2.3.2. Language Preferences

After the data collection started, I classified the participants into two groups according to their language preferences for communication during tutoring sessions and thinking-aloud while composing. Three participants with longer periods of residence in Canada (from 4 to 10 years) and the participant from Indonesia preferred to use mostly or exclusively their second language (English); whereas the other five participants with shorter periods of residence used mostly their first language (Cantonese), with some code-switching from time to time. In general, participants in the second language preference group could speak English very fluently, and had fewer grammatical errors in writing (except Charles, who had been here for 10 years) than participants in the first language preference group.

2.3.3. Writing in First and Second Languages

According to participants’ responses to their questionnaire profile, six people
indicated that it was easier for them to write technical reports or research papers in school or at work in their second language than their first language. It was not surprising that more than half of the participants considered academic writing more manageable in their second language than their first language, since most of them were from Hong Kong where high school textbooks, assignments, tests, and examinations for most courses are in English.

According to participants' responses about learning to write in English in their native country, reading English texts, studying grammar, and studying vocabulary were the three most common activities in their high school English classes. In contrast, for the participant who had been studying in Canada for 10 years, studying vocabulary was not a common activity in his high school English classes. In addition, the majority of participants said they thought that grammar and vocabulary choices were the major problems in their second language writing; grammar was also their priority concern in engineering writing.

2.3.4. Reading in First and Second Languages

The majority of participants did very similar kinds of academic and first/second language leisure reading. They read a Chinese newspaper almost daily, mostly the sports section of English newspapers weekly, and they seldom read English novels or magazines. They spent most of their time on their engineering studies. The time they said they spent on academic reading varied from 3 to 15 hours per week. The time they spent on engineering writing (mostly calculations) varied from 0 to 5 hours per week, and the time they spent on their ESL writing varied from 1 to 6 hours per week.
2.4. The ESL Learning Context

My class observations of the four ESL instructors teaching the participating students indicated that in general all four ESL classroom learning contexts were similar. The four ESL teachers mainly employed a product-oriented instructional approach, concentrating on genre analyses and linguistic forms. They had curriculum guidelines to follow and a textbook (Blicq, 1987) to use. The writing course basically focused on learning different academic genres such as argumentation, comparison and contrast, process writing, descriptive writing, etc. Analyzing exemplary texts was the most common activity in all four classes. Brainstorming on writing topics and doing grammar exercises were occasionally carried out (with the former usually given prior to writing assignments, and the latter after examinations). The writing of thesis statement and topic sentences was taught at the very beginning of the course (before data collection for the present study), though the majority of participants said they had learned all these (including different academic genres) in high school. I observed the teacher in the first experimental group and her class weekly, whereas I observed the other three teachers and their classes only four times in total during the initial semester of data collection. I did these observations to inform myself about their general context for learning ESL writing, and to try to pitch the tutoring sessions to this, but I did not collect data systematically in these settings to analyze for the thesis.
2.5. Transcription of Protocols and Tutoring Data

2.5.1. Transcription Procedures

All the concurrent think-aloud protocols produced by participants while composing both the technical description and argument tasks prior to and after the tutoring sessions were transcribed, using both Chinese and English, thus keeping participants' original verbalization of their thoughts intact and avoiding possible distortions in translation. The entire protocols were transcribed, including participants' verbalization of decision making, metacomments, text production, text reading, as well as other utterances. During the process of transcription, the protocols were segmented into separate statements according to a silence or pause of three seconds or more before or after individual statements, indicating separate units of thoughts. This interval of three seconds as a demarcation into units for analysis was adopted from Cumming's (1988) study of ESL writers' average pauses in protocols; it was slightly briefer than the pauses of six seconds in Flower and Hayes' (1981) study of native-speaking English writers. I also listened to all the 84 audio-taped tutoring sessions and transcribed, using both Chinese and English, parts which I thought revealed either distinct changes in individual participants' responses or their progressions over time.

2.5.2. Transcription Conventions

The conventions employed in transcription follow Cumming (1988, p. 77). For example, conventional punctuation marks were used along with several special conventions. Words or phrases inside number signs (#) were spoken in Cantonese but have been translated to
English in the thesis. Hesitation markers (e.g., ah, um, mm) were transcribed verbatim. Words or phrases which could not be transcribed were noted in parentheses with a question mark (i.e., (?)). Each segment of the discourse was indicated by a slash (/) sign, representing a pause of three seconds or more. I have inserted some parenthetical statements to describe participants' behaviors using square parentheses (e.g., [reread text], [referred to dictionary], etc.). I made no attempts in the transcriptions to correct or modify participants' syntactic or morphological deviances from standard English for their verbal reports originally spoken in English. Data deleted from extracts of verbal reports are indicated by ellipsis (e.g., ...).

2.6. Coding and Rating of Data

Both product and process analyses were undertaken to answer the three research questions guiding the study. To conduct these analyses, different theoretically-informed and empirically-tested rating or coding instruments were adopted or developed from previous related research on English as a first or second language writing.

2.6.1. Coding and Rating of Texts: Research Question 1

To answer Research Question 1, the 124 pieces of writing produced for the 7 pairs of comparable tasks were initially blind rated by 2 ESL teachers and 2 Engineering professors; then I and a second coder coded them for the text analyses. (These included texts produced by 10 students including Alex who wrote 4 pre-post writing tasks but did not participate in any tutoring session. His data was later discarded. Another student, Peter, wrote 8 writing tasks and he participated in 4 tutoring sessions, while the other 8 students participated in all 10 tutoring
sessions and each of them wrote all 14 tasks.) Only the 36 compositions (excluding the 4 pre-post compositions produced by Alex) from the pre- and post-tutoring sessions were analyzed to answer Research Question 1, however. The other ratings were used to interpret case studies of individual students. Whereas the ratings of compositions revealed an overall impression on the quality of some component writing skills in participants' writing performance, text analyses helped to illuminate important textual or rhetorical changes in individual participants' written texts which would not have been apparent from the rating of texts alone.

The blind ratings performed by ESL teachers were done with the nine-band rating scheme (scale 1 to 9) developed by Hamp-Lyons (1990, 1991). This is a multiple-trait rating scheme which had been developed for scoring compositions for the English Language Testing Service (ELTS) in a test administered worldwide to post-secondary nonnative speakers of English by the British Council (Hamp-Lyons & Henning, 1991, p. 341). Appendix A displays this rating scale (Hamp-Lyons, 1991, pp. 148-151) indicating its global rating scale and its band descriptors.

Among all rating categories, "global quality" is the holistic rating for an overall impression judgement of the whole piece of composition. Criteria for "communicative quality" assess the ability to communicate the message to the reader. Criteria for "organization" assess the quality of structure and coherence of the writing. Criteria for "argumentation" assess the quality of content and rhetorical persuasion in the composition. Criteria for "language accuracy" assess the correctness of syntax, morphology, punctuation and spelling. Criteria for "language appropriacy" assess the quality of grammatical and lexical features in the text.

I typed all compositions before rating them so as to avoid effects related to handwriting and to facilitate later text analyses. No errors were corrected, thus keeping
participants' original copy intact. Five raters who had no access to information about the participants' backgrounds rated 10% to 35% of the 124 compositions. All of them were experienced language instructors who were completing their Ph.D.s in second language education at the time of the rating. Practice ratings were first performed on 8 to 20 compositions from the pilot and the main study. Reliability between the first two raters was so low (Alpha .69 over 40 pre-post compositions) that I requested another two raters perform additional ratings. However, they also could not reach a high reliability in their ratings. A fifth rater later substituted for the third rater who, by this time, had left for his native country.

At first, reliability of practice ratings between these two raters -- the fourth and the fifth people involved -- was low (Alpha .72). Then they conducted more practice rating sessions, discussing discrepancies which emerged. After that, the two raters independently rated 30 more compositions from the main study. Overall, reliability between these two raters was high (Alpha .90) over these 30 compositions. Inter-rater reliability (Alpha) for the six rated categories was: .89 for global quality, .76 for communicative quality, .90 for organization, .87 for argumentation/content, .75 for language accuracy, and .79 for language appropriacy. After establishing this level of reliability, the fourth rater (not me, because I knew the students and would have been influenced by this) individually rated the rest of the compositions.

Two engineering professors were requested to help in the rating of the students' texts because of their expertise in the domain. A simple seven-band rating scheme (scale 1 to 7) was developed for this purpose. It comprised three categories -- content, organization, and language use. Caution was taken not to burden engineering professors who had hectic academic schedules with any detailed band descriptions, since the number of compositions to be rated (124)
was very large.

Two engineering professors -- a chemical engineering professor and a professor teaching humanities courses -- individually rated all 124 compositions, including 40 pre-post compositions (produced by ten participants), for the three categories. No practice ratings were performed on any compositions from the study. Overall, inter-rater reliability between the two professors was high (Alpha .90) in their global ratings of the 40 pre-post compositions (and .92 over 124 compositions). Inter-rater reliability (Alpha) for the three rated categories in the pre-post compositions was: .76 for content, .77 for language use, and .55 for organization. Reliability for the category of organization was low. For this reason, I decided that only the chemical engineering professor’s ratings would be analyzed to address Research Question 1, mainly because of his expertise in chemical engineering, and his recent experience in language teaching. First, he would be the best person to judge the pre-post technical description task since it involved chemical engineering process writing. Second, he would be familiar with the two reading articles on engines for the pre-post argument task. Inter-rater reliability (Alpha) for content ratings on this argument task between him and the other professor teaching humanity courses was .80 over 20 compositions. Third, he was coordinating a new English writing course for second year chemical engineering students, mostly ESL students. Fourth, inter-rater reliability between his ratings and the ESL teacher’s (the fourth rater who rated all the compositions) on both pre-post tasks was quite high (Alpha .82) over 40 compositions.

2.6.2. **Text Analyses**

I used two approaches to text analysis to look for any marked changes between
participants' pre-post texts which might not have been apparent from text ratings alone. I adopted Lautamatti's (1978) topical progression analysis for the first text analysis. According to Lautamatti, the concept of topical progression (the progression of sentence topics) and topical depth together represent the topical structure of a written text. Three kinds of sentence progression are identified in Lautamatti's scheme: parallel progression, sequential progression, and extended parallel progression (Lautamatti's topical progression analysis, with samples exemplified, is displayed in Appendix B). Witte (1983) gave a clear explanation to distinguish the three, "In a parallel progression, the topics of the various sentences are referentially identical, using repeated lexical items, synonyms, near-synonyms, or pronouns. In a sequential progression, the comment of a preceding sentence, usually the adjacent sentence, becomes the topic of the following sentence. An extended parallel progression refers simply to a parallel progression which is temporarily interrupted by a sequential progression" (p. 319).

The purpose of employing topical progression analysis in the present study was to investigate if participants' post-tutoring texts would increase in text length compared to their pre-tutoring texts and in the use of parallel and extended parallel progressions, but not sequential progressions. This kind of result, according to Witte (1983), indicates improvement in topical structure -- globally between sentence topics and discourse topics, and locally between successive sentences, that is, more detailed elaboration on important ideas or semantic coherence.

The second approach to text analysis, Lautamatti's topical structure analysis, comprises both topical progression analysis (described above) and topical structure analysis, which defines five different types of topical structures, distinguished as five sentence types. A type 1 sentence is the simplest and a type 5 sentence is the most sophisticated. Appendix B
displays the distribution of these five different types of topical structure, with examples from Lautamatti’s study and from mine.

To establish the reliability of these analyses (topical progression and topical structure/sentence types), I and a second coder, who had no access to information about participants’ backgrounds and was completing a Ph.D. at the time of coding, independently coded 10% (i.e., twelve compositions) of all the compositions after discussion of the two analyses. Inter-rater agreement averaged 84% for the topical progression analysis and 83% for the five sentence types, over 12 compositions.

2.6.3. Use of Strategic Knowledge: Research Question 2

I coded the 40 think-aloud protocols (including Alex’s which was later discarded from analysis) from the pre-post writing for participants’ application of five strategies highlighted in the procedural facilitation cues: goals, fit, word, rules, and LI-L2, or attention paid to these five aspects of writing. Following Cumming (1988), I considered these to be five distinct, heuristic search strategies that adult ESL writers used frequently to evaluate problems they encountered while composing:

. global intentions and local gist (i.e., goals)

. discourse coherence or fit between parts of writing (i.e., fit)

. lexical expression (i.e., word)

. syntactic, morphological, orthographic, or punctuation conventions (i.e., rules)

. code-switching between first and second languages (i.e., LI-L2)
I abbreviated these as \( g, f, w, r \) and \( l \), respectively, in my coding scheme of the present study; when they appear on their own in the think-aloud data, I refer to them as single configurations. Appendix C displays these coding categories, their operational definitions and examples from protocol transcriptions which demonstrate protocol statements coded under each individual category. However, participants often demonstrated the application of more than one strategy in their thinking processes, particularly in the post-tutoring writing, so my analyses coded four additional, complex combinations of these five fundamental categories: from double to quintuple configurations. Double configurations refer to protocol statements indicating that participants were using two heuristic search strategies together: \( gf, gr, gw, gl, fr, fw, fl, rw, rl \) or \( w1 \). Triple configurations refer to combinations of three heuristic search strategies: \( gfr, gfw, gfl, grw, grl, gwl, frw, fwl, frl \) or \( r1 \). Quadruple configurations refer to combinations of four of them: \( gfnu, gfrl, gnu, nfl, gfwl \) or \( fnvl \); and quintuple configurations refer to combinations of all five: \( gfwrl \). My operational definitions of these categories are:

**Goals** - Protocol statements under this category indicate that participants are either attending to something they want to achieve through their writing -- in respect to the global purposes (intentions) of their writing and/or to the local goals of formulating, considering, and structuring content in their written discourse; or trying to set and monitor goals to accommodate readers of their writing.

**Fit** - Protocol statements under this category show that participants are focusing on assessing the relationship between parts of their written discourse, often ideas forming the substantive content of their writing, either individually or collectively by attending to the overall coherence of text in reference to goals, discourse organization, or the relationship between text and diagram/figure.

**Word** - In statements under this category, participants are attending to the semantics of particular vocabulary items or lexical expressions, either explicitly or implicitly evaluating their
appropriateness, qualities, or desirability, or checking their redundancy.

**Rules** - In these statements participants are focusing on grammatical, punctuation or orthographic conventions. They either resolve the problem automatically or by engaging in more extensive thinking processes with explicit or implicit reference to a grammar, punctuation, or spelling rule. In some cases, no resolution is made.

**L1-L2** - In these statements participants use direct translation or code-switching for finding, generating, structuring, or assessing an element or elements in the text. Sometimes they focus on lexical matters, comparing equivalent word or expression choices in their first and second languages. In many instances, they simply code-switch to express their thoughts or ideas forming the content of their writing.

To establish the reliability of these codings, I and a second coder, who had no access to information about participants' backgrounds and was completing a Ph.D. at the time of coding, independently coded 45% (i.e., eighteen compositions) of all the protocols from the pre- and post-tutoring writing tasks. We first practised coding three protocols from the main study, discussing and resolving discrepancies which emerged. Then each coder independently coded eighteen randomly selected protocols, coding each statement for the five configurations. Inter-rater agreement averaged 85%. For individual protocols, agreement ranged from 78% to 92%. One week after coding the full set of protocols, I randomly selected 20% of the protocols to check my intra-rater reliability. The agreement between my initial and subsequent codings averaged 94% over nine protocols. For individual protocols, my agreement between initial and subsequent codings ranged from 92% to 96%.
2.6.4. *Uses of Knowledge-telling and Knowledge-transforming: Research Question 3*

Of particular interest for Research Question 3 was whether participants might have moved in their thinking about their writing from less knowledge-telling (i.e., simply telling their knowledge, or attending to only one problem space at a time) to more knowledge-transforming (i.e., to engage in a substantive mental dialectic between the content space and the rhetorical space while they composed) over the period they received tutoring through procedural facilitation.

I devised a scheme for coding domain-knowledge processing in the think-aloud data distinguishing between these two main categories: (a) knowledge-telling and (b) knowledge-transforming. (See Appendix D for operational definitions and protocol examples).

In statements that involve knowledge-telling, participants just told their knowledge. They either (1) told the knowledge of a topic, including reading information provided or (2) restated or reread what they had written or any information provided in the writing task. No process of higher level thinking such as problem solving behaviors, heuristic searches or decision making were apparent in these protocol statements, possibly because some participants use this simple strategy for generating content (Scardamalia & Bereiter, 1985; Cumming, 1989). If some participants brought forth higher level thinking but did not report it in their thinking-aloud, then it was not accessible for my analyses.

In statements that involve knowledge-transforming, participants engaged in problem solving, heuristic searches and/or decision making while attending to the substantial content of their writing. Often conceptual and/or textual changes were apparent. Thus, extensive mental effort was applied to: (1) recognizing the topic/purposes of writing, (2) planning and/or structuring content, (3) processing and exploiting the topic (or text or diagram) for understanding,
(4) making changes in domain-specific vocabulary or expression choices, (5) making conceptual changes by evaluating, adding or deleting possible content in reference to purposes of the written task, or (6) making conceptual changes because of ideational changes like adding, deleting or reordering sentences or paragraphs in reference to the relevancy, adequacy or coherence of content, (7) reviewing content, or (8) making self-explanations or self-monitoring to justify conceptual or ideational changes made. To establish the reliability of these codings, I and a second coder, who had coded the use of strategic knowledge previously for Research Question 2, independently coded 45% of the 40 pre-post protocols (i.e., 18 protocols). After practising coding three protocols from the main study and resolving discrepancies, each of us independently coded eighteen randomly selected protocols. Inter-rater agreement averaged 88%. For individual protocols, agreement ranged from 80% to 92%. One week after coding the full set of protocols, I randomly selected 20% of the protocols for intra-rater reliability. The agreement between my initial and subsequent codings averaged 96% over nine protocols. For individual protocols, agreement between my initial and subsequent codings ranged from 92% to 98%.

2.7. Procedures for Analyses

For statistical analyses, all rated, coded and tallied data, in both raw numbers and percentages, were entered into SPSS-PC (1990). The small number of participants suggested that simple tallies, group means, and Wilcoxon Matched-Pairs Signed-Ranks Tests were appropriate ways to consider and assess trends in the data. Qualitative analyses were also conducted to provide more in-depth, case study accounts of important changes in participants' writing (shown in their written texts), thinking (manifested in their think-aloud protocols), and text evaluation
and self-regulation (obtained from tutoring sessions) related to the three research questions.

2.8. Assumptions and Limitations

A few assumptions and methodological limitations to my research needed to be noted. First, I assumed that the pre-post writing tasks and topics devised or chosen approximated engineering academic tasks and would elicit some kind of engineering knowledge from first year engineering students, an assumption which might be challenged by engineering professors who prefer much simpler writing tasks or researchers who favor more naturalistic studies of writing.

Second, I assumed that participants had thoroughly read and understood the assigned readings before attending the writing sessions, since the reading articles were given to them at least one week ahead of time. No attempt was made preceding their writing performance to test their prior knowledge or understanding of the articles they were supposed to read, so I could not be certain whether or how well participants had understood any readings prior to their writing session, nor did I test their reading comprehension of the articles.

Third, a greater number of participants (with an equivalent distribution of males and females) and an experimental and control group would be needed to make valid inferences and discern differences in writing performance, particularly to empirically assess and confirm the effects of procedural facilitation of strategic knowledge on second language writing development. Thus the small number of participants and the lack of a control group in this study threatened its internal validity (i.e., confidence in establishing causality) and restrained the possibility of conducting sophisticated statistical analyses.

Fourth, the use of just two instead of multiple pre-post writing tasks and not
administering them several weeks after termination of the training might have presented another limitation in establishing internal validity. I did not undertake a detailed investigation of writing development over time or after the training was finished. I should have designed the study to consider immediate effects, attrition, and lasting, permanent effects (cf. Mellow et al., 1996).

Fifth, with respect to the design of the intervention, this study employed self-control training (cf. Peverly, 1991, p. 81) in which participants were informed of the significance of the five thinking prompts, and were instructed to apply them as general executive skills (e.g., for planning and revision of text). Research is replete with evidence that this kind of training is effective in producing maintenance and transfer, but not the other two kinds of training -- blind training or informed training (for a review, see Peverly, 1991). Nevertheless, this kind of instructional design creates serious threats to external validity -- particularly the Hawthorne Effect -- because participants were well aware that they were being trained and tested and would therefore perform differently than when they wrote spontaneously.

Sixth, concerning practice effects, thinking-aloud 14 times in total probably affected participants' thinking-aloud and other behaviors while composing (see Stratman & Hamp-Lyons, 1994, for a discussion of such reactivity in verbal reports about writing processes). As a consequence, these verbal report data may indicate that the students became more proficient at verbalizing their thoughts while composing, in ways that I encouraged them to during the tutoring sessions, rather than indicating definite changes in how they thought or composed.
Chapter 3

Results of Text Ratings and Analyses

Research Question 1 asked:

*What aspects of the quality of the compositions written by ESL engineering students improve after the training in procedural facilitation of strategic knowledge in second language writing?*

Text ratings indicated that, after the tutoring, in the technical description task participants improved the global quality of their texts as well as their language accuracy and language appropriacy. For the argument task, topical progression analysis demonstrated improvement in topical depth (with a considerable increase in the use of extended parallel progressions), and topical structure analysis revealed improvement in syntactic complexity (with a significant increase in the use of more complex sentence types) after the tutoring. But few other differences emerged between the pre-post argument texts. Participants also tended to write more words and more sentences in the two tasks after the tutoring than they had prior to the tutoring.

3.1. Ratings of Compositions

All 36 pre-post compositions were rated, using Hamp-Lyons’ (1991) 9-point rating scale (displayed in Appendix A) by ESL instructors and a newly devised 7-point rating scale by
engineering professors, respectively. Both rating results showed that qualities of the compositions produced varied across tasks, indicating that task and knowledge variables influenced participants' writing performance.

3.1.1. ESL Ratings

Group means and standard deviations for ESL ratings of all six aspects (global quality, communicative quality, organization, argumentation, language accuracy, and language appropriacy) of participants' pre- and post-tutoring compositions on both the technical description and argument tasks are displayed in Table 3-1. Substantially greater mean differences in ratings between the pre-tutoring and post-tutoring compositions were obtained for the three categories of global quality, language accuracy, and language appropriacy in the technical description task, showing statistical significance ($p<.05$) according to Wilcoxon Matched-Pairs Signed-Ranks Tests. For the argument task no statistically significant pre-post comparisons were obtained, though a greater range was apparent in the mean ratings for the six aspects in the post-tutoring (from 5.0 to 5.6) than the pre-tutoring writing (4.6 to 5.0) on this task. Standard deviations were relatively similar between the pre- and post-tutoring writing on both tasks.
Table 3-1: Comparisons of ESL Ratings on Pre- and Post-tutoring Compositions

<table>
<thead>
<tr>
<th></th>
<th>Technical Description</th>
<th></th>
<th>Argument Task</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>Global Quality</td>
<td></td>
<td></td>
<td>5.2</td>
<td>(.8)</td>
</tr>
<tr>
<td>Communicative Quality</td>
<td></td>
<td></td>
<td>5.2</td>
<td>(.8)</td>
</tr>
<tr>
<td>Organization</td>
<td></td>
<td></td>
<td>5.2</td>
<td>(1.0)</td>
</tr>
<tr>
<td>Argumentation</td>
<td></td>
<td></td>
<td>5.6</td>
<td>(1.0)</td>
</tr>
<tr>
<td>Language Accuracy</td>
<td></td>
<td></td>
<td>4.8</td>
<td>(.7)</td>
</tr>
<tr>
<td>Language Appropriacy</td>
<td></td>
<td></td>
<td>4.9</td>
<td>(.6)</td>
</tr>
</tbody>
</table>

(Scale: 1 - 9)

* \( p < .05 \) (Wilcoxon Matched-Pairs Signed-Ranks Test)

3.1.2. Engineering Ratings

As mentioned in Chapter 2, because of low inter-rater reliability on the ratings between the two engineering professors, I will consider mainly the chemical engineering professor's ratings. Tables 3-2 and 3-3 display their separate ratings of content, organization, and language use on the pre-post technical description and argument tasks, indicating they had different standards in their assessments of the students' writing. Nevertheless, despite this discrepancy, both engineering professors agreed that the technical description task showed distinct improvements but the argument task did not. Professor B who teaches engineering humanities courses was generally in accord with the ESL instructors, rating the category of language use significantly higher \( (p < .05) \) on the technical description task after the tutoring compared to before it. In contrast, professor A (who teaches chemical engineering) rated the category of content in the technical description task significantly higher \( (p < .05) \). No other differences appeared in either of their ratings of other aspects of the pre-post compositions.
Table 3-2: Comparisons of Engineering Professor A’s Ratings on Pre- and Post-tutoring Compositions

<table>
<thead>
<tr>
<th></th>
<th>Technical Description</th>
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<th>Argument Task</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Content</td>
<td>Mean</td>
<td>S.D.</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td></td>
<td>2.9</td>
<td>(1.5)</td>
<td>4.1*</td>
<td>(.6)</td>
</tr>
<tr>
<td>Language Use</td>
<td>3.6</td>
<td>(1.6)</td>
<td>4.1</td>
<td>(.3)</td>
</tr>
<tr>
<td>Organization</td>
<td>3.9</td>
<td>(1.1)</td>
<td>4.7</td>
<td>(.7)</td>
</tr>
</tbody>
</table>

(Scale: 1 - 7)
*p < .05 (Wilcoxon Matched-Pairs Signed-Ranks Test)

Table 3-3: Comparisons of Engineering Professor B’s Ratings on Pre- and Post-tutoring Compositions

<table>
<thead>
<tr>
<th></th>
<th>Technical Description</th>
<th></th>
<th>Argument Task</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Content</td>
<td>Mean</td>
<td>S.D.</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td></td>
<td>4.2</td>
<td>(.8)</td>
<td>4.6</td>
<td>(1.0)</td>
</tr>
<tr>
<td>Language Use</td>
<td>3.5</td>
<td>(1.3)</td>
<td>4.5*</td>
<td>(.5)</td>
</tr>
<tr>
<td>Organization</td>
<td>3.7</td>
<td>(1.1)</td>
<td>4.1</td>
<td>(1.2)</td>
</tr>
</tbody>
</table>

(Scale: 1 - 7)
*p < .05 (Wilcoxon Matched-Pairs Signed-Ranks Test)

3.2. Text Analyses

The text analyses are reported in three parts. The first part presents pre-post differences in topical progression analysis, which represents changes in topical depth. The second part reports quantitative changes in topical structure analysis, which interprets changes in syntactic complexity. The third part provides two case studies illustrating qualitative changes in overall topic and paragraph development in two individual participants’ written texts. I have chosen cases of students who made distinct improvements between the pre-tutoring writing and
their post-tutoring writing on the argument task (William) and the technical description task (Simon), respectively.

3.2.1. *Topical Progression Analysis*

Tables 3-4 and 3-5 compare group means (in numbers and percentages and standard deviations) for the topical progression analysis of the students' use of parallel progressions, sequential progressions, and extended parallel progressions between the pre-post written texts on both tasks. Overall, more substantial changes were evident in the technical description than in the argument task. In the technical description task between the pre-post tasks, students made more frequent use of extended parallel progressions (going from 12.2 to 22.7% on average, \( p < .01 \)), increased the total number of words they wrote (from 364.8 to 435.1 on average, \( p < .05 \)), and increased their total number of sentences (from 18.7 to 25.8 on average, \( p < .01 \)). Moreover, they decreased their sequential progressions (from 73.1 to 55.7% on average, \( p < .01 \)). In the argument task, statistically significant differences appeared only in the increase of extended parallel progressions (from 21.6 to 38.1% on average, \( p < .01 \)) and total number of sentences (from 18.9 to 24.2 on average, \( p < .01 \)). Interestingly, greater standard deviations appeared in the use of extended parallel progression on both post-tutoring tasks than pre-tutoring tasks, indicating a wider spread of its occurrences in participants' post-tutoring writing.

These results, particularly for the technical description task, demonstrate significant increases in text length and in extended parallel progressions, together with a marked decrease in sequential progressions. These are indicators of improvement in topical structure and depth, globally between sentence topics and discourse topics, and locally between successive sentences.
Collectively, they reveal more detailed elaboration on important ideas or content. Examples of topical progression analyses from the two case study participants’ texts are displayed in Appendix E.

Table 3-4: Pre-Post Comparisons on Topical Progression Analysis of the Technical Description Task

<table>
<thead>
<tr>
<th>Types of Progression</th>
<th>Pre</th>
<th></th>
<th>Post</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>S.D.</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>Parallel Progression</td>
<td>2.6</td>
<td>(1.8)</td>
<td>5.5**</td>
<td>(2.5)</td>
</tr>
<tr>
<td>No.</td>
<td>14.8</td>
<td>(9.3)</td>
<td>21.7</td>
<td>(8.6)</td>
</tr>
<tr>
<td>%</td>
<td>12.2</td>
<td>(4.7)</td>
<td>22.7**</td>
<td>(9.1)</td>
</tr>
<tr>
<td>Extended Parallel Progression</td>
<td>2.2</td>
<td>(1.2)</td>
<td>5.8**</td>
<td>(2.8)</td>
</tr>
<tr>
<td>No.</td>
<td>12.2</td>
<td>(4.7)</td>
<td>22.7**</td>
<td>(9.1)</td>
</tr>
<tr>
<td>%</td>
<td>73.1</td>
<td>(11.8)</td>
<td>55.7**</td>
<td>(11.4)</td>
</tr>
<tr>
<td>Sequential Progression</td>
<td>12.9</td>
<td>(4.1)</td>
<td>13.5</td>
<td>(3.3)</td>
</tr>
<tr>
<td>No.</td>
<td>73.1</td>
<td>(11.8)</td>
<td>55.7**</td>
<td>(11.4)</td>
</tr>
<tr>
<td>%</td>
<td>14.2</td>
<td>(4.0)</td>
<td>14.5</td>
<td>(2.8)</td>
</tr>
<tr>
<td>Total No. of Subtopics</td>
<td>364.8</td>
<td>(92.1)</td>
<td>435.1*</td>
<td>(82.4)</td>
</tr>
<tr>
<td>Total No. of Words</td>
<td>18.7</td>
<td>(4.5)</td>
<td>25.8**</td>
<td>(5.1)</td>
</tr>
<tr>
<td>No. of Words per sentence</td>
<td>19.5</td>
<td>(2.1)</td>
<td>17.2</td>
<td>(3.0)</td>
</tr>
</tbody>
</table>

*p < .05  
**p < .01 (Wilcoxon Matched-Pairs Signed-Ranks Test)
Table 3-5. Pre-Post Comparisons on Topical Progression Analysis of the Argument Task

<table>
<thead>
<tr>
<th>Types of Progression</th>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>Parallel Progression</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>3.3</td>
<td>(2.4)</td>
</tr>
<tr>
<td>%</td>
<td>18.2</td>
<td>(14.4)</td>
</tr>
<tr>
<td>Extended Parallel Progression</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>3.9</td>
<td>(1.5)</td>
</tr>
<tr>
<td>%</td>
<td>21.6</td>
<td>(5.6)</td>
</tr>
<tr>
<td>Sequential Progression</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>10.7</td>
<td>(3.2)</td>
</tr>
<tr>
<td>%</td>
<td>54.7</td>
<td>(18.2)</td>
</tr>
<tr>
<td>Total No. of Subtopics</td>
<td>11.9</td>
<td>(3.0)</td>
</tr>
<tr>
<td>Total No. of Words</td>
<td>386.8</td>
<td>(89.2)</td>
</tr>
<tr>
<td>Total No. of Sentences</td>
<td>18.9</td>
<td>(4.6)</td>
</tr>
<tr>
<td>No. of Words per sentence</td>
<td>21.2</td>
<td>(5.4)</td>
</tr>
</tbody>
</table>

**p < .01 (Wilcoxon Matched-Pairs Signed-Ranks Test)

3.2.2. Topical Structure Analysis

Tables 3-6 and 3-7 indicate the post-tutoring writing showed certain increases in syntactic complexity compared to the writing done before the tutoring (see Appendix B for definitions of each sentence type). In the technical description task, uses of sentence type 2 decreased from 41.1 to 32.2% (p < .05), uses of sentence type 4 increased from 1.1 to 6.9% (p < .05), and the more complex sentence type 4-plus (i.e., sentence types 4 and 5) increased from 2.7 to 9.3% (p < .05). In the argument task, a statistically significant difference was evident only in the increase of complex sentence type 3-plus (i.e., sentence types 3, 4, and 5) -- from 22.8 to 34.3% (p < .05). Even though the technical description task showed more pre-post differences in this topical structure analysis, more complex sentence types (3-plus and 4-plus) were more prevalent in the argument than the technical description task. Students’ access to a source text
and the knowledge it contained might have had an impact on the syntactic complexity of their writing, as the argument task involved reading an article of ten pages.

Table 3-6: Pre-Post Comparisons on Topical Structure Analysis of the Technical Description Task

<table>
<thead>
<tr>
<th>Sentence Types</th>
<th>(Increase No.)</th>
<th>(Increase %)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>S.D.</td>
</tr>
<tr>
<td>Type 1</td>
<td>10.0</td>
<td>(4.8)</td>
</tr>
<tr>
<td>Type 2</td>
<td>7.3</td>
<td>(2.4)</td>
</tr>
<tr>
<td>Type 3</td>
<td>0.8</td>
<td>(1.1)</td>
</tr>
<tr>
<td>Type 4</td>
<td>0.2</td>
<td>(.5)</td>
</tr>
<tr>
<td>Type 5</td>
<td>0.3</td>
<td>(.7)</td>
</tr>
<tr>
<td>3 Plus</td>
<td>1.3</td>
<td>(1.0)</td>
</tr>
<tr>
<td>4 Plus</td>
<td>0.4</td>
<td>(.7)</td>
</tr>
</tbody>
</table>

*p<.05

**p<.01 (Wilcoxon Matched-Pairs Signed-Ranks Test)

Table 3-7. Pre-Post Comparisons on Topical Structure Analysis of the Argument Task

<table>
<thead>
<tr>
<th>Sentence Types</th>
<th>(Increase No.)</th>
<th>(Increase %)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>S.D.</td>
</tr>
<tr>
<td>Type 1</td>
<td>8.1</td>
<td>(3.0)</td>
</tr>
<tr>
<td>Type 2</td>
<td>6.2</td>
<td>(2.8)</td>
</tr>
<tr>
<td>Type 3</td>
<td>2.9</td>
<td>(1.9)</td>
</tr>
<tr>
<td>Type 4</td>
<td>0.7</td>
<td>(.7)</td>
</tr>
<tr>
<td>Type 5</td>
<td>1.0</td>
<td>(1.2)</td>
</tr>
<tr>
<td>3 Plus</td>
<td>4.6</td>
<td>(2.7)</td>
</tr>
<tr>
<td>4 Plus</td>
<td>1.7</td>
<td>(1.7)</td>
</tr>
</tbody>
</table>

*p<.05

**p<.01 (Wilcoxon Matched-Pairs Signed-Ranks Test)
3.2.3. Case Study of William’s Argument Tasks

William made significant improvements before and after the tutoring in the argument task. According to the ESL instructors’ ratings, his argument texts improved in global quality (from 4 to 6), communication quality (from 4 to 6), organization (from 3 to 6), argumentation (from 3 to 6), language accuracy (from 5 to 6), and language appropriacy (from 5 to 6). According to the chemical engineering professor’s ratings, he improved specifically in the categories of content (from 2 to 4) and language use (from 3 to 4). Appendix F displays William’s compositions for both the argument tasks.

My impression of differences on this task is that William achieved improvement primarily in the overall topical organization of his paragraphs. He wrote three paragraphs in the pre-tutoring task then five paragraphs in the post-tutoring task. His post-tutoring text seems more discernibly organized, with one specific, relevant idea presented in each paragraph, compared to his pre-tutoring text which presents many ideas off topic, focusing on Diesel’s book instead of on the incongruities between the engine and the theory.

The introductory paragraph in the pre-tutoring text presents its thesis statement (pro-argument) at the very beginning and includes many irrelevant details (from "This was very important" to the end "became very interesting to European engineers ...”). In his post-tutoring introductory paragraph, the thesis statement was clearly stated at the end of the paragraph ("The success of Otto’s engine meant the success of Otto’s theory that guided him."). In addition, the content was relevant and concise, even though the "introduction initial" (cf. Swales, 1990, p. 142) was not well connected with the thesis statement:

"Success of Diesel’s engine meant success of his theory that guided him." Diesel’s theory is based on Nicolas Leonard Sadi Carnot’s
theory of carnot cycle. This theory gave Diesel an idea to invent this kind of engine. During the 10 ten years, Diesel spent his time on research of the ideal carnot cycle theory. This was very important for the following decade because Diesel's theory was published 10 years after he had started the research. Therefore, his theory became very interesting to European engineers and the invention of Diesel's engine started. (pre-tutoring: introduction)

In the middle of the 18th century, Nicolaus August Otto developed a new concept on building a special kind of engine called Otto engine. This kind of engine became popular in the late 18th century. The success of Otto's engine meant the success of Otto's theory that guided him. (post-tutoring: introduction)

With respect to the second paragraph, the content in William's pre-tutoring text was irrelevant to the topic, discussing Diesel's book instead of the theory or discrepancies between theory and practice. The topic sentence, "In 1893, Diesel's theory was published", does not fit this paragraph; it does not reflect what is to be elaborated. In contrast, the topic sentence in William's post-tutoring text fits the whole paragraph, reflecting one single purpose describing the four parts or steps in Otto's theory of internal combustion. In addition, it fits the intended element in the third paragraph of describing how Otto followed his theory of internal combustion "to complete his successful engine":

In 1893, Diesel's theory was published. After his books reached Europe, two major German firm, Krupp and Maschinenfabrik, was interested in this idea of inventing Diesel's engine. Diesel's book acted like a promotion to European about thermal efficiency. The promotion helps to gain more financial aided which helped Diesel to continue his research. For that reason Diesel's engine was invented which was widely used in the following decades. (pre-tutoring: 2nd paragraph)

Otto's theory on internal combustion engine is divided into four parts. Otto's engine is basically an internal combustion of fuel and air in a cylinder. The whole cycle takes four steps: mixing a proportion amount of fuel and air; compressing the mixture; combusting the mixture by some kind of ignition device, nowadays
a spark plug; and removing the exhaust gas. (post-tutoring: 2nd paragraph)

There were only three paragraphs in William's pre-tutoring argumentative writing (I compare later the third paragraph of his pre-tutoring text with the fifth paragraph of his post-tutoring text since both are the conclusions). In the third paragraph of his post-tutoring text, the argument is made more substantive by the subsequent description of how Otto followed the theory to complete the engine. This paragraph shows a detailed elaboration of the topic sentence "Based on his theory, Otto had made a successful four-stroke atmospheric engine" (the topic sentence), a fit between the two (the topic sentence and the paragraph), as well as a more thorough development of the thesis statement (than in the pre-tutoring text):

Based on his theory, Otto had made a successful four-stroke atmospheric engine. In 1866, 5000 Otto's engine were sold. The reason was because Otto's engine were three to four times more efficient than steam engine. Otto's engine contained a heavy free piston inside the vertical cylinder. When the mixture of fuel and air was injected into the cylinder, the heavy piston compressed the mixture... That completed a four-stroke cycle, intake, compress, combust and exhaust. Otto had followed his theory to complete this successful engine. (post-tutoring: 3rd paragraph)

In the fourth paragraph of the post-tutoring task, the topic sentence ("Otto's theory not only guided him but also guided engineers in nowadays automobile industry") reflects the single purpose of this paragraph (how "modern engines utilizes the four-stroke cycle"), and fits the goal of proving "that Otto's engine was successful because of his theory". In all, these content ideas were adequately supported and discernably organized in a logical sequence:

Otto's theory not only guided him but also guided engineers in nowadays automobile industry. Since modern automobile engines are more sophisticated and compact than atmospheric engine, the principles and theories are the same. Modern engine utilizes the four-stroke cycle first demonstrated by Otto. That causes over 10
million new engines a year employ this mode of operation. It tells us that Otto’s engine was successful because of his theory. (post-tutoring: 4th paragraph)

Further improvements in the overall topical organization of paragraphs appears in comparing the concluding paragraphs between the pre- and the post-tutoring writing. In the pre-tutoring text, the conclusion (third paragraph) is not persuasive enough. It presents an example to illustrate how successful Diesel’s engine was ("Diesel’s engine was used in warships and submarines in the World War 1..."). Then it points out that "nowadays", "most of them are replaced by fuel-rejection engine which is still based on Diesel’s theory", thereby indicating that "the success of Diesel’s engine" derived from "his theory that guided him". In the post-tutoring text, the conclusion tries to consolidate previous supporting ideas, to converge on the key argument that Otto’s engine was particularly successful because of the theory. It starts by stating the reason why "Otto’s engine was so successful" -- "because he constructed the atmospheric engine by following his theory which is still used as a fundamental principle by many engineers in the world." This statement not only clearly points out the positive relationships between the engine and the theory, but also the contributions and importance of the theory ("as a fundamental principle..."). Finally, in emphasizing the significance of the theory to the engine, a conditional "If Otto did not invent this theory" is used to indicate that otherwise "his engine would not have been so successful and the automobile industry would not have developed so quickly in the 19th century."

In the following century after his theory had been published, Diesel’s engine has replaced the position of steam engine. Diesel’s engine was used in warships and submarines in the World War 1. Even nowadays, there are still Diesel’s engine. However, most of them are replaced by fuel-rejection engine which is still based on Diesel’s theory. Therefore, the success of Diesel’s engine meant
of his theory that guided him. (pre-tutoring: conclusion)

Otto's engine was so successful because he constructed the atmospheric engine by following his theory which is still used as a fundamental principle by many engineers in the world. If Otto did not invent this theory, his engine would not have been so successful and the automobile industry would not have developed so quickly in the 19th century. (post: conclusion)

In support of these observations, topical structure analysis likewise indicated considerable improvement in William's topical progression and a slight increase in his syntactic complexity in these compositions. In the topical progression analysis, William's argument writing showed more extended parallel progressions (from 2 to 8) in the composition after tutoring. This illustrates a greater elaboration on the discourse and sentence topics (which were key to the coherence of the text). His texts also showed a significant increase in the number of words (from 225 to 383) and sentences (from 16 to 24), and a slight increase in the number of sentence topics (subtopics) in the two argument tasks. As regards changes in syntactic complexity between his pre-post writing on this task, there was some slight improvement. There were more type 3 sentences in the post- than the pre-tutoring text, particularly a considerable increase in the use of 3-plus sentences from the first (18%) to the second (25%) text. Examples of sentence type 3 (ISE = mood subject ≠ topical subject) from his post-tutoring text are:

It tells us that Otto's engine (topical subject) was successful because of his theory.

When the mixture of fuel and air was injected into the cylinder, the heavy piston compressed the mixture.

3.2.4. Case Study of Simon's Technical Description Tasks

Simon made significant improvements in the technical description task. According
to the ESL instructors’ ratings, he improved in global quality (from 4 to 6), communication quality (from 4 to 6), organization (from 4 to 6), argumentation (from 5 to 6), language accuracy (from 4 to 6), and language appropriacy (from 4 to 5). According to the chemical engineering professor’s ratings, Simon improved in all three categories of content (from 2 to 4), language use (from 4 to 5), and organization (from 3 to 5). Appendix G displays Simon’s pre-post compositions on the technical description task.

As with William, my impression of Simon’s technical description tasks is that he achieved particular improvement in the overall topical development of his paragraphs and syntactic complexity, in spite of a decline in total words in his post-tutoring text (from 358 to 299). For example, comparing his two pre-post introductory paragraphs, his pre-tutoring text appears concise and clear. Nonetheless, the introduction in the post-tutoring text is actually more effective and sophisticated. On the one hand, the introduction to the first text merely repeats the instructions from the writing prompt. On the other hand, the post-tutoring text poses a relevant and clear "introduction initial" (background, cf. Swales, 1990) which was visibly absent in the pre-tutoring text:

This is a technical description about the integrated gasification combined-cycle technology. This kind of technology is new and more efficient for controlling CO₂ emissions. (pre-tutoring: introduction)

Today, more advanced fossil-energy technologies are under development. Recently, a new system is just being applied. It is an advanced pulverized coal plant with an advanced flue-gas desulphurization system. People are paying attention to this system because it is an efficient method to control CO₂ emissions. (post-tutoring: introduction)

Overall, the topic sentences in both Simon’s pre- and post-tutoring texts (from the
second to the fourth paragraph) fit together coherently and serve the goals of the compositions. However, those in Simon’s post-tutoring text are more clearly stated and in logical sequences (e.g., "The primary component of this system is ..." and "The secondary component of the system is ..." in the second and the third paragraph, respectively). These two sentence topics combine sequential and extended parallel progressions, not only reflecting a single purpose, but also indicating logical sequences (describing successive processes or components). In addition, these two topic sentences use effective transitional elements (the phrases, "The primary/secondary component of the system") to connect and organize the two paragraphs effectively. Thus, the ideas in the post-tutoring text appeared more coherent, discernably organized, and cohesive:

The centre of the cycle is called a gasifier, in which the main reaction is. It is a kind of oven of reaction. Coal is loaded and will be combusted in it... There is an exit for ash after the combustion. (pre-tutoring: 2nd paragraph)

There are 3 streams for the oven. Steam comes from a turbine which... The middle stream is for the air, which ... The purpose of the gas turbine and the steam turbine is to convert ... The combustion of the coal releases a great amount of heat which ... This process increases the pressure of the steam and it will expand through the blades on the turbine rotor causing them to rotate, and hence power is supplied. (pre-tutoring: 3rd paragraph)

The primary component of this system is a boiler which ... In the boiler, the heat ... When the water is heated enough to become steam, it ... The steam expands through the blade ... There is an exit for the boiler. It allows ash to be disposed by trucks after the combustion. (post-tutoring: 2nd paragraph)

The secondary part of the system is made up of three devices. In the coarse separator, fines will be ... into the contactor, which is linked to the boiler, and ... There is a channel connecting both the reducer and the coarse separator for gas recycling. Lime, which is ... It is proved by practice that the content of CO₂ reduces quickly in the cycle. (post-tutoring: 3rd paragraph)
The concluding paragraphs in his two texts both contain similar ideas, discussing the main advantage(s) of the specific technology. The major differences are that the conclusion in his post-tutoring writing explicitly mentions the advantages of the new system: "Comparing with other technologies, the rate of CO$_2$ emission is relatively low". In addition, it uses a commentary, "That is why it is considerable", to end the writing. Simon's pre-tutoring writing lacks this final touch, its argument seeming suspended in the air:

The main advantage of this technology is that a special solvent is used to absorb H$_2$S and COS along with some CO$_2$ and H$_2$O. Moreover, coal is grounded to a small particle size and fed into the burner so that the efficiency of combustion is higher. Thus, there is no significant additional released CO$_2$ associated with SO$_2$ control. The level of CO$_2$ releasing is lowered. The annual release of CO$_2$ would be down to approximately 2.42 Mt. (pre-tutoring: conclusion)

The main advantage of the system is the idea of the recycling of the reducing gas. Improvement in this kind of system are achieved through greater utilization of the sorbent materials and using noncarbonate sorbents. Comparing with other technologies, the rate of CO$_2$ emission is relatively low. That is why it is considerable. (post-tutoring: conclusion)

In addition, Simon's post-tutoring writing showed a slight increase in syntactic complexity. In the pre-tutoring writing, there were no sentence types 3, 4, and 5, whereas in the post-tutoring text, some sentence types 3 and 4 appeared. For example:

(type 3 sentences: ISE = mood subject ≠ topical subject)

It is proved by practice that the content of CO$_2$ reduces quickly in the cycle.

That is why it is considerable.

(type 4 sentence: ISE = topical subject ≠ mood subject)

When the water is heated enough to become steam, it goes to the
steam turbine.
Chapter 4

Results of Analyses of Use of Strategic Knowledge

Research Question 2 asked:

Do ESL engineering students demonstrate greater use of strategic knowledge in their writing processes after the training in procedural facilitation of strategic knowledge in second language writing?

Analyses comparing participants' pre-post think-aloud data while composing showed an overall increase in participants' verbalizations and time spent writing, and along with it, an increase in their strategy use. When converted to percentages, for the purposes of comparing the pre-tutoring and post-tutoring writing, analyses showed more uses of strategies related to the fit prompt in both the technical description and argument tasks in the post-tutoring writing, and in the technical description task only an increase in strategies related to the goals prompt, accompanied by a decrease in strategies related to rules. Heuristic search strategies related to choosing words and making cross-language comparisons remained relatively constant across the two tasks before and after the tutoring. That is, these students seemed to have learned to attend strategically more often to the coherence of their writing, and in the technical description task to be more goal-oriented rather than concerned about rules of grammar, punctuation, or spelling. The second significant finding is that participants' complexity of
references to these heuristic strategies increased significantly in the post-tutoring writing: they tended to utilize two or three or more of the strategies in conjunction after the tutoring, and to less frequently use only one of the strategies, as they had in their thinking about their writing prior to the tutoring.

4.1. Protocol Length and Time

A comparison of the total number of protocol statements between the pre- and the post-tutoring writing on both tasks (displayed in Table 4-1) shows that participants produced significantly more statements in their post-tutoring verbal reports, with group means for the technical description at 246.1 before the tutoring and 463.1 ($p < .05$) after, and for the argument task at 298.5 before the tutoring then 460.8 afterwards ($p < .05$). Participants produced longer texts (see section 3.2.1.) and they produced longer verbal reports of their thinking in the post-tutoring writing than they had for the writing before the tutoring. This may indicate they had practised and became better at verbalizing their thinking, or it may indicate they were using more strategic knowledge while they wrote.

Table 4-1: Pre-Post Comparisons of the Total Number of Statements in Each Protocol on Both Tasks

<table>
<thead>
<tr>
<th></th>
<th>Technical Description</th>
<th>Argument Task</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>No.</td>
<td>Mean S.D.</td>
<td>Mean S.D.</td>
</tr>
<tr>
<td></td>
<td>246.1 (114.0)</td>
<td>436.1* (147.7)</td>
</tr>
</tbody>
</table>

*p < .01 (Wilcoxon Matched-Pairs Signed-Ranks Test)
NOTE TO USERS

Page(s) not included in the original manuscript are unavailable from the author or university. The manuscript was microfilmed as received.

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UMI
4.2. Pre-Post Comparisons of Strategy Use

Table 4-4 shows group means and standard deviations contrasting participants’ use (in raw frequencies and percentages) of heuristic search strategies related to the five procedural facilitation prompts. There was a dramatic increase in raw frequencies of all five heuristic search strategies from the task prior to the tutoring to the tasks written after the tutoring (reflecting people’s increased verbalization), but when these raw frequencies were converted into percentages, many of the heuristic search strategies (e.g., rules in the technical description task, word in the argument task, and L1-L2 in both tasks) remained at constant levels for the writing before and after the tutoring.

However, certain heuristic search strategies were used significantly more often after the tutoring. Statistically significant differences appeared in strategies referring to "goals" in the technical description task (changing from 10.3 to 17.0%, $p < .05$) and to "fit" in both tasks (changing from 4.1 to 9.6%, $p < .01$ and from 4.9 to 10.3%, $p < .01$ in the technical description and argument task, respectively). These findings suggest that the tutoring might have affected the students’ strategic use of thinking related to the goals and fit prompts; or at least it suggests their thinking about their writing developed in this direction.

Correspondingly, there was a considerable decline (from 27.8 to 17.9%, $p < .05$) in the students’ uses of strategic knowledge related to the rules prompt in the two technical description tasks. This may indicate these students shifted some of their strategic resources from attention to rules of grammar, punctuation, and spelling prior to the tutoring to greater strategic attention to the goals and coherence of their writing after the tutoring, at least in the technical description task.
Nonetheless, the students' uses of strategic knowledge mostly involved heuristic searches related to their choices of words, cross-linguistic comparisons and rules. They devoted the majority of their attention to strategies involving words, and secondarily to strategies involving rules in both tasks. Strategies involving word choices appeared in about one third of all statements in the think-aloud protocols and those involving rules appeared in about one quarter of all statements in both the pre- and post-tutoring writing tasks. These three heuristic prompts showed a greater range (from 17.9 to 34.0%) in the post-tutoring writing than in the pre-tutoring writing (from 26.9 to 29.8%) on the technical description task. This trend was the reverse in the argument task. Appendices H and I list each student's uses of all five heuristic search strategies on the four pre-post writing tasks.

Table 4-4: Pre-Post Comparisons of Five Heuristic Search Strategies Knowledge in Two Sets of Tasks

<table>
<thead>
<tr>
<th></th>
<th>Technical Description</th>
<th>Argument Task</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Goals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>7.3</td>
<td>(1.8)</td>
<td>38.1**</td>
</tr>
<tr>
<td>%</td>
<td>10.3</td>
<td>(5.6)</td>
</tr>
<tr>
<td>Fit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>4.1</td>
<td>(4.1)</td>
<td>25.9**</td>
</tr>
<tr>
<td>%</td>
<td>4.1</td>
<td>(4.7)</td>
</tr>
<tr>
<td>Word</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>26.6</td>
<td>(20.6)</td>
<td>95.6**</td>
</tr>
<tr>
<td>%</td>
<td>29.8</td>
<td>(13.4)</td>
</tr>
<tr>
<td>Rules</td>
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<tr>
<td>No.</td>
<td>Mean</td>
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</tr>
<tr>
<td>19.6</td>
<td>(11.0)</td>
<td>53.5*</td>
</tr>
<tr>
<td>%</td>
<td>27.8</td>
<td>(15.0)</td>
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<td>LI-L2</td>
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<tr>
<td>No.</td>
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<tr>
<td>28.5</td>
<td>(34.9)</td>
<td>75.1*</td>
</tr>
<tr>
<td>%</td>
<td>26.9</td>
<td>(22.1)</td>
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</tbody>
</table>

*p < .05

**p < .01 (Wilcoxon Matched-Pairs Signed-Ranks Test)
4.3. Pre-Post Comparisons of Complexity of Strategy Use

Table 4-5 displays pre-post comparisons (as group means) of participants' verbal reports of their uses of strategic knowledge either as a single mention of a strategy, a double mention (of two heuristic search strategies together), or a triple plus mention (of three, four, or five heuristic search strategies at the same time). There were great pre-post variations in participants' complexity of strategic thinking about their writing.

Foremost, there was a marked contrast between the pre-post tasks in strategy use involving single strategies. Single mentions of strategies were prevalent in participants' thinking processes while writing both pre-tutoring tasks, but they declined considerably in raw frequencies, as well as in percentages -- from 81.3 to 64.7% ($p < .01$), and from 78.6 to 66.0% ($p < .05$) -- in the post-tutoring technical description and argument task, respectively.

Correspondingly, participants' use of complex configurations of strategies in conjunction increased significantly from the pre-tutoring to the post-tutoring writing. References to double configurations of strategies showed a substantial increase from 16.0 to 27.5% ($p < .01$) in the technical description task. References to three or more strategies increased from 2.7 to 7.9% ($p < .01$) in the technical description task and from 2.1 to 9.0% ($p < .05$) in the argument task.
Table 4-5. Pre-Post Comparisons of the Complexity of Strategic Knowledge on Two Tasks

| Configurations | Technical Description | | | Argument Task | | | Pre | Post | Pre | Post | Mean | S.D. | Mean | S.D. | Mean | S.D. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | S.D. | Mean | S.D. | Mean | S.D. | Mean | S.D. |
| Single | No. | 53.5 | (30.5) | 124.0* | (51.7) | 63.3 | (38.6) | 114.7* | (38.9) |
| | % | 81.3 | (11.4) | 64.7** | (14.9) | 78.6 | (12.9) | 66.0* | (17.0) |
| Double | No. | 12.7 | (11.8) | 54.6** | (29.3) | 15.5 | (10.6) | 50.0** | (38.0) |
| | % | 16.0 | (9.2) | 27.5** | (10.0) | 19.3 | (11.4) | 25.1 | (7.5) |
| Triple+ | No. | 2.6 | (4.1) | 17.8** | (18.4) | 2.1 | (2.8) | 19.0** | (24.3) |
| | % | 2.7 | (2.9) | 7.9** | (6.0) | 2.1 | (2.6) | 9.0* | (10.1) |

*p<.05  **p< .01 (Wilcoxon Matched-Pairs Signed-Ranks Test)

4.4. Strategies Related to Goals

4.4.1. Goals Prior to Tutoring

While composing both the technical description and argument tasks prior to tutoring, participants referred very little to their goals. Indeed, most of them (five out of nine participants) demonstrated no advance planning of local gist or discourse organization. They simply started off by reading the topic, referring to the information or article provided, and/or processing the topic/figure for understanding, then transcribing their thoughts directly onto paper:

[Reread part of the topic] technical description, so, just integrated gas, gasification combined-cycle technology [started writing].
(Simon, pre-technical description, 8:20, 1st side of tape, pre-writing phase)

Only four participants thought out their content before writing prior to the tutoring. They made implicit references to global goals (intentions) and local goals (gist). Among them,
Two participants (William and Leo) repeated almost verbatim the given topic, or planned only the introductory paragraph:

//He, originally he wanted to make an ideal Carnot Cycle, and from it, from it to develop his idea. Let me write down the topic first. Um, the success of Diesel's engine meant or did not mean the success of the theory that guided him. According to this piece particular example, I think he wasn't success. How to start? This piece of writing should introduce at the beginning, should mention Diesel's original idea, what he wanted to do, beginning, should say at the beginning that/ Rudolf Diesel, introduce his person, introduce he's, should introduce at the beginning his character, then expand his idea, and then talk about his achievement; and then lead to the thesis statement. Say at the beginning: in the past century, in the past, should be in the last century, almost, in the last century./

(Leo, pre-tutoring argument task, 5:36, 1st side of tape, pre-writing phase)

Two other participants (Bernard and Charles) enumerated the key elements to be included in their texts. Both considered global and local goals and the organization of discourse units. However, only Charles demonstrated any conscious reflections in his planning:

My strategy for writing this, ah, for this essay, will be one introduction and two body paragraphs. The first one will be on the ah, operation of this plant, how it work, and the second paragraph will be to talk about the efficiency of the ah, of controlling CO₂ emissions, and finally the, the conclusion will be ah, probably maybe to give my ah general opinion about it. Okay, so ... Let’s see how many process, how many major steps these, maybe this is deeper approach to it. Okay, so certainly this, the gasifier combustion does consider one, the hot-gas cleanup is considered a second ah, second step in the process of turning coal into electricity, and of course the gas turbine is one, and certainly the, certainly the steam turbine is another one, okay... mention the disposal of ash, so I'll label that 1.1. While hot-gas cleanup, this also waste, I should mention that as ah step 2. That's ah 2.1. .../Generator is 5.1. There are 5 major steps found in this process. (Charles, pre-tutoring technical description, 32:00, 1st side of 1st tape, pre-writing phase)
While attending to the formulation of local goals and gist or transcribing their thoughts onto paper, participants were seldom concerned about who their readers were in the writing prior to tutoring. Even when they were, they simply reread the part on readers from the topic, without demonstrating any deeper reflection on what their readers' expectations might be or how to accommodate their needs:

#To whom is it written? [continued to reread the topic] Your readers for this technical description are boss and colleagues. #Should be written to# colleagues. #Why is it written to the# boss? #Let's see, the# boss #should know. It said he knew it#. I am [started writing]. (Edward, pre-tutoring technical description, 8:22, 1st side of tape, pre-writing phase)

#Let's see, your colleagues# know little about it. Um, um, fossil-fuel/ [continued writing]. (Henry, pre-tutoring technical description, 9:20, 2nd side of 1st tape, drafting phase)

Due to their lack of goal-directed planning, most participants approached their writing with unclear intentions of what they should write or include next in their texts. They made frequent references to a "what next strategy" (Bereiter & Scardamalia, 1987a; Cumming, 1988), expressing difficulties in searching for relevant, more, or elaborated content to accomplish the writing task:

Ah, in fact, #then I don't have any important thing to write. Write# conclusion./ #What to write in the# conclusion?/ Ah, conclusion, conclusion. / (William, pre-tutoring argument task, 4:14, 2nd side of tape, drafting phase)

What should I write here? What should I write here? Um, the success of Otto's engine didn't mean the success of the theory that guided him, okay, so/ (Lorraine, pre-tutoring argument task, 44:50, 1st side of tape, drafting phase)

Overall, in the drafting phase of both pre-tutoring writing tasks, participants' attention to their goals was likewise scarce. Most of them just wrote what they knew about the
topic. When some students referred to their goals while composing, they simply repeated verbatim the topic, either as a reminder of the main purpose of the task or to form local goals to decide on the next element to be involved in the text:

/Okay, the schematic of an advanced coal plant was inte./ to explain how it works and ah./ technical description, okay./ (Simon, pre-tutoring technical description, 10:14, 1st side of tape, drafting phase)

/ah, the remaining gas, the remaining coal smoke which contains less fuel, #no#, which contains less greenhouse gases will be discharged. #Finished talking about its# process, #then talk about its# efficient, #why it is# efficient, efficient./ (William, pre-tutoring technical description, 35:40, 1st side of tape, drafting phase)

Only one student (Leo) showed some emergent planning while he was composing the pre-tutoring task:

/#Then the second# paragraph, #the first point#/ [Read from text] ... #Here, a# point. #The first# point #is# failure in non-isothermal combustion, #the main advantage #of# isothermal combustion #is to make the# (?) reversible, #because if# reversible, #the# efficiency of process is at maximum, #reached its# maximum. #That is to say#, non-isothermal combustion #can# lead #to the second# point #which is about# low (?) of work done. This is ah, at the beginning/ [continued writing] (Leo, pre-tutoring argument task, 20:08, 1st side of tape, drafting phase)

4.4.2. Goals After Tutoring

In contrast to the scant attention people gave to their goals in their pre-tutoring writing, their verbal reports of both post-tutoring writing tasks revealed numerous references to their goals. Many students approached their post-tutoring writing with definite intentions (global goals) about what the text should achieve, clear notions of gist (local goals) it should entail, as well as strong concerns for how to adjust their initial plans or written elements to accommodate
their readers’ expectations or concerns. Most significantly, many participants explicitly mentioned the goals prompt or its cue questions and their increased strategic use of goals referred not only to goal-setting in the pre-writing phase, but also to working forward and backward with goals throughout their writing processes.

In their post-tutoring writing, thinking about the goals prompt seemed to have helped people in stating the major purpose of writing a technical description or taking a position in the argumentative writing. In addition, it guided them in deciding the major content and overall structure of their writing:

Describe, technical description of #this# power plant. #My# goal #has two things only#: explain how it works and why efficient way to control CO₂ emission./ #My goal #has two things only, and writing more is of no use. (William, post-tutoring technical description, 15:20, 1st side of 1st tape, pre-writing phase)

#So, it is# technical description./ Ah, readers #are# boss and colleagues./ #So, the# goal./ same, how it works./ #and# why it is an efficient way to control, for controlling CO₂ emission. #This one is very important, CO₂ emission. Let me erase and rewrite it#.

Um, okay, reader, boss and colleagues, technical description. (Bernard, post-tutoring technical description, 2:45, 1st side of 1st tape, pre-writing phase)

Participants often mentioned concerns for their readers in the initial phase of their post-tutoring writing:

Some readers will be my client, my, my, ah, partners, my, and generally speaking, the employees are my readers. (Peter, post-tutoring technical description, 1:44, 1st side of tape, pre-writing phase)

#Then, the# reader, #they are the# professor and student. #That is to say, the# professor #is familiar with it, but maybe the# students #are not familiar with this# topic./ (Bernard, post-tutoring argument task, 2:25, 1st side of 1st tape, pre-writing phase)
Likewise, while referring to the two different kinds of expected readers (the boss and colleagues) in the post-tutoring writing tasks, participants often reminded themselves of different levels of topical familiarity among their readers and of the need to make modifications of planned elements before executing them:

#Oh yeah, if this (technical description) is written to the boss, he must know this (power plant) is an efficient way. But if I am going to explain this to the colleagues, I must explain some (reasons why it is an efficient way for controlling CO₂ emission), um#. (Henry, post-tutoring technical description, 10:20, 1st side of 1st tape, pre-writing phase)

Some (colleagues) may know some, know some, that means I don't need to explain term (i.e., terminologies). Term, that means#, introduce a few term, terminology. So, I should mention some terminology. (Edward, post-tutoring technical description, 3:00, 1st side of 1st tape, pre-writing phase)

In the drafting phase of their writing, participants often referred back to the global or local goals they had initially decided upon to guide their writing, particularly when they started composing or before they proceeded with the next planned element. They attempted to check and maintain the coherence and continuity of their arguments in reference to their initial plans, reader awareness, or organization of discourse units. Thus their references to their goals were often in conjunction with their thoughts about the coherence of their texts. Sometimes, references they made to their goals happened at points when they got stuck in elaborating or retrieving relevant content:

#What is it? First, um#, goal, debate, no. This one is not like this, should write, um, what to write at the beginning? The goal, goal, first, use# (the point) success to bring out the main theme, then it leads to the second (point). Okay, first, is um, how to write at the beginning? Let’s see the outline. Ah, introduction, define, no, oh yeah. Start by saying# Diesel good, the Diesel engine is very useful, engine [started writing] (Henry, post-tutoring
In their post-tutoring writing many students showed particular concern for their readers as they wrote, particularly whether their readers would understand their intended meanings or be able to comprehend the overall discourse, and they tried to modify the initial planned elements accordingly:

before it, okay. But I’ll tell the reader and, could the reader relate this back to the ah, to the first paragraph of the description, of the description of its stages? That’s the problem. That might be a problem. It might be, the reader might find this too confusing. (Charles, post-tutoring technical description, 8:11, 1st side of 2nd tape, drafting phase)

was based on #the# theory, based on #what? Let’s see#, based on #his# theory, was based on the, his. the, ah, Carnot’s theory. #If I mention this, will it be useful? Um, the readers, will they not understand what I am talking about? Ah, they won’t. They should understand#. Was based on Carnot Cycle, Carnot Cycle, #but do I need to# explain# it? #If I# explain, #will it be off topic? But, um, ah, oh no, now I am writing# to your professor and about a hundred students (in the class), #that means they are# suppose(d) #to know what it is. Right, ah#, based on the Carnot Cycle, #um, then what#? Diesel’s idea was based on Carnot Cycle, um, Carnot Cycle/ (Henry, post-tutoring argument task, 4:22, 2nd side of 1st tape, drafting phase)

In the post-drafting revision phase, people often mentioned their goals and text coherence in combination as a criterion for determining what they needed to add or delete in
accordance with particular problems:

Um, #let me see#. The greenhouse, #I shouldn't talk about that paragraph, should delete it. That paragraph is: first talk about what that# greenhouse #has# under develop. #There's no need to talk about so many things. I just need to talk about the# proposal, and things concerning this piece of writing. Right! Let me read the text once more, see if it is coherent or not#. [Reread and made further rule and word changes] (Edward, post-tutoring technical description, 5:24, 2nd side of 2nd tape, post-drafting revision phase)

Goal, #let me see. The# goal is to write about to reduce# greenhouse gas emission. #I've done that already#. Fossil fuel energy, energy technology, um, fossil fuel technology, #have I mentioned it#?/ Electric power, electric energy, energy, #it seems I haven't mentioned it#/ Well, can I add it in the second or third paragraph#?/ (Bernard, post-tutoring technical description, 12:24, 1st side of 2nd tape, post-drafting revision phase)

4.4.3. Case Study of Goals: Simon

Simon, an above average writer in this group, and a predominant L2 user, was the participant who demonstrated the most increase between the pre- and post-tutoring tasks in his attention to his goals. Initially, Simon was a low strategy user, making very infrequent or no references at all to individual aspects of his writing (see Appendices H and I). His initial references to his goals were scarce -- with raw frequencies of 8 (22%), and 1 (7%), in the technical description and argument task, respectively. His approach to writing prior to the tutoring was mainly knowledge-telling, with only some strategy use about his vocabulary choices and grammatical rules.

In his post-tutoring writing, Simon showed significant changes in his use of heuristic search strategies, particularly in respect to goals and discourse coherence. His attention
to his goals increased from 22 to 44% (raw frequencies from 8 to 52) and from 7 to 32% (raw frequencies from 1 to 28) in the technical description and argument task, respectively. Nevertheless, Simon's references to goals in his post-tutoring writing were rather different from the majority of participants' -- his references were predominantly implicit. He seldom explicitly mentioned the prompt goals. He either stated global goals (e.g., stating position in an argument) or set local goals (i.e., formulating gist):

Okay, it doesn’t mean yes or no. So, first, I choose to say no. It doesn’t mean the success of the theory; so, thesis statement/ (Simon, post-tutoring argument task, 14:14, 1st side of 1st tape, drafting phase)

Second paragraph to explain how and why an, ah, schematic/ (Simon, post-tutoring technical description, 11:14, 1st side of tape, pre-writing phase)

But he did distinctly display reader awareness:

(previous segments: the ending make a brief prediction or recommendation) to about ah, about the system to the colleagues./ (Simon, post-tutoring technical description, 26:14, 1st side of tape, pre-writing phase)

It’s not clear, why? [Reread the previous sentence] Normally the successful result ... Scientific knowledge is an important part of theory. No, it’s not clear, and ah, not fit. It doesn’t fit./ (Simon, post-tutoring technical description, 37:44, 1st side of tape, drafting phase)

Sometimes his attention to goals combined with his attention to discourse coherence:

and hence, so do I explain why it is efficient? Why it is efficient, or do I have to say the advantages in the third paragraph? In the third paragraph,/ summarize, so in the third paragraph summarize and ah, then make recommendation./ (Simon, post-tutoring technical description, 21:30, 2nd side of tape, drafting phase)

The conclusion is, don’t have to tell if the theory is, ah, does this part fit the whole piece of writing?/ (Simon, post-tutoring technical
4.5. Strategies Related to Discourse Coherence

4.5.1. Discourse Coherence Prior to Tutoring

In their initial planning of both pre-tutoring tasks, participants seldom attended to the coherence of their texts or how planned elements or different parts of their compositions might fit together globally or locally. Most references to discourse coherence were implicit and concerned mostly or exclusively "what to include or omit". People seldom reasoned or deliberated over such decisions.

In the pre-writing phase, attention to discourse coherence was mostly evident in participants' searching for appropriate elements in the reading of the article to serve as content for the argument task:

/[Referred to parts of the reading article] #Um, those in the middle are garbage#. / ... #Um, this is the first point#. (Edward, pre-tutoring argument task, 10:02 & 14:04, 1st side of tape, pre-writing phase)

/And the other point is the piston? Okay, [Read the article] (Lorraine, pre-tutoring argument task, 14:38, 1st side of 1st tape, pre-writing phase)

Very few participants (mostly just William and Charles) referred to discourse coherence while composing. The following two protocol extracts exemplify their attention to coherence in conjunction with goals by considering whether the planned elements and discourse organization fit the particular genre they were writing:

/... Um, argumentative mode, #which means no need to write#
descriptive. #Then no need to# mention #what this# engine #is#, #also no need to mention how it# work. #Um, how to say his# success? #That is to say, the most important thing is to talk about what he made to make changes.../ (William, pre-tutoring argument task, 15:14, 1st side of tape, pre-writing phase)

/actually, the, the ah, the first para, actually before I said having two paragraphs and first discussing, first discussing his theory on the stratified charge and then the second paragraph discussing about his ah, about the operation of his engine. If I write the argumentative essay in this, in this method, I don’t think it’s considered as a, I don’t think it’s the proper format of a argumentative essay. So probably I’ll just combine the two paragraphs of his theory and the stratified charge, and ah, of the actual operation of his engine, and compare and discuss whether he or not, he used his theory on the, he used his theory to build his engine or not. So, basically is going to, the essay is going to be consisted of ah, the introduction, the argumentative paragraph, and the conclusion ... (Charles, pre-tutoring argument task, 25:54, 1st side of 1st tape, pre-writing phase)

Similarly, the next two extracts show William deciding on an element to be included in the introduction of his composition and Charles reviewing the relevance of his content:

/#The# body #is to write some# paragraph. #Um, write his# work research theory, #this should be written in the# introduction. #This is his# following work in reason, #why so successful#./ (William, pre-tutoring argument task, 19:26, pre-writing phase)

/apply it to the engine. The one reason, the one reason, the one reason that ah apply it to the engine, the one reason, no, I should not talk about why he didn’t apply it. I should just simply talk about, talk about how his actual engine work .../ (Charles, pre-tutoring argument task, 7:54, 2nd side of 1st tape, drafting phase)

Only one student, Bernard, attended to discourse coherence (implicitly) during the post-writing phase in reviewing his content and making both rhetorical and conceptual changes:

/... #I’m not going to write any more. Oh, not too many things written#.../ Okay, emitted by fossil fuel combustion. #Here, can
add#, ah, emitted, [added a phrase] please refer to Table 8.8 duration of recoverable fossil-fuel reserve,/ will be reserve, duration of recoverable, #is it not in use#? Okay, #cross out this sentence. The# introduction [Reread it] ... Okay, #cross it out, add# power plant with advanced flue cleanup system ... #No need to read the rest, regarding, #that's it#/ (Bernard, pre-tutoring technical description, 8:52, 2nd side of tape, post-drafting revision phase)

4.5.2. Discourse Coherence After Tutoring

The attention students devoted to discourse coherence was extensive and explicit in their post-tutoring writing. Most participants' strategic references to discourse coherence increased considerably in both post-tutoring writing tasks (see Appendices H and I). They displayed increased concerns for how different intended elements might fit globally with an overall plan or locally with specific discourse units. Thus, attention to discourse coherence was closely interrelated with attention to goals.

For instance, the first extract below exemplifies that in trying to formulate local gist for their writing, participants on the one hand employed the fit prompt to conceive how particular planned elements might cohere globally with their stated position or major goal. On the other hand, as in the second extract below, they attended to what content or elements their texts should entail. The second extract displays how participants developed global rhetorical plans (cf. Flower & Hayes, 1984; Cumming, 1989):

Modern day (refers to "modern day's# engine #is different" in the previous sentence), #does it# fit #or not? My# goal #is to say I agree. Then, in order to be# fit, I must talk about his# theory, #talk about his# engine, #talk about how# successful #when# combine #the two. This is the main thing, and this can cover everything./ (William, post-tutoring argument task, 18:18, 1st side of 1st tape, pre-writing phase)
The first thing I am going to write is about the theory, the theory itself. It's very, at, after all, um, after all, I compare the two engines. I think from that, I control, I can tell clearly that whether, (?) if, if ah, effective in, and ah, in the engine or not. Okay, um, now it's better. Okay, fit./ (Lorraine, post-tutoring argument task, 11:00, 1st side of 1st tape, pre-writing phase)

While drafting both post-tutoring compositions, participants often referred to discourse coherence to check whether single parts of their compositions fit globally with the overall planned gist or locally with particular discourse units:

[Reread the sentence] Technically speaking, there's never been a correct, oh, now this doesn't fit/ Just cross it out. (Simon, post-tutoring argument task, 2:20, 1st side of 2nd tape, drafting phase)

It's not clear, why? [Reread the previous sentence] Scientific knowledge is an important part of theory. No, it's not clear, and ah, not fit. It doesn't fit. (Simon, post-tutoring argument task, 37:43, 2nd side of 1st tape, drafting phase)

Some people attended to discourse coherence not only for conceptual concerns but also for rhetorical concerns:

The conclusion is, don't have to tell if the theory is, ah, does this part fit the whole piece of writing?/ (Simon, post-tutoring argument task, 43:15, 1st side of 1st tape, drafting phase)

which, #oh no, the# gas turbine. #Does my topic sentence fit#? (William, post-tutoring technical description, 3:28, drafting phase)

Some participants made conceptual or rhetorical changes by adding or deleting content so as to obtain a fit -- conceptually or rhetorically -- between parts of their compositions:

is not, ah, was not. #Then I can write a short paragraph to end it. This can# fit #the topic sentence. As a result, his theory was not/ (Henry, post-tutoring argument task, 16:19, drafting phase)

/#oh no, I can't have so many# main points! #Come on, let me see. The best is to have two# main points #only. Ah, how many# main points #have I written? I've written three# main points.
#First#, not isothermal; economic, #and# some difficulties. #Ah, then this one is# others. Okay, #it's correct, correct. It's better to# limit (the points) #a little bit. In this case, ah, right, if I add this one (point), it will# fit its# topic sentence. Since the combustion, #is#, would not raise/ (Henry, post-tutoring argument task, 11:40-12:28, drafting phase)

In the post-writing phase, participants referred explicitly to discourse coherence while reviewing what they had written in the text:

/[Reread the text] ... Since green, the problem of greenhouse effect is really a burden to the Government and to the whole country, the proposed design, okay, #here change it to a day. Ah, let me see if it# fits #or not.../ (Bernard, post-tutoring technical description, 22:53, 1st side of 2nd tape, post-drafting revision phase)

/fit between thesis statement and introduction?/ (Lorraine, post-tutoring argument task, 11:28, 1st side of 2nd tape, post-drafting revision phase)

Sometimes the students checked the fit between parts of their composition from another angle, to assess whether any written element was "not fit":

/Okay, #finished writing. Okay, now, let me check again whether there's anything not fit. The beginning said# Greenhouse effect is one of the worst environmental problem in the world. #Ah, should be the# problems. Um, okay, #nothing wrong here#. The carbon dioxide, mainly produced in the, in generating, in the power plant generating because/ (Henry, post-tutoring technical description, 18:00, 2nd side of tape, post-drafting revision phase)

Likewise, in the post-drafting revision phase, participants often attended to discourse coherence simultaneously with their goals as a criterion for examining whether they had achieved the purposes or the continuity they had intended for their texts as well as assessing what necessary changes needed to be made:

/The improved method/ will brings more revenue than before. #This one#, um, will brings more revenue than before, um, #no, it can't be like this (i.e., it's better not to mention this)# -- than
before/in the past. #I didn’t mention how things were in the past/before#. #It seems that there’s no connection here. How’s the methods in the past? Better say# the improved method is a rich investment. Okay, is a rich investment. #This is better. In this way, there’s no need to talk about the past#. #At the same time, it can be related to the front, and is quite# fit. (Edward, post-tutoring technical description, 0:34, 2nd side of 2nd tape, post-drafting revision phase)

Okay, any problems with# fit? Fit, #it’s quite# fit, #but, with regards to# goal, I need to add one more paragraph#. There are a lot of advance,/ um, ah, advantages, [Reread 2nd paragraph].../ then, let me put an asterisk sign here./ Um, um,/ drastically; #let me see how to make these# fit. Furthermore, [Reread] ... #is it good to add it here#?/ ... Furthermore, #put an asterisk sign here. Let me see which one should come first#/ #Then, here, use# in addition, drastic way. #Oh, it’s not good to add it here. Let me erase the asterisk sign#. In the long run, #it’s better to add it here#. Furthermore, #okay, add it from here#. (Bernard, post-tutoring technical description, 15:20, 1st side of 2nd tape, post-drafting revision phase)

4.5.3. Case Study of Discourse Coherence: William

William (along with Simon and Henry) demonstrated the greatest increase in his strategic use of discourse coherence. According to ESL ratings, William, an average writer in this group and a predominant L1 user, demonstrated improvement in the quality of content and language accuracy in the technical description task, and in all qualities of the argument task. According to the chemical engineering professor’s rating, William improved in the argument task but not the technical description task, achieving better quality of content and language use in the argument task.

William increased his strategic use of discourse coherence to 13% of his protocol statements in his post-tutoring writing from 2% in his pre-tutoring writing (raw frequencies from
1 to 44) in the technical description task and to 14% from 8% (raw frequencies from 10 to 36) in the argument task. He typically referred to discourse coherence (a) in checking whether single parts of his writing conceptually or rhetorically fit his intended goals and particular discourse units; (b) in attempting to achieve text coherence or continuity; and (c) in making conceptual or textual changes:

procedure, led them to most important procedure. #Oh no need, no need to have this sentence#. Technical description# doesn’t need this. The next step/ (William, post-tutoring technical description, 35:04, 2nd side of 1st tape, drafting phase)

which, #oh no, the# gas turbine, does my# topic sentence fit #or not# fit?/ ... hot gas cleanup, #oh, no continuity# (William, post-tutoring technical description, 3:34 and 7:30, 1st side of 2nd tape, drafting phase)

William’s attention to discourse coherence was conceptually well integrated with other aspects of his writing. The following statement displays how he shifted his attention between textual concerns and conceptual concerns: from rhetorical decision making about word choices to conceptual concerns about local goals and gist, then back to rhetorical concerns and audience awareness, and finally again to the conceptual concern of assessing the information in his introductory paragraph, attempting to ensure coherence between the beginning and the end of his composition:

conclusion, conclusion, #can I use, I# paraphrase? Um, #There’s no reason that I have to mention those# steps #from the beginning again. This would be# redundancy. #My# goal #is to make colleagues understand, so I can just write a brief# conclusion, #no need to write more, just write a precise and clear# conclusion. #My# introduction #is too long; but I think since there isn’t any# new information, it isn’t too extreme, and should be# okay. (William, post-tutoring technical description, 34:40, 1st side of 2nd tape, drafting phase)
4.6. Strategies Related to Word Choice

4.6.1. Word Choice Prior to Tutoring

In both pre-tutoring writing tasks, what concerned participants most was local decision making about vocabulary choices. One third of their five heuristic search strategies was devoted to word choice. Although frequent, people's considerations of word choices were mostly brief and isolated by themselves in the writing prior to tutoring, such as:

"/its main responsibility is ah, to transfer, to transport the waste gas./" (Leo, pre-tutoring technical description, 26:54, 1st side of tape, drafting phase)

In addition, participants seldom used a dictionary to search for words while composing the pre-tutoring tasks (though note the following example):

"/In almost every domestic, let's see, domestic car, #look up the dictionary, see if there's the word# domestic. D o m e s, d o m e s, [read definition]/" (Bernard, pre-tutoring argument task, 28:34, 2nd side of 1st tape, drafting phase)

In a few instances, word choices were made in conjunction with consideration of rules, in both the drafting and post-drafting revision phases:

"... #This (expression) is not good#. Regarding to the electric power,/ ah, it has been found that, it has been design, ah, it has been design, a power, it has been,/ it has been designed/" (Bernard, pre-tutoring technical description, 9:20, 2nd side of tape, post-drafting revision phase)

Only Charles attended to word choices (e.g., "outputting/producing") in consideration with other heuristic searches such as discourse coherence (e.g., "I should not mention about the electricity.") and goals (e.g., "I will only be mentioning CO₂ emission."):

"/Okay, so, this paragraph somehow connected to the first one, but"
haven't to be, but is better to be. So, I should say, this process, process of ah, converting, this process of converting ah, coal into electricity is ah, is an efficient, an efficient ah, is an efficient method to, is an efficient method to, [Reread] this process of converting coal into electricity is an efficient method of ah, is an efficient method of ah, is an efficient method of ah, of, of ah, I want to say that it's an efficient method of ah, of outputting, is an efficient way of ah, producing electricity and at the same time an efficient, no, I should not mention about the electricity, since in this paragraph I, I will be only mentioning CO₂ emission. Okay, so, the process of converting coal into electricity is an efficient method of ah, controlling, of controlling ah, CO₂ emission. [Reread this sentence] (Charles, pre-tutoring technical description, 20:04, 2nd side of 1st tape, drafting phase)

4.6.2. Word Choice After Tutoring

In the post-tutoring writing, concerns for the qualities of words and expressions continued to predominate as the heuristic strategy to which participants devoted the majority of their attention. The major differences between the use of this strategy in the pre- and the post-tutoring writing processes were: first, participants made more frequent references to word choices in their post-tutoring than in their pre-tutoring technical description task (See Table 4-4); second, participants explicitly mentioned the word prompt in their post-tutoring writing, compared to their pre-tutoring writing; and third, participants made numerous lengthy deliberations over word and expression choices only in their post-tutoring writing, particularly in the drafting phase.

In the pre-writing phase, participants usually made brief considerations of appropriate words or expressions for use in the introductory paragraph, thesis statement, or topic sentence:

and the reason why it is widely used. No, this is not the topic sentence. Well, um, topic sentence. How to express that something efficient? Okay, um, the readers for this writing, why
it is an efficient way, this, ah, okay. (Lorraine, post-tutoring technical description, 39:01, 1st side of 1st tape, pre-writing phase)

So, thesis statement. This is, thesis statement is ah, the question is whether or not the success of Diesel’s engine meant the success of his theory that guided him. So, success, well, um, um, no, can’t. So, so, how should I expect the thesis statement here? State in a different word?/ (Lorraine, post-tutoring technical description, 12:25, 1st side of 1st tape, pre-writing phase)

Sometimes they referred to a dictionary to look up meanings of difficult vocabulary items:

#let me look up the dictionary. What’s the meaning of# Desulphurization? (Leo, post-tutoring technical description, 6:55, 1st side of 1st tape, pre-writing phase)

I am checking the dictionary for the word sorb. (Charles, post-tutoring technical description, 12:10, 1st side of 1st tape, pre-writing phase)

Another noticeable change evident in the post-tutoring writing was that participants attended simultaneously to a local level of decision making about words and expressions, particularly engineering terminology, and a global level of setting goals, demonstrating a conceptual integration of the two:

Some (readers) may know some (i.e., something about the power plant), know some, #that means I don’t need to explain those# term. Term, #that means I need to# introduce #a few# term, terminology. #So, I should mention some, neither too many nor too few#, terminology. #What’s that? How to explain it? It’s called# pulverized, p u l/ (Edward, post-tutoring technical description, 3:02, 1st side of 1st tape, pre-writing phase)

/the Word desulphurization, #first, need to# explain how it works, #and# why it is an efficient way for controlling CO₂ emission. #First, need to, that is, need to# explain #how its whole# pulverized coal plant work. So, I have to divide it into two ... (Leo, post-tutoring technical description, 9:44, 1st side of 1st tape, pre-writing phase)

Likewise, the protocol example below shows how Bernard effectively modeled and
practised specific procedures from the procedural facilitation tutoring -- to deliberate over word or expression choices in his advance planning:

[at the end of the pre-writing/planning phase] Um, #what now? Okay#, word choice./ #any terminologies#/ Okay, Carnot Cycle, #not much to say#. Carnot heat cycle, diabetics, exothermatic,/ #and do I need to talk about# endothermatic?/ (Bernard, post-tutoring argument task, 14:44-15:19, 1st side of 1st tape, pre-writing phase)

Thinking about word choices dominated participants' concerns while they transcribed their thoughts into writing. In addition to making explicit references to the word prompt, participants demonstrated great efforts in searching for relevant or the best word choices to convey their intended meanings, either by retrieving them from memory, looking them up in a dictionary, or referring to synonyms. In addition, they seemed to have integrated certain tutoring procedures into their writing processes, for example, checking the appropriateness and redundancy of vocabulary choices, choosing equivalent, appropriate or better alternatives, considering implications of their choices globally and locally, or trying to ensure that they had clearly and precisely stated their expressions or meanings for their expected readers. Mostly, participants attended to word choices in the form of appropriate, better, or alternative words and phrases. While doing so, they reviewed previous sentences or text often, reread them several times, and checked to see if they had made correct choices, effectively framed their sentences, or clearly presented their meanings:

[Reread the previous sentence] Physical features of the advanced pulverized coal plant can be simply divided into two different um/, pro port,/ two different um interval? #Oh no, why# physical features? #Can I use another word#? Physical features/ (Leo, post-tutoring technical description, 45:30, 1st side of 1st tape, drafting phase)
drive, but also they can ah, drive, #use# (the word) drive? #Is there any other word I can use#? Ah, turn the steam, turn the steam turbine on, turn, ah, they also,/ (Bernard, post-tutoring technical description, 8:58, 2nd side of 1st tape, drafting phase)

In contrast to the pre-tutoring writing, in the post-tutoring writing, participants quite frequently looked up words in a dictionary or a dictionary of synonyms during their production of texts, and tried to figure out what alternative word choices were available for crafting their sentences. Thus they appeared to have actively practised what they were encouraged to do in the tutoring and other writing sessions -- using dictionaries (including synonyms) for references when they could not retrieve other vocabulary choices from memory:

Raw coal/ is initially/ introduce,/ #let me see whether there's any other word for# e d meaning, see whether there’s any other word. Words like# leading, leader. [Referred to a dictionary] First, this should be, #oh, it's different#/. L e a d pass through, #or is#, um, guided. #Okay, use# guided, #don't use# introduce./ (Leo, post-tutoring technical description, 12:49, 2nd side of 1st tape, drafting phase)

#Again# first introduce? #Let's see whether there’s any# synonym, #any other# word choice [Looked up the word in a dictionary of synonyms]. (Leo, post-tutoring technical description, 10:08, 2nd side of 1st tape, drafting phase)

In addition, what was visibly absent in the pre-tutoring verbal reports but was prevalent in the post-tutoring writing was participants' explicit mentioning of "redundancy" of word or expression choices, which they had practised while editing their texts during tutoring sessions. Many instances showed that when they noticed they had repeated a word or an expression several times in previous parts of their texts, they searched for other alternatives:

and why it is efficient. The following paragraph will describe how it works and why it is an efficient way for controlling, #again# redundancy, #can't use this word again#. The following paragraph describe how it works and, how it works and why,/ and why ah,
and why it generates, or produce/ (William, post-tutoring technical
description, 18:50, 2nd side of 1st tape, drafting phase)

When the CO₂ gas, CO₂ smoke from the power plant will be trans,
ah, is transferred, ah, #a lot of# redundancy, #but# (?), #use#
transferred. #Um, don't use it#. Anchor,/ #I can't say# anchor.
Enter, enters the contactor on, of the cleanup system. (Henry,
post-tutoring technical description, 1:52, 2nd side of tape, drafting
phase)

Sometimes, heuristic searches involving word choices were in retrospect, during
the process of text revision. Participants, for example, chose to delete a whole sentence because
it was "not well written":

Um, #it seems this is not well written./ It seems, not that good./
Ah, the whole sentence is not well written, let me delete it#. (Leo,
post argument task, 43:40, 1st side of 1st tape, drafting phase)

Quite often participants considered the appropriateness of word or expression
choices together with their linguistic accuracy, for instance, when focusing on phrasings with
prepositions:

With respect to the,/ ah, the respect with? Respect, in respect of?
#Let me look up the word# respect. [Referred to a dictionary]
#Let's see what# preposition #is used for the word# respect. With
respect to the issue, okay, with respect, okay, #no need to look up
the word in the dictionary any more. (Leo, post-tutoring technical
description, 21:44, 1st side of 1st tape, drafting phase)

Contract to #or# with? #Let me look up the dictionary#/.../
(38:42) #Um, I don't need to use# preposition. #This one#
contradict, #don't use# preposition. The, this was contradict the
Diesel's theory/ (Henry, post-tutoring argument task, 37:32 and
38:42, 2nd side of 1st tape, drafting phase)

As they had in the pre-writing phase, participants attended to local levels of
decision making about word choices in conjunction with the global level of setting goals,
planning discourse units, making references to reader awareness, as well as assessing the fit
between parts of their writing, conceptually integrating all these concerns during their production of texts:

Ah, the introduction should be, of course, adjust to the reader, and um, but um, what does it tell the reader? What should I tell the reader in the first paragraph? Of course, I need to mention that it’s a./ the power plant is a efficient, and say that it’s a, and I have to mention about the ah, the process, the stage of the power plant. So, I have to have the word efficient in it, and the stage and something to do with the operation of the power plant (Charles, post-tutoring technical description, 22:18, 1st side of 1st tape, drafting phase)

#Actually don’t need the word# and. The full operation of this new technology and its efficiency will be, will be, um, described as follows. Okay, #this, should be okay if it is for senior colleagues. It# fit #the whole piece of writing#. #Then, um, now write# topic sentence #to enter into the second paragraph. Um,/ (Leo, post-tutoring technical description, 42:08, 1st side of 1st tape, drafting phase)

Infrequently, participants translated between their first and second languages to search out equivalent wordings or phrasings:

in a new, #it’s better to use the word# way. The advanced, with advanced, is a new way of producing electric power, is a, #no, don’t use this word# way, is a, #don’t use this word# way, is a new,/ is a new, #um, untraditional method, different#, is a way./ is a way that,/ is a way that is different/ from the original./ (Edward, post-tutoring technical description, 12:14, 2nd side of 1st tape, drafting phase)

is a fact, #a method#, is a way./ #don’t use this word#/ is a new system/ (Edward, post-tutoring technical description, 12:14, 2nd side of 1st tape, drafting phase)

Often, participants made greater deliberations over their word choices in their post-tutoring writing, compared to their very brief considerations of appropriate word choices prior to the tutoring:
(4:10) They enter the gas turbine, and push the drive, ah, they enter the gas turbine, #any other# terminology #can be used? To# move #them, the word# move #is not good; to# drive #them, but# drive #has already been used#; push #them#, push the turbine, they enter the gas turbine and push it. They enter the gas turbine and,/ #okay#, power it up, power it up to drive the generator. Then the electricity... /drive, but also they can ah, drive, #use# drive? #what other word I can use#? Ah, turn the steam, turn the steam turbine on, turn, ah, they also,/ they can turn on the steam turbine. (Bernard, post-tutoring technical description, 4:10- 9:00, 2nd side of 1st tape, drafting phase)

### 4.6.3. Case Study of Word Choice: Edward

According to both the ESL instructors’ and the chemical engineering professor’s ratings, Edward, the most novice writer in this group and a predominant L1 user, improved significantly in the technical description task, demonstrating better qualities in all aspects of his writing, particularly language use. Though his post-tutoring argumentative writing was judged to be poorer in quality (according to both sets of ratings), neither raters noticed that Edward’s pre-tutoring text was largely copied from the reading article provided.

Edward was an initial low strategy user in both pre-tutoring writing tasks; he mainly told his knowledge and demonstrated no planning at all. Though he made little improvement in the complexity of his strategy use in the post-tutoring writing, he showed significantly greater use of all five heuristic strategies. He demonstrated the greatest increase, among all participants, in strategies involving word choice -- from 8 to 29% (raw frequencies from 3 to 119) -- in the technical description task. But unusually, in the argument task, he attended less frequently to word choices (decreasing from 50 to 24% between the pre- and post-tutoring tasks). But in terms of raw frequencies of heuristic strategies he actually made only 4
references to word choices in his pre-tutoring writing, compared to 52 references in his post-tutoring writing (see Appendices H and I).

My observations are that Edward productively adopted into his composing specific strategic processes in reference to the five procedural facilitation prompts from the tutoring. For example, he either explicitly or implicitly referred to the five thinking prompts to direct his planning, to monitor his production of text, and to evaluate his writing. Thus his goal-directed and self-regulated post-tutoring writing processes contrasted sharply with his unmonitored pre-tutoring composing. In addition, Edward displayed more local decision making about word choices in the post- compared to the pre-tutoring writing. The following two protocol statements exemplify the limited attention he paid to the aspect of word in his pre-tutoring writing:

In conclusion,/ in sum, comma,/ (Edward, pre-tutoring argument task, 29:39, drafting phase)

tunnel #or# funnel?/ (Edward, pre-tutoring technical description, 31:04, drafting phase)

But the next protocol example reveals his lengthy searches and greater efforts to decide on the most appropriate words or expressions in his post-tutoring composing. In comparison to the pre-tutoring writing, he focused more frequently as well as more intently on considering how best to state his meanings by searching for alternative choices from memory or by referring to a dictionary:

...new idea.../(12:10) in a new, #it's better to use the word# way. The advanced, the advanced is a new way of producing electric power, is a, #don't use the word# way, is a, #don't use this word# way, is a new./ is a, um, #an untraditional method, different#, is a way./ is a way that,/ is a way that is different/ from the original, o r i g i n a l, original./ original./ that is different, is a, is a new way that's different from,/ is a./ is a new way. #That one (the word way) is correct#, of producing/ e l e c t, electric power. #This is
better. This one, let me see#, a new way of producing electric power. #Is this correct? Let me try#, is a new system, is a new system of producing electric power./ desulphurization system is a new #what# producing electric power? Is a new, #come on, besides# system, #what other words can be used#? System, a new network. #Let me look up the word in a dictionary#/ [Read from the dictionary] System, complex form organization/.../ #is a#, is a new system, is a new um (?). #No, don't use this one#, is a new, is an advanced, is a more, is a more technique, technology, is a more technical, it is a more technical, #no#, is an advanced, (?)/ Um/, advanced, #no#/. #Let me consult the dictionary to see what other words meaning advanced can be used. [Read definition of advanced] ... promoted, improve, is a improved, is a improved, is a, is an improved method, #right#, of producing electric power./ (Edward, post-tutoring technical description, 12:10-18:41, 2nd side of 1st tape, drafting phase)

In the post-drafting revision phase, Edward also showed great deliberations over appropriate word choices in conjunction with intended goals, discourse coherence, or linguistic accuracy:

/The improved method/ will brings more revenue than before. #This one#, um, will brings more revenue than before, um, #no, it's better not to say# than before. #I didn't mention how things were in the past#. #It seems no connection here. How's the methods in the past? Better say# the improved method is a rich investment. Okay, is a rich investment. #This is better. In this way, there's no need to talk about the past#. #At the same time, it can be related to the front part, and is quite fit. And it is important to the environment. The desulphurization method in the improved method, #oh no, should be# of, of the improved method, #should be# of, can reduce rich gas, #not# will, #should be# can. Like SO2 during the combustion process of coal, SO2 can reduce for sulphur recovery. #Oh no#, can be processed, #right, can be processed# for sulphur recovery. #Right#. By this reduction, each year, #not# each year, each year, #just say# by this reduction, #two hundred and sixty-six# tons of sulphur can be recovered each year. By this reduction, #two hundred and sixty-six# tons of sulphur can be recovered. Each year, #should be this, not# each year, #is after# each year. And it brings annually thirty million to whom possessed this system./ (Edward, post-tutoring technical description, 0:01, 2nd side of 2nd tape, post-drafting revision phase)
4.7. Strategies Related to Rules

4.7.1. Rules Prior to Tutoring

Participants' concerns for rules of language usage were prevalent in both their pre- and post-tutoring writing. It was the second most frequent heuristic strategy mentioned in their think-aloud protocols. In the pre-writing phase of both pre-tutoring writing tasks, references to rules typically appeared in participants' exploration of the topic (diagram or article) for understanding or in their planning of local goals. For example, observe deliberations over the verb form of "go" in the first quotation below and over the form of the verb "prove" in the second protocol extract:

/So, I am not to burn the coal, with air in the burner, and the ash will come down in container, which will be um/ ship to some, shipped to somewhere I don't know where it's gone, I don't know where it's go, I don't know where it go. And/ (Peter, pre-tutoring technical description, 7:24, 1st side of tape, pre-writing phase)

/... So by comparing the theory and the actual operation of the engine, I can show that, I can show that the theory, he did not apply his theory in the actual building of his engine. By doing so, I, by doing so, it is proving, it can be proved./ the argument can be proved./ (Charles, pre-tutoring argument task, 19:14, 1st side of 1st tape, pre-writing phase)

In the drafting phase, participants were most concerned about local decision making about conventional language usage, such as, grammar, punctuation, or spelling; and in many instances, they did this so exclusively that they might have neglected the global aspects of their writing. Strategic references to rules were mostly implicit, except those concerning conventional spelling:

/Ah, what is a special, what is the special/ (Simon, pre-tutoring technical description, 35:12, 1st side of tape, drafting phase)
the idea, theory is based on, the theory/ is based, was based./ based on mixing/ (Lorraine, pre-tutoring argument task, 1:32, 2nd side of 1st tape, drafting phase)

4.7.2. Rules After Tutoring

In both post-tutoring writing tasks, participants attended most frequently to grammatical or spelling rules. References to rules in the pre-writing phases were minimal. Only in a few instances were language rules applied implicitly, for instance, when writing an introduction, thesis statement or topic sentences:

[Wrote the introduction in the pre-writing/planning phase] Recently, a new advanced pulverized coal plant with an, has been built, has been, has builded/ has been builded. #Oh, I don't know how to use it#, has build, have been, the car has been build, the car is made in Japan, the car is made./ are #what#? Made with #what#? The power plant has build, has been build, the power plant is build, the car is made. It had, the car has been made./ ... has been build. (Edward, post-tutoring technical description, 36:44, 1st side of 1st tape, pre-writing phase)

Later, when drafting their texts, the students made both explicit and implicit references to grammatical rules or spelling accuracy, either while composing a sentence or after a whole sentence was complete:

#should be# stated, #not# state. #This is# rules #problem; which stated that ah, the isothermal, the isothermal combustion/ (Henry, post-tutoring argument task, 40:10, 2nd side of 1st tape, drafting phase)

less air pollution, um, #delete it. In this way#, active (voice) #is better than# passive (voice). (Bernard, post-tutoring technical description, 30:24, 2nd side of 1st tape, drafting phase)

In addition, they often referred to a dictionary to check their spelling:

inside the cyclone, #actually, how to# spell cyclotron? C y c l o
Strategic attention to rules in the post-drafting revision phase was similar to that in the drafting phase, except for participants' retrospective views of their texts:

The desulfurization method in the improved method, #oh no, should be# of, of the improved method, #should be# of, can reduce rich gas, #not# will, #should be# can. (Edward, post-tutoring technical description, 1:24, 2nd side of 2nd tape, post-drafting revision phase)

Sometimes, attention to grammar rules in this final review was in conjunction with other aspects of writing such as goals or word choices:

Okay, now, I am writing, I am copying the draft and, ah, and also attacking the grammar errors [made changes to grammatical errors and word choices, with an explicit reference to the aspect of goal - - reader awareness] a recycled gas, the recycled gas. Do they make sense (to the readers)? (Lorraine, post-tutoring technical description, 8:54, 1st side of 2nd tape, post-drafting revision phase)

4.7.3. Case Study of Rules: Charles

Among all participants, Charles (as well as William) demonstrated the greatest percentage increase in strategic uses of rules in both the technical description and the argument task. Indeed, for all other participants their attention to rules declined between the pre- and post-tutoring writing. According to the ESL instructors' ratings, Charles, an average writer in this group and a predominant L2 user, improved in the technical description but not the argument task, demonstrating improvement in discourse organization, language accuracy, and language appropriacy in the technical description task, but just in his communicative quality in the argument task. According to the chemical engineering professor's ratings, Charles improved
considerably, achieving better content and organization in his post-tutoring writing than his pre-
tutoring writing.

At the beginning of the tutoring, Charles pointed out that grammar was his main
concern. In his opinion, he had few problems with goals and discourse coherence, but he needed
to focus primarily on rules and secondarily on word choices. He was an initial high strategy user
and showed rather detailed advanced planning in his pre-tutoring writing. Charles increased from
16% prior to tutoring to 33% after tutoring (raw frequencies from 14 to 70) in his strategic use
of grammatical and spelling rules in the argument task. In the technical description task, his
corresponding increase was from 19 to 25% (raw frequencies from 13 to 72). In other words,
he paid more attention to what he intended to achieve in the tutoring -- improvement in grammar.
His post-tutoring thinking processes revealed that he referred to rules implicitly and solely in the
drafting phase of his writing, and sometimes simultaneously with attention to word choices:

okay, the, okay, ah, into the engine has two distinct requirement. The start of the piston in the cylinder must be driven by a, a, a, the
second ah requirement, the second character, characteristic is the
working fluid, is for the, the second requirement and, okay, the
second requirement, the characteris (i.e., characteristics), the
second, the theory that Diesel hope to incorporate into his engine
has two distinct requirements. The start cycle of the piston in the
cylinder must be driven by an isothermally expansion, ah, in the,
of the fluid, isothermal expansion in the fluid, in the fluid that
occurs when heat flow from a large heat reservoir into the fluid,
working fluid .../ (Charles, post-tutoring argument task, 25:04, 1st
side of 1st tape, drafting phase)

... The rest of the components in the coal smoke enters the, the
rest of the components in the coal smoke enter the reducer for
further reduction of ah, for further reduction of gas. Then all the
components pass through the regenerated sorbent that helps. sorbent
that helps ah absorb, that help absorbs the fair, that helps absorbs
additional, that help absorbs ah, that ah enters through the
regenerated sorbent that absorbs ah carbon dioxide. The
components then goes through, the component then go through the coarse separator, the coarse separator. In the coarse separator, the finer particles is separated, final, finer particle, the finer particles are separated for disposal and the large particles are again processed by the contractor. These particles goes through, these particles go through, these particles go through the same process repeatedly until it ah, until/ they are reduced to finer... (Charles, post-tutoring technical description, 7:18, 2nd side of 2nd tape, drafting phase)

4.8. Strategies Related to Language Switching

Three participants (Simon, Lorraine, and Charles) used their second language (English) exclusively in their thinking-aloud while composing. The other six participants (William, Henry, Bernard, Edward, Leo, and Peter) switched between their first and second languages (Cantonese and English) and to varied extents (e.g., Peter used English predominantly in his thinking-aloud).

4.8.1. Language Switching Prior to Tutoring

In both pre-post writing tasks, the six participants who switched between their linguistic codes did so mainly to access available linguistic and cognitive resources more efficiently. For example, they predominantly thought in English while transcribing what they knew about a topic onto paper, and they usually switched to Cantonese for (more and less consequential) problem solving and decision making, as well as for progressive exploration or comprehension of the topic, diagram, or reading article they were attending to.

In their pre-tutoring writing, because the vast majority of these participants lacked deliberate and goal-directed advance planning, they simply wrote what they knew about the topic
in English, and they seldom code-switched for problem solving or decision making. When they did, they mainly shifted to their first language for processing and comprehending the topic, diagram, or article, rather than for exhibiting appropriate on-line self-regulation or evaluation after composing:

[Referred to article] /#Um, then, the middle part is useless./ (Henry, pre-tutoring argument task, 10:02, 1st side of 1st tape, pre-writing phase)

move it, and move it to the reducer, to, and reduce gas ... #enter into# contactor, #then to# reducer, #and then to# regenerate absorbent, separate, coarse separator, reduce. #That is to say, when it burns, it results in those things. And then there will be remains, there will be, that is#, any waste, #and so#, process the coal, #and# reducer, #go to#, go to the reducer, reducer, to ah reduce, reducing gas, #turn to#, advance, #then enter into, well, what's the use of this middle one#? #For# regenerated sorbent./ (Bernard, pre-tutoring technical description, 21:37, 2nd side of tape, drafting phase)

4.8.2. Language Switching After Tutoring

In preparing for their post-tutoring writing, these six participants code-switched to access available resources in both first and second languages more expediently. They tended to think solely in English while telling their knowledge then switched to Cantonese mostly at points when they had to make decisions or metacommments. Their strategic uses of the two linguistic codes were frequently in conjunction with their attention to other aspects of writing such as in combination with goals or discourse coherence:

#Um, I don't understand here, why it would, why# gas turbine #and# compression #have to be connected together#? (William, post-tutoring technical description, 20:16, 1st side of 1st tape, pre-writing phase)
First, um#, goal, (?) debate, #no. This one is not like this, should write, um, what to write in the beginning? The# goal, first, success, #use this to bring out the main theme and lead to the second (point). Okay, first, is, um, how to write in the beginning? Let’s see the# outline. Ah, introduction, define, #no, oh yeah. Start by saying# Diesel #good, the# Diesel engine is very useful, engine [then told his knowledge in the second language -- English].

(Henry, post-tutoring argument task, 37:20, 1st side of 1st tape, pre-writing phase)

They typically translated between the two languages to quickly search out equivalent words or expressions:

#Though there were great changes, and very complicated#, complicated/ (Bernard, post-tutoring argument task, 4:55, 1st side of 1st tape, pre-writing phase)

The following example shows the complexity of some of this language switching, as William attended to word choices, consulted a dictionary, and focused strategically on language rules:

/Coal plants are now integrated, are now integrated/ with new technology./ new technology to reduce pollutants./ technologies./ Coal plants are now/ integrated, integrated, #what's another word#/?/ Are now, coal plants are now installed, installed, #no, not good#, integrated, #no, not good. This word is not good, also actually it's wrong./ How to write it#/? Coal plant/ are now installed, grammar, #no mistakes! Coal plants are installed, coal plants are now, (?) cope with, equipped with, #not correct#. Coal plants are now/ equipped,/ #Oh buoy!/ [Looked up the word in a dictionary] How comes there isn't such a word#/? Equipment, #sometimes is a# verb./ Equip,/ #Can I use this word# equipped? I can't find it, um#/ Equpped with/ equipped/ equipped./ #how comes that I can't find it#/? Equip, equipped./ (?) fuel./ #No, it's not here! What should I do? How to fill it#/? Now/ equipped, #there isn't such a word here#/! Upgraded? Coal plants are now, #oh, come on, this# word choice! Coal plants are now/ contained, #no#, are now installed, #no, can't#, are new, coal plant./ #oh, its' really difficult to find the word! Are now/ in/ equipment. #Is there such a# verb? #There's a# verb, #but there's nothing about it (in the dictionary)#!/ Equip, furnish, are now provided, [Read from the dictionary] fit out, supply with outfit or apparatus, point./ equip./ #okay, try, now I really don't know any other./ What#/?
New, #how to write it? Coal plants are now equipped with new/technology, with new/ah/ procedure. #I can’t find other# word choice. #Okay#, equipped with new machine, machine, with apparatus/ to reduce pollutants./ reduce pollutants. Integrated combined-cycle technology is the efficient way to control/greenhouse gas. [Reread] Coal plants are now equipped with new apparatus to reduce pollutants./ (William, post-tutoring technical description, 2:02-11:50, 2nd side of 1st tape, drafting phase)

In the post-writing phase of both post-tutoring writing, these six participants code-switched while attending to various aspects of their writing. Therefore, language switching in this phase was always in conjunction with other strategies and mostly implicit. Only two participants (Bernard and Henry) explicitly attended to the L1-L2 aspect in their final reviews of their written texts:

Okay, #ah, there isn’t any problem with L1-L2#. (Bernard, post-tutoring technical description, 12:28, 1st side of 2nd tape, post-drafting revision phase)

/has fewer chance has left, #smaller chance# has left, fewer chance has, ##smaller chance, what’s that? Let me use Chinese to say it#, has less,/ #um, but, oh yeah, I can use# as a result,/ has less, has fewer chance./ smaller chance #should be better, right#? Chance, smaller, chances, smaller, smaller chances. #What kind of noun is# chance? Chance, [referred to a dictionary],/ chance #is, come on, it doesn’t say anything about it. Is a, oh no, ah no#, chance #is# uncountable noun. Smaller chance, uncountable noun, small, has a small, has a small, has a smaller chance to lead from the transition,/ from the transition processes, from transitional/… (Henry, post-tutoring technical description, 26:20, 2nd side of tape, post-drafting revision phase)

4.8.3. Case Study of Language Switching: Leo

Leo, an average writer in this group and a predominant L1 user, produced better qualities of writing, specifically in the categories of content and language use, in both post-
tutoring tasks compared to the pre-tutoring tasks. He also made greater strategic use of language switching in the technical description tasks, demonstrating an increase from 14 to 34% (raw frequencies from 14 to 185). However, in the argument task, his language switching remained constant over the pre- and post-tutoring writing, but it nonetheless was the most prevalent heuristic search strategy he employed (in 35% and 36% of his protocol statements). The significant increases in Leo's uses of language switching were not only for exploring and comprehending the writing topic/diagram, but were also (as noted above) for accessing resources in both languages for the formulation of goals in advance planning, back-tracking goals with reference to the coherence of text, and making metalinguistic and ideational changes in writing and revision of texts. In short, this strategy was used for nearly all decision making and problem solving (including exploring the writing diagram/figure for understanding) in his writing processes:

/*The 4th# point, #ah, just the 3rd# point. #Then the 4th# paragraph, #what to talk about here? Talk about his# success. #How# success(ful)? #The# success #of the idea (i.e., theory)#/ um./ #okay, talk about# four stroke, #the# four stroke design./ #talk about how's his# four stroke design. #There's a lot of things mentioned in the diagram on page 104, right? Actually, the# four stroke, #it's very nicely closed, also, there's a# free piston. #On the one hand, it can be the# shock absorber. #On the other hand, it can be,/ um./ #it can produce a# steady pressure/ for combustion/... #then, the 5th paragraph is the# conclusion. Okay, #start writing./ #Let me give it a# title #first#, argumentative writing,/ #how to write it?#/ Ah./ A success, the, um,/ a success engine,/ a success engine design/ [continued writing in the second language -- English] ... definitely successful, #right?/ Actually no need to have# clear indication, #it should be okay, right? It's better to make it simple#, okay./ (Leo, post-tutoring argument task, 19:04, 1st side of 1st tape, pre-writing phase)

#Actually no need to use the word# and. The full operation? The full operation, the full operation of this new technology and its
efficiency will be, will be um, #okay#, described as follows. Okay, #this, to senior colleagues, should be okay (i.e., senior colleagues should be able to understand).# Okay, #fit# fit #the whole piece of writing. #Okay, #fit# fit #the whole piece of writing. And then, now, from #topic sentence #to the second paragraph. Um./ (Leo, post-tutoring technical description, 42:08, 1st side of 1st tape, drafting phase)

4.9. Changes in the Complexity of Strategy Use

As described in section 4.5., in their pre-tutoring writing, participants predominantly attended to single heuristic search strategies, seldom simultaneously utilizing two or more of them in conjunction. In the post-tutoring writing, participants increased substantially their complexity of strategy use by using more frequently two or more heuristic search strategies in combination. Here I try to show how this change occurred, referring to two students who initially were either low or high in the complexity of their strategy use in the pre-tutoring writing, documenting how this changed in the post-tutoring writing.

4.9.1. Initial Low Complexity Strategy Users: Case Study of Peter

Initial low strategy users (Simon, Edward, Lorraine, and Peter) increased their complexity of strategy use (or complexity of thinking) by using two or more (usually two) heuristic search strategies in conjunction in their post-tutoring writing, in comparison to predominantly single heuristic search strategies in their pre-tutoring writing. The following protocol examples exemplify Peter's use of single heuristic search strategies, mostly on local issues of writing, in his writing prior to tutoring:

Although Diesel's theory did not guide him to make a productive engine in, an energy efficient energy, ah his contributions in, contri, his contri, his contribution on making it energy... (Peter,
Like other initial low complexity strategy users, Peter made the greatest increase between pre- and post-tutoring writing in his use of two strategies in conjunction in his post-tutoring argument task (see Appendices J and K). Mostly, he focused on goals and discourse coherence while conceptually integrating the two to check whether parts of his writing fit globally with the overall planned gist, locally with particular discourse units, or adjusted to readers' needs accordingly:

Coal is sent to a gasifier in which ah, gasification is taken place. Okay, coal is sent to gasifier which is where gasification is taken place. This sounds quite like (?). Maybe I can change the whole sentence to a gasifier in which gasification is taken place. Ah, then I have to explain why, what is gasification or ah/how gasification works./ (Peter, post-tutoring technical description, 33:14, 1st side of tape, drafting phase)

Okay, let me think about it. Do I have to say something about ah Otto's engine? Otherwise, no body knows what's, ah, no body knows what um, what ah Otto's engine was. Ah, um./ (Peter, post-tutoring argument task, 13:34, 1st side of tape, pre-writing phase)

Sometimes, he attended to appropriate word choices in conjunction with intended goals or linguistic accuracy:

no, did not mean success of his theory, his poor theory. Am I characterizing his theory? Anyway, that's what I am trying to do. Um, okay./ (Peter, post-tutoring argument task, 25:38, 1st side of tape, drafting phase)

Therefore, it avoids the effect. No, it can't avoid the effects. It decrease, or reduce, reduce is better, r e d u c e, reduces the effects ah, it reduce the, the ah./ (Peter, post-tutoring technical description, 42:42, 1st side of tape, drafting phase)
Among all participants, Peter showed the greatest increase from 8 to 42% (raw frequencies from 5 to 28) between pre- and post-tutoring writing in his use of two or more heuristic search strategies (i.e., double-plus configurations) in the technical description task. The following protocol example displays his strategy use of quadruple configurations in his post-tutoring writing tasks:

#It seems too many these# gasifier, gasification, gas #words#. Ah, maybe I can use more other words or rephrase the sentences so that I don’t have to use much gasifier, gasification stuff. Actually I can ah, omit (the part) inside the gasifier. I can say coal is partially combusted during process and the ash is separated, and ah, by saying deposited, I can say disposed, so people understand it is dumped and they don’t have to know where it goes and ah, it’s not the principle of this system. Then, okay, and ah,/ (Peter, post-tutoring technical description, 23:58, 1st side of tape, drafting phase)

4.9.2. Initial High Complexity Strategy Users: Case Study of Henry

Initial high complexity strategy users (William, Henry, Bernard, Charles, and Leo) also increased substantially their complexity of strategy use after the tutoring. In their pre-tutoring writing, they utilized predominantly single and over 20% double configurations of strategy use. However, they seldom used three or more heuristic search strategies in conjunction. Only one student, Henry, made one reference to quadruple configurations of strategy use in the pre-tutoring technical description task. But in their post-tutoring writing, they showed more strategic use of triple to quintuple configurations (see Appendices J and K).

Henry demonstrated the greatest increases from 0 to 4% (raw frequencies from 0 to 6) in his use of the most complex, quintuple configurations of strategies, and from 23 to 61% (raw frequencies from 24 to 106) in his use of two or more heuristic search strategies in
conjunction (i.e., double-plus configurations), in his post-tutoring argument task. According to the ESL instructors’ ratings, Henry improved in all aspects of writing, and according to the chemical engineering professor’s ratings, he improved particularly in content, in his post-tutoring writing tasks. The following quintuple configuration exemplifies Henry’s complex strategy use while drafting his post-tutoring text. He explicitly mentioned readers, carefully reformulated ideas to accommodate their needs, conceptually integrated the reshaping of local goals with the use of appropriate word choices, and implicitly attended to grammar rules ("difference, differences"): 

/and reliable engine did not appear until #1920# when the fuel is perfect. However, the success of Diesel’s theory, #okay, this fits better, and people will understand more clearly#. Diesel’s theory that guided him did not mean, #ah, yes, #I can use# his since #I’ve already mentioned it. Diesel’s engine meant or did, oh, did not mean, did not mean the success of his theory that guided him because the combustion of Diesel engine is not isotherming, it is not reliable and economic, and some technical difficulties, #should be# technical differences. #Ah, no, how to say it? Have some, have some technical differences, and are #extreme#, #no, don’t talk about# technical. And some difference, and some differences, #okay#, differences, #don’t talk about# difficulties, differences between the/ (Henry, post-tutoring argument task, 44:50-46:35, 1st side of 1st tape, drafting phase) 

The quintuple configuration below shows Henry did strategic back-tracking after one part of his text was complete. First, he related the need to reformulate ideas to a rhetorical concern of conforming to grammar rules. Then he made references to heuristic search strategies of discourse cohererce and word choices, attempting to maintain coherence in particular discourse units ("the thesis statement"). Finally, he conceptually interrelated the concern for word choices with local goals to be included in the writing:

/Um, between #its, ah, the last part can be changed; shouldn’t be#
practical, #should be# practice, #because (?) both are# nouns. #Um, so, does this part# fit #the# thesis statement? #First, already# defined #he's not# success, #then said# it is not economic and reliable. #Ah, I don't need to talk about# reliable. It's not economic, and, #let me see#, because the combustion of a piston, ah, #about# economic, #how to say it#? It's not economic in Diesel's ideal engine and also some differences between the theory and practice. #Ah, this expression is# okay. #So, the first# main point #I need to write is#: not isothermal./ (Henry, post-tutoring argument task, 0.00-1:46, 2nd side of 1st tape, drafting phase)
Chapter 5

Results of Analyses of Knowledge-Transforming

Research question 3 asked:

*Do ESL engineering students demonstrate greater use of knowledge-transforming behaviors in their writing processes after the training in procedural facilitation of strategic knowledge in second language writing?*

Participants demonstrated significantly greater use of knowledge-transforming and less frequent use of knowledge-telling in their post-tutoring writing processes compared to their pre-tutoring writing processes -- in the technical description task only. These increased knowledge-transforming behaviors displayed more complex and sophisticated dialectic processes between the two problem spaces of content and rhetorical concerns.

5.1. Knowledge-telling and Knowledge-transforming

Comparisons between the pre-post verbal reports on participants' domain-knowledge processing are displayed as group means in Table 5-1 for the technical description task only. Knowledge-telling significantly diminished from 77.5 to 60.0% ($p < .01$); and conversely, knowledge-transforming significantly increased from 22.6 to 40.0% ($p < .01$) in the post-tutoring technical description compared to the pre-tutoring one. Table 5-2 shows these
analyses for the argument task, where there was also a slight increase in knowledge-transforming between the pre- and post-tutoring tasks, and a corresponding decrease in knowledge-telling, but this change is not statistically significant.

Table 5-1: Pre-Post Comparisons on the Use of Knowledge-telling and Knowledge-transforming on the Technical Description Task

<table>
<thead>
<tr>
<th></th>
<th>Knowledge-telling</th>
<th></th>
<th>Knowledge-transforming</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>No.</td>
<td>157.3</td>
<td>(89.6)</td>
<td>203.0</td>
<td>(87.4)</td>
</tr>
<tr>
<td>%</td>
<td>77.5</td>
<td>(14.3)</td>
<td>60.0**</td>
<td>(16.4)</td>
</tr>
</tbody>
</table>

*p < .05  
**p < .01 (Wilcoxon Matched-Pairs Signed-Ranks Test)

Table 5-2: Pre-Post Comparisons on the Use of Knowledge-telling and Knowledge-transforming on the Argument Task

<table>
<thead>
<tr>
<th></th>
<th>Knowledge-telling</th>
<th></th>
<th>Knowledge-transforming</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>No.</td>
<td>190.2</td>
<td>(135.8)</td>
<td>248.3</td>
<td>(69.0)</td>
</tr>
<tr>
<td>%</td>
<td>81.2</td>
<td>(18.0)</td>
<td>73.3</td>
<td>(9.3)</td>
</tr>
</tbody>
</table>

**p < .01 (Wilcoxon Matched-Pairs Signed-Ranks Test)

5.2. From Knowledge-telling to Knowledge-transforming

Participants displayed more knowledge-transforming and less knowledge-telling in their post-tutoring writing processes as their attention to the substantive content they wrote about integrated and interacted more frequently with their attention to the rhetorical concerns of
their written discourse. These consequential dialectic processes were particularly manifest in participants' goal-directed planning during the pre-writing phase, their heuristic searches and problem solving in the drafting phase, and their text evaluations and revisions during the post-writing phase. Selected extracts of protocol statements here illustrate unique changes in participants' writing processes in reference to case studies of individual participants.

5.2.1. Knowledge-transforming in Pre-writing Phases: Case Study of William

Pre-post differences in participants' knowledge-transforming behaviors were pronounced in their progress toward planning in their pre-writing phases. Whereas only four participants demonstrated advance planning in their pre-tutoring writing, all participants (nine in the technical description and eight in the argumentative writing) displayed advance planning in their post-tutoring writing. Instead of simply rehearsing their thoughts as they had in their pre-tutoring thinking processes, or just enumerating key intended elements, participants demonstrated effortful "conceptual planning" — "planning that consists of thinking about the composition" (Bereiter & Scardamalia, 1987a, p. 310). Such profound changes in knowledge-transforming behaviors were particularly evident in William's pre-writing phase of his pre-post argument tasks.

William, an initial high strategy user and an initial high complexity strategy user, did rather detailed advance planning in his pre-tutoring writing. Nevertheless, his planning in the pre-tutoring writing mainly involved intended goals in the rhetorical space. That is to say, his reflective thinking went on almost entirely within either the content space or the rhetorical space, and there was no or limited (see the next protocol example) interaction between the dual problem spaces:
/(11:35) #Um, in this case, first I should write a piece of argumentative essay; #first# state #my position. Okay, let me write# introduction. Introduction, #I need to# restate #this# statement, restate the success of Diesel, Diesel’s engine meant or did not mean the success of ah, his, mean success of that, mean the success of, mean the success of his theory that guided him is true, or, #or, um#,# argumentative, #I need to# restate #this# statement. Restate, restate the success of Diesel’s engine meant, the success of Diesel engine meant the success of, meant the success of guided theory.

He demonstrated limited knowledge-transforming initially. Though he translated problems from the rhetorical space to the content space, he lacked a two-way process between the dual problem spaces. For instance, while working in the rhetorical space to decide upon his intended elements, he shifted to the content space in questioning the meaning of Otto’s theme and realized the need to "find out some information about the book" (Otto had written), but then he stopped there and did not convert the rhetorical problems to subgoals to be achieved in the content space:

If I, and, his theme #is,/ what does it mean#? Prove, restate, several things #I need to# mention. #They are#, his/ ah rational, ah, his theory, his,/ um, #his# theory, #his# theory, #he did# research, #did# research, #he did, he had# publish,/ #he had, his book# promote #his idea. He went to find# financial aid, financial support. Um, argumentative mode, #that means no need to write# descriptive, #so there’s no need to# mention #what this# engine #is. How it# work #also need not to be mentioned.

[Read the article] #Then, the# body, #what to write in the# body? Um, body./ #The# body #would write some# paragraph. #The part to write his# work research theory #should be written in the# introduction. #This is his# following work in reason, #why it is so successful./ Um, then, I should write the# conclusion, #to# restate #things he had done, and this would be his# reason, ah, success./ In this way, after starting writing the# introduction, #after the# introduction, write that he# promote #the idea to the Europeans, let them know all these. So I have to find some information about the book he# promoted./ [Read the article, then started writing]
In contrast, William showed marked changes in knowledge-transforming behaviors in his post-tutoring writing. Not only did he more frequently access knowledge-transforming, he also displayed more complex dialectic processes alternating between the dual problem spaces. The following protocol excerpts exemplify recurring instances of knowledge-transforming behaviors in William's pre-drafting phase in his post-tutoring argument task -- how one problem or concern in either problem space gave rise to another, how operations on these beliefs led William to his final decision on text planning, and how he constantly transposed content problems back to rhetorical concerns.

In the beginning of the pre-writing phase of his post-tutoring argumentative writing, William was working in the rhetorical space, deciding "to take a pro-argument position" then he came to the decision that he needed to mention the theory that guided Otto. This was a content problem, however. So, he shifted from the rhetorical problem space to the content space, asking "then what's his theory?". Working in the content space led William to consider one important issue after another (e.g., first "what's his theory?", then "its problem is the explosion", "four stroke, how?", "two stroke or four stroke?", "his theory is combination of fuel and air", and "better than steam engine, more powerful"). These became subgoals to be achieved in the content space. These subgoals, when transcribed to the rhetorical space, gave rise to reader awareness ("What can I say to convince readers that he's successful?"), to deciding upon the key elements to be achieved ("divide it into two parts: his Otto engine and theory"), as well as to reasons supporting his argument ("If both theory and engine match, that means it's correct"):

(0:00) [Read the topic] Um, student./ and professor, student, professor and student. Otto, Otto's engine, success of Otto's
engine, meant or did not mean the success of the theory, the success of his theory that guided him. Yes or no? Yes, that means agree with this sentence, that (position) success, that success, and theory. So, if you agree, then what’s his theory? It is: the combustion of fuel and air is not similar to (?) engine. Its theory is: (We) need to use the right amount of fuel and air mixture. That is, the mixture will have gas, fuel gas, gas, it means there will be an explosion. Its problem is the explosion, fuel and air mixture. Four stroke engine, four stroke engine, four stroke, how? Um, Two stroke or four stroke? Argumentative, the success of Otto’s engine, is his theory correct or not? (4:01) How to say it? Just now I agreed to this sentence (i.e., the success of Otto’s engine meant the success of the theory that guided him), that is agree. Agree. But its theory is: combustion of the mixture of fuel and air. That’s better than steam engine, more powerful. Four stroke. What can I say to convincing (i.e., convince) readers that he’s success? Theory, that means it’s important to start from his theory, and his Otto engine; divide it into two parts: his Otto engine, and theory. If both (i.e., theory and engine) match, that means it’s correct.

This working in the content space also led William to determine what key elements/goals to be entailed in different discourse units in the rhetorical space ("my first paragraph needs to write about his theory. Second paragraph needs ..."). In addition, he further related these to other rhetorical concerns about how best to convey his ideas ("Or better mix them together when talking about them?") and reader awareness:

Um, (?) Otto engine, um, Otto, Otto, Otto, how’s Otto’s engine? can, to modern, it’s modern. Um, there’s a cylinder, then mix gas. Stroke, how’s that? Powerful stroke. Otto? In this case do I need to talk about modern automobile engine? Otto? Need to talk about the theory, need to talk about the engine, also about whether he’s success. How to write it? Not enough. Um, how to say it? Otto, engine, that is, um, cylinder, fuel, and air combustion, or the theory is correct? Then, do I need to describe his engine? Also to describe his theory? So, if introduction says it’s correct, then my first paragraph need to write about his theory. Second paragraph needs to mention about his engine. Third
paragraph may talk about his application; no, talk about how his theory and engine guide modern automobile engine; and then conclusion. Or better mix them together when talking about them? Um. Or first talk about his theory, then about the success of his Otto engine was based on his theory? And my reader don't know anything about it, so I must first talk about his theory. After talking about his theory, that is first part, intro. Second part is theory. Third part is engine. Fourth part is, um, is modern, ah, automobile engine. The fifth is conclusion. That is, whether or not he's success.

Planning goals to be accomplished in the rhetorical space through enumeration and outlining led William to other rhetorical concerns such as the continuity of text ("But then what's that connection?"), the most important goals to be included ("theory and his engine are the most important"), as well as the need to modify his text planning so as to accommodate the most consequential issues ("I have to make changes"). This modification of text planning then initiated further content problems (first "What's his theory?", then "internal combustion", and then "four stroke functions: intake, compression, extension, and exhaustion"). While further compiling his beliefs in this way, William translated his content concerns to the rhetorical problem of how best to convey his ideas ("to evenly describe" them). This gave rise to further content problems ("What's intake?") and led to further changes in his beliefs ("Fuel plus air and ..."), and so on (e.g., "why was it successful?", "His best should be atmospheric", "Always his problem was power explosion too big", and "modern day engine"). Simultaneously, William referred these content problems to problems in the rhetorical space such as: text coherence ("in order to be fit"), the position/main goal he had chosen ("My goal is to say I agree"), and goals to be achieved ("I must talk about ..."), until he was satisfied that "this can cover everything":

But then what's that connection? Success of Otto's engine. Now the most important thing (to bear in mind) is that theory and his engine are the most important. Argumentative, if so,
I have to make some changes (in the planning). Automobile, I have to talk about his theory. What's his theory? His design. um, his design is two stroke or four stroke, six stroke. Internal combustion. Theory is, um, internal combustion. His theory is four stroke engine; divided into four stroke functions: intake, intake, compression, um, extension, and exhaustion. Exhaust then (?) form Otto's engine. Exhaust, these four stroke, I have to evenly describe these four theory. What's intake? Fuel plus air and ah, proportion. Proportion, compression, um, mix the fuel and air combustion. Expansion is combustion, ah, with something like an electric ah plug. More spark dots, exhaust, then drive away those exhaust gas. Um, let me see how to write it. Inside when the mixed fuel and air, um, how to fit those spark dots? Steam engine, success. Success, ah, third paragraph will talk about he find it is successful, then I won't be off topic, that is, why his engine was so successful in the eyes of people nowadays, us. From modern day, why was it successful? His theory, his engine, modern automobile engine, based on this thing, that means to explain his theory, then talk about his engine. (14:03) His best should be atmospheric. Let me see. [Read the article] How to say it? His engine basically based on his theory. But here this paragraph says um, more pressure, to push the piston downward, four stroke end, explode. Always his problem was power explosion too big. The problem, dangerous of explosion, very powerful explosion. So he needed to find something to stop it. Modern day's engine is different. After explosion it went downward, then come up again. Modern day, is it fit or not? My goal is to say I agree. Then, in order to be fit, I must talk about his theory, talk about his engine, talk about how successful when combine the two. This is the main thing, and this can cover everything.

Repeatedly, while William enumerated and outlined the planned elements with reference to the organization of discourse units, he translated them to content problems (but less often now) and/or further related them to other rhetorical concerns such as text coherence ("Whether it is fit or not depends on how I am going to write it"), and how to express his ideas ("talk about them separately").
Then the fourth paragraph will mention about automobile, automobile. Since, ah, modern day ah engine is different from Otto's engine, since they are different, the principle is the same. Ah, that is to say he, Otto's, his theory has guided modern day's um automobile engine. He gave a benefit to them. Conclusion, that is conclusion. Whether it is fit or not depends on how I am going to write it. Just now I said introduction, then I have to explain his theory, problem, his theory was to control what problem, and how to make his engine; that is, how his engine was. In that case, problem can be included in the part about engine. This, I will base on his theory. Then, I will say his engine match his theory; and then talk about modern day, then about his success. Talk about them separately, and my topic, my thesis statement will say his automobile engine, he's really successful. Otto, Otto's engine was directly based on his theory. Okay, his theory is mentioned already; also his engine, also how he based on his theory to build his engine. Approximately like this. Then talk about his success, its usefulness, how comes that his engine is considered as a success.

Next, William reviewed his intended goals and checked discrepancies between his planning and the goals in the rhetorical space. Then he proceeded to plan to write a particular discourse unit (the introduction). Immediately, he transposed it to a content problem. Then conceptually he alternated between ideational elements (knowledge of the topic to be presented in the introduction) and how best to convey his ideas in the dual problem spaces:

Okay, I've talked about his engine, but I haven't mentioned about his success. I've talked about his theory (?), say why he was successful. Okay, almost, I can start writing introduction. Introduction, first I have to talk about the thesis statement. My thesis statement has to mention his success, um, and I will briefly talk about his modern day automobile technology. Let me see. Introduction is a background. Then I should talk about background, mention that in mid nineteenth century, new idea, how to say it? That is, to say in the early eighteenth century, steam engine has been very popular, ah, is very popular engine. In those days, in those, in those, in eighteenth century, in the middle of the century, um, a new developed, to take the idea, take over the steam engine. How am I going to introduce my
idea?/ Introduce, in the middle of eighteenth century, a new idea, a new idea on,/ on engine. um, a new type to improve the output power of the (?). #can I mention three or four times? No, I can't#/ In the eighteenth century, steam engine is very popular. #Let's see#, steam engine,/ steam,/ steam engine, #how it be called# steam engine? #In 1966, I need to mentioned the# background. #Then I need to talk about# steam, #need to talk about this./ [Started writing] (William, post-tutoring argument task, 0:00-24:58, 1st side of 1st tape, pre-writing phase)

5.2.2. Knowledge-transforming in Drafting Phases: Case Study of Charles

In both pre-tutoring writing tasks, the majority of participants simply retrieved knowledge from memory and directly translated it into their drafting of their writing. Their production of text was primarily an unmonitored and straightforward process. The problems they addressed were mostly of minor consequences, involving discrete textual aspects of writing, rarely of conceptual significance. Even Charles, a predominant second language (English) user, an initial high strategy user and initially a high knowledge-transformer, tended to knowledge-tell more and correspondingly knowledge-transform less in his writing prior to tutoring than after tutoring. In the first protocol example, Charles was telling his knowledge about the topic in the drafting phase. When transposed to the rhetorical space, his working in the content space gave rise to genre awareness ("this is a technical report") and it reminded Charles to present his knowledge in a "simple" way. This was a one-way dialectic process:

... The advanced, advanced coal plant with integrated gasification combined-cycle technology is a very simplistic process to convert ah coal into electricity. And ah, there are five major, there are five major component. Should I say component or step? There are five major, ah, there are five major steps. Ah, there are five major steps found in this process. There are five major, five major steps,/ five major steps, ah, associated, associated with this process./ Ah, since ah, since this is a technical report, it should be simple, right?
So, I should say first step, second step, third step, fourth step, fifth step, ah okay. There are five major steps associated with this process... (Charles, pre-tutoring technical description, 30:38, 1st side of 1st tape, drafting phase)

The second example exemplifies a two-way dialectic process (from a rhetorical concern for text coherence to content production, and from content production to content limitation in reference to the setting of rhetorical goals). But still, Charles’ knowledge-transforming behaviors were less sophisticated than those in his post-tutoring writing (exemplified later):

Okay, so, this paragraph somehow connected to the first one, but haven’t to be, but is better to be. So, I should say, this process, process of ah converting, this process of converting ah coal into electricity is ah, is an efficient, an efficient ah, is an efficient method to, is an efficient method to, this process of converting coal into electricity is an efficient method of ah, is an efficient method of ah, of ah, I want to say that it’s an efficient method of ah, of outputting, is an efficient way of ah producing electricity and at the same time, an efficient, no, I should not mention about this electricity, since in this paragraph, I will be only mentioning carbon dioxide emission. Okay, so, this process of converting coal into electricity is an efficient method of ah, controlling, of controlling ah carbon dioxide emission./ (Charles, pre-tutoring technical description, 20:04, 2nd side of 1st tape, drafting phase)

Charles, in the following protocol examples, demonstrated sophisticated knowledge-transforming behaviors, shifting his attention between the dual problem space particularly to assess subtleties of the appropriateness of word choices and to convert this and other rhetorical concerns to subgoals to be achieved in the content space in his post-tutoring technical description task. In the first protocol example (below), Charles started by working on how to convey his ideas in the rhetorical space. Then he related his knowledge telling in the content space to concerns in the rhetorical space such as the appropriate length of intended elements to be accomplished ("that gets too detailed when I say that"), the appropriate length of
specific discourse unit ("the introduction"), reader awareness, and word choice ("I have to have the word "efficient" in it"). Later, in drafting the first paragraph, Charles referred the content problem to a concern for the best vocabulary choice ("alternating", "transfer to", "incorporating", "updating", or "redesigning"), assessing the consequence of selecting the word "incorporating". He further converted it into a concern for the appropriate text length in the rhetorical space. This led to his modification of the text he had already written (only a few sentences). He then transposed the content problem back to the problem of choosing the relevant word ("redesigning", "proposed"). This gave rise to further content problems ("plant already existed", "what about these statistics on the second page?"), which led to further changes in Charles' content knowledge ("still in development", "all these are estimates based on the efficiency improvement"): How should I begin this (writing)? Should I mention ah, how do I begin this? This is the advanced, this is a advanced ah flue gas desulphurization system. It is, ah, a very, this plant, this plant is similar to auto-power plant except it uses a sub, it uses um, it uses a greater amount of sorbent materials to, to reduce the CO₂? Oh, it's too detailed. The first paragraph will be ah brief, introduction sentence. So, if I say ah, the advanced bla bla bla is highly efficient, the process is very unique in itself. Ah, no, the introduction should be, of course, adjusted to the reader, and um, but what does it tell the reader? What should I tell the reader in the first paragraph? Of course, I need to mention that it's a, the power plant is a efficient and say it's a, and I have to mention about the ah process, the stages of the power plant. So, I have to have the word efficient in it, and the stages and something to do with the operation of the power plant. So, you are [reread the topic]. Okay, so, efficiency and the stage. Ah, let's see. The whole idea is that this power plant reduces CO₂ emission. [Started drafting] The need to reduce greenhouse gas emission, ah, has pushed our company into, into alternating, into ah, what's that word for transfer into? Has pushed our company into adopting, into, not adopting, but into ah, into incorporating, into incorporating a new system, into incorporating, in, ah, that's gets too detailed when I say that. Okay, the need to reduce greenhouse gas emission has pushed our company into ah, into re, redesigning
our power plant. The proposed, ah, hang on, I need to know if this is, this plant already existed or not [reread the topic]. So, it's still in development. Then what about these statistics on the second page? Approximate greenhouse-gas emissions for selected advanced fossil-fuel technology. I guess all these are estimates based on the efficiency improvement. Okay, it's an estimate. The power plant have not ah, then implemented. The proposed, the proposed plant/ (Charles, post-tutoring technical description, 20:34, 1st side of 1st tape, drafting phase)

In the next protocol example, Charles was working in the content space and came to the decision that he would use statistics to support his claims ("I'll use statistics to back them up"). Then he translated the problem encountered in the content space ("from greenhouse gas power plant emission") into the problems of how to convey his ideas ("how can I put this") and of text continuity ("how can I relate it back to the sentence?") in the rhetorical space. His mentioning of statistics in the content space called forth the problem of modifying the text ("I should take off this sentence and put it at the end later") in the rhetorical space. Then he continued working in the content space ("reducing annual emission to 0.81 Kg/kWh. This represents ...") and came to a further content problem ("0.81 Kg/kWh of CO2?"). While operating on the content ("this process has an efficiency of 0.81 when comparing to other systems"), Charles made problematic the intended local elements to be accomplished ("compare with one or all other techniques?") in the rhetorical space. Then he converted this concern further into another rhetorical problem of choosing relevant words or expressions ("How to word them? Put them in the sentence?"). After contemplating how to transcribe his intended meanings onto paper, he decided to choose an alternative way of resolving the content problem or telling his knowledge in a chart form of the rhetorical space:

So, this result is a great improvement for the current power plant./ This estimate, estimate, this ah, predicted, predicted result, this ah
predicted result is an, is a great improvement from the current power plant, ah, from the current power plant emission of, is ah, a great improvement comparing to the current power plant, ah, greenhouse gas emission, ah, power plant emission, okay, power plant emission. And now I will use the statistics to back up them./ Okay, emission, okay, ah,/ from greenhouse gas power plant emission,/ um,/ let's see, greenhouse gas, how can I put this, relate it back to the sentence? 0.81, ah, I know. Ah, maybe I should take off this sentence and put it at the end later. Reducing annual emission to 0.81 Kg/kWh. Ah, this represents, represents ah, the following, following,/ this means that, this represents um, this represents a drop, this represents the following, following reduction in ah greenhouse,/ 0.81 Kg/kWh of CO₂? Ah, okay, this process has an efficiency of approximately reducing annual CO₂ emission to 0.81 Kg/kWh comparing, comparing to ah other systems, comparing to 0.96,/ ah, okay, hang on, there are so many techniques, so, do I simply pick one to compare?/ Or do I compare with all? If I compare with all, how do I word them? Put them in the sentence? Okay. This process has a, an efficiency of approximately reducing annual CO₂ emission to .81 Kg/kWh, comparing to ah, other technologies, comparing to other technology, comparing to other technology that produces ah, that admits,/ that admits ah over, that admits more than,/ um, how can I put all these in, into the, how can I compare all these? That's two, three, four, six technology to compare to. It's better if I put in a chart form, okay. This process has an efficiency of approximately reducing annual emission to point, well, how about draw the chart here and just ask it to refer to the chart?/ (Charles, post-tutoring technical description, 17:30, 1st side of 2nd tape, drafting phase)

Finally, Charles converted the content problem of drafting the conclusion to the rhetorical problem of how to conclude the writing. He further translated it into other rhetorical problems such as referring to goals to be accomplished as checklists and attending to appropriate lexical choices ("efficient", "advanced flue gas desulphurization system", and "the reduction of greenhouse-gas emission"). Later when he pondered over other essential lexical choices, he related this rhetorical concern back to the written elements (of the introductory paragraph) in the content space before deliberating over lexical choices "redesigning" and "updating" in the
rhetorical space. Then he justified his lexical choice "redesigning" by referring to the rhetorical problem of modifying extensively the written text:

Okay, ah, the concluding sentence is ah, is what? Ah, something to do with ah, doesn’t have to do with the course I guess, but it has to do with the efficiency. Okay, ah, in summary, this system has the highest efficiency for reducing greenhouse gas emission. Um, how can I conclude this? Um, um, any range of device, okay, let me see the thinking, the, the requirement, okay, to explain how it work and why it is efficient, why it is an efficient way for controlling CO₂ emission, okay./ Ah, how about ah flue-gas desulphurization system is ah, is a very inexpensive ah system? Okay, how about ah, what can I say? Prediction? No, not prediction. Um, pulverized advanced coal, um,/ I don’t really know what, how, what, how I should conclude the, the, ah, the writing. Conclude, the word that I need to have is efficient and the name advanced flue-gas desulphurization system. Um, and what else? And the reduction of greenhouse-gas emission. Okay, let’s see the introduction. [Reread the introduction] Okay, how about updating? Not redesigning, updating the,/ into, updating the current electric power plant. The proposed, into, no, no, if I change it to updating, I will have to change too much of, of the rest of the writing. So, push our company has a, push our company into um, okay, redesigning, redesigning ah, the, has, redesigning the, has pushed our company into redesigning ah the entire power, electric power plant, power plant, okay. (Charles, post-tutoring technical description, 33:04, 1st side of 2nd tape, drafting phase)

5.2.3. Knowledge-transforming in Post-writing Phases: Case Study of Leo

What substantially differentiated participants’ writing processes between the pre-post writing was the presence of a post-drafting revision phase, and particularly knowledge-transforming within it. Overall, participants conceptually integrated concerns in both problem spaces, or interconnectedly converted problems encountered in one space to the other, and further translated these specific problems or concerns into new goals to be accomplished, viewing their writing retrospectively. Very often, participants’ knowledge-transforming behaviors in this post-
writing phase were manifest in their problem detection and evaluation of their written texts. These knowledge-transforming behaviors stemmed from "working backward with goals" (Bereiter & Scardamalia, 1987a, p. 183), thereby creating a more confined two-way process of problem finding and problem solving transfer between the content space and the rhetorical space. They mainly worked backward with goals or intended elements to be entailed in the rhetorical space as a checklist, and shifted between this matter and a concern for coherence of their texts (content) to be achieved in the content space. While alternating between these goals in the dual problem spaces and coherence concerns in the rhetorical space, they often converted or further related these concerns to the problem of appropriate word choices (or grammatical rules) to be resolved in the rhetorical space, and later conceived a new word or expression as the best choice in light of the written elements in the content space.

For instance, Leo, who did not have any post-drafting revision phases in his two pre-tutoring writing tasks, after drafting the text of his post-tutoring argument task (and technical description), effectively adopted some evaluation and revision procedures from the tutoring into the post-writing phase of his writing process. Repeatedly, Leo shifted his attention between goals in the dual problem spaces and coherence in the rhetorical space, and proceeded with problem detection, problem evaluation, and problem solving, while alternately rereading and reviewing his text. As problems arose, he converted the concerns for goals in either space and coherence in the rhetorical space into problems of lexis or syntax to be resolved in the rhetorical space:

/final product. That's all [finished drafting the whole text]. #I think it's# okay. #Now use those# goal and fit #to# check #whether the text is okay or not. The whole piece of writing, the# goal #is/ whether agree or not it's a# success. #Ah, whether the# theory #has# success (i.e., successfully) guide him. Ah, the first paragraph, thesis statement #said, it has mentioned# verify the
truth, the success of a guided concept is the key factor to, to the eventual accomplishments... Then I used a considerable phrase to realize to be the maturity ideas of internal combustion, stratified charge and a 4-stroke design. From this one, it elicited the following paragraphs. The first paragraph on the thought of internal combustion is the first step to the completion of the Otto's engine model. I talked about all these in the first paragraph. The next, should be this paragraph. The concept of internal combustion is the notion of burning fuel. This one is to explain, and this says the theory of internal combustion process contribute a considerable effort to the engine product. Aha, it can be said that this fit the first paragraph. The second paragraph said the determination of stratified charge is definitely the pivotal moment to the realization of the engine model. This helps the development. The last sentence said as a result, the above beneficial concept is prove to, is proved to the sign of success of the engine. is proved to be the sign, sorry, to be the sign, not to the sign, to be the sign of success, success of the engine. Right. Okay, should fit. (Leo, post-tutoring argument task, 38:24-40:04, 2nd side of 2nd tape, post-drafting phase)

When he backtracked (in the content space) to the fourth paragraph of his text, he converted the rhetorical concern for coherence to the problem of missing elements ("wide application") to be added, as subgoals to be achieved in the content space, related it to particular discourse units ("the conclusion") in the rhetorical space. Then, as he realized that the missing element was not included in the concluding paragraph, he resolved this content problem by making lexical changes ("don't say various fields ... Otto's industry should be okay") to one sentence in the rhetorical space. Finally, he further translated this resolution in the rhetorical space to the subgoal of adding more information in the content space ("add a little more information at the end"):

Okay, now the third paragraph, the fourth paragraph. The design of 4-stroke cycle symbolizes its wide applications not just for the Otto's engine but guides a way to the future developments in the various fields. Also fit. But it seems the last part didn't
mention, yeah, should mention how, how it, what other special things about it. Um, something is missing here. Well, I haven't talked about how wide application in other field! #Um, um, actually I should add, but conclusion has mentioned it, maybe it's okay. But, really, something is missing, missing a sentence, that is wide application, unless I change this sentence. Not just for the Otto's engine but guides a way to the future development in Otto's industry. Otto's industry should be okay. Okay, Otto's industry, don't say various fields. Otto, Otto industry, then I need to add a little bit more information at the end. I think I need to add a sentence before therefore. Dramatic amount of efficiency for the en, for the engine, ah/this, ah/tendency/this leads to a tendency for the field/ to improve even more the ah/this leads to a tendency for the field to improve even more um, even more the ah/ah, performance of its old engine. In this way, I've mentioned a little bit, and should be okay here, okay. (Leo, post-tutoring argument task, 41:02, 2nd side of 2nd tape, post-drafting revision phase)
Chapter 6

Case Study Profiles

This chapter presents case study profiles of each of the students. The purpose is to document individual students' progressions over time, focusing mainly on what went on in the tutoring sessions, and to describe some possible effects of procedural facilitation (by citing data from students' post-tutoring think-aloud protocols while composing). The chapter first outlines some general findings from these case studies, then offers narrative accounts of students' progressions as nine individual profiles -- arranged from initial low strategy users to initial high strategy users. The chapter closes with a summary of some common trends and individual differences.

On the whole, these case study profiles show evidence of the students' greater spontaneity in text evaluation, increased self-regulation, and stronger evaluative, diagnostic and remedial capacities as the tutoring sessions proceeded. In the beginning tutoring sessions, the majority of students seldom took initiatives in text evaluation. They constantly needed prompting from the tutor (me), and their responses were brief and restrained. They lacked capacities in detecting, evaluating, and resolving problems. By the final tutoring sessions, all of them appeared to have assimilated the use of the five thinking prompts through procedural facilitation into their composing routines and appeared to become more independent and articulate in their self-regulation and text evaluation.
6.1. Profiles of Initial Low Strategy Users

6.1.1. Profile of Edward

Edward, who preferred to use his L1 mainly while composing, was an initial low strategy user. His ESL teacher regarded him as the most novice writer in her class because he could not distinguish between the verb "to be" and the verb "to have". He demonstrated substantial improvement in self-regulation and text evaluation after the beginning three and over the remaining seven tutoring sessions. He stood out as a big achiever, achieving greater confidence in self-regulation. Also, he reflected and commented on his texts more independently over time as well as in greater detail. In the beginning tutoring sessions, Edward demonstrated little self-regulation of his composing, particularly in reference to global concerns of his writing. While checking and editing local errors by himself or under tutor-prompting, very often he could not discern whether a correction was syntactically correct. In evaluating the quality of his written work, Edward needed to be constantly prompted, and his responses were limited. But as the sessions progressed, he came to use the goals and fit prompts to refine his content, to reformulate goals, to check text coherence, and to restructure his writing. Edward also tried to adjust his goals according to his increased awareness of his readers' needs. That is, he began to attend to more than one dimension of his writing simultaneously, in particular, to tackle and evaluate higher level problems, which he seldom did or often found difficult in the beginning sessions. For example, in the last few tutoring sessions, he took greater initiative in using a goal-directed approach to judge for himself whether he had achieved his goals or whether the goals fit the topic and the writing. Furthermore, he demonstrated more self-awareness and confidence in his
own sense of linguistic accuracy and analyzed language use more extensively than before.

In the beginning tutoring sessions, Edward knew already that English grammar was the main trouble spot in his ESL writing. While rereading his short written text for self-initiated revisions, he constantly paused and asked:

#Nothing wrong, is it nothing wrong?# (1st session: greenhouse effect)

But he seemed uncertain of the nature of the problems and the reasons for them:

The greenhouse gas is caused by, #why# "is"? #Why# "ed"? It has, it have, #do we say# "it have"? I have, #what else use# "have"? The increase, increase, #correct? Why correct? How to distinguish between# noun and verb? (1st session: greenhouse effect)

He detected very few errors by himself:

#What problems are there? It seems there are a lot of problems, right? But I don’t know what the problems are#. (3rd session: letter to an engineer)

From the 4th session onward, changes in Edward’s behaviors became obvious. As he turned the pages of his writing, which now showed many more crossed-out parts and consisted of an outline, his tone was getting more determined, not only in editing his grammatical problems, but also in analyzing the content and the rhetoric of his writing:

It can applied to, it can be applied to; after deviation, after learning deviation (4th session: calculus)

#Nothing wrong with# grammar, #but something wrong with knowledge#. Pulling force, #what did I want to say? I was talking about# action, reaction force, #about# how it changes physically with different forces. #I should have continued by talking about# how it changes, #not just about# object change. #Actually it is# how object to be reflected physically, #not# changed, #should be# reflected, word problem #here#. (6th session: statics)
While using the prompts to evaluate his text, Edward began to comment in a more detailed and spontaneous way than he had in the beginning sessions. He showed familiarity with procedures like using word choice to describe or substitute detailed information:

Word choice? #Quite good because there are fewer mistakes and less redundancy. #Use some word choices #to# describe #these#? Encouragement, [with tutor's prompting] contributions, #is there such a word in# English? #What are these#? Performance, [with tutor’s prompting] consequences. (3rd session: letter to an engineer)

He also evaluated his goals and text coherence against his perception of his readers' needs:

Goals, #since you don’t understand this writing, that means it is not good, not detailed enough. I should talk about the topics of calculus. #But I am afraid it may become too difficult that readers won’t be able to understand. I’ve given examples #of# deviation #and# integration. #At least readers #will know what# deviation #and# integration #are and their uses. I think if I give it to grade 12 students, #my# readers, #to read, they will understand#. Enough supports to fit this topic sentence? Yeah, fit, #because# readers #should know that’s the slope. The next paragraph, fit #or not? It’s difficult to say. It seems something’s missing. #I’ve talked about# integration, #but should talk about (?)# integrate. #It seems there’s a lot of things to be added if I have to make readers understand clearly. So, anything to add to the goals? #Um, depends on who’s the reader. Engineering professors? #Oh well, then I’ll write very long, a whole book, because they know more than I do#. (4th session: Calculus)

In the two final tutoring sessions, not only did Edward evaluate his writing more independently and confidently than he had in the beginning tutoring sessions, he also showed increased complexity of thinking and increased spontaneity in his responses:

Iron 157 is a new designed material, #should use# adverb, newly, and it’s my design, #so it should be# my newly designed material. That is made by mixing iron and aluminium that is unique from original industry metal. What’s industry metal? Noun, noun, #should be# industrial metal, #add# it is a 1, rules problem. #But# original #is an# adjective, #should it be# originally? #You said#
adverb, adjective, noun. #Is# "industrial" #in# verb #form like# "designed"? #No, ah, so it should be# original industrial metal, adjective, adjective, noun, #and it’s okay, right? Do I need to add# s #to# metal? #No, okay#. The original metal? #The idea is not# clear, #change it to# traditional #or# ordinary. #Do I need# “the”? #No. Why? Because# ordinary #is an# adjective, #ah, means# something common, #not# specific, #I refer to# the most commonly used metal, one kind. #These are# rules, word, and goals problems. (9th session: material)

Fit, overall coherence? #Quite good#. Introduction fit #or not#? Fit, #but maybe too short, only one sentence# -- the thesis statement. #Maybe add something, first talk about the# lack of metal in the world #and ... Oh no, it’s too long for the# introduction. #I’ll start by saying# our company will produce ... #As# a thesis statement, #this sentence is quite good. It said# iron 157 is unique, useful, and applied in automobile industry. Fit, #it# fits #what’s in the# body parts. Fit between topic sentence and the next paragraph? Iron 157 is a very hard metal with light weight. Fit, #fifty fifty. It’s about# very hard metal with very light weight. #But I haven’t talked about, I should talk about its# structure and #how it has# a light weight, #before mentioning ... The other two# topic sentences -- Iron 157 is cheap to manufacture; and Iron 157 is an excellent material for making car engine and chassis -- #are not bad. But I may also use the word# advantage #in these topic sentences, like#: Another advantage of iron 157 is ... #How about the# conclusion? Fit, #it’s quite good because it# summarizes #everything in the writing#. (9th session: material)

Edward effectively incorporated specific tutoring procedures -- such as text evaluation and self-initiated revisions -- into the post-drafting revision phase of his post-tutoring writing by attending to the global aspects of goals and coherence at points where problems arose, and making local changes in words and syntax:

/The improved method/ will brings more revenue than before. #This one#, um, will brings more revenue than before, um, #no, it’s better not to mention this#... #I didn’t mention how things were in the past#. #It seems that there’s no connection here... Better say# the improved method is a rich investment#... #This is better. In this way, there’s no need to talk about the past#. #At the same time, it can be related to the front, and is quite# fit... The
greenhouse, #I shouldn’t talk about that paragraph, should delete it... #There’s no need to talk about so many things. I just need to talk about the# proposal, and things concerning this piece of writing. Right! Let me read the text once more, see if it is coherent or not#.

... SO₂ can reduce for sulphur recovery. #Oh no#, can be processed, #right, can be processed# for sulphur recovery... The sorbent system is important to the environment because it absorb large amount of CO₂ and prohibit, #no, not# prohibit, and prevent, #better (?)#, and prevent it/ to go up to the atmosphere. #No, not# goes, #should be go... (Edward, post-tutoring technical description, 0.00-7:53, 2nd side of 2nd tape, post-drafting revision phase)

In addition to these post-drafting revision and knowledge-transforming behaviors, Edward developed another executive strategy -- advance planning -- over the period of the tutoring. His starting to rehearse his thoughts and enumerate key intended elements in advance of composing, evident in the fourth session, was a great leap forward in his progress from simply knowledge-telling to demonstrating advance planning of his texts.

In these manners, Edward achieved noticeable improvement in his strategy use between the pre-tutoring and post-tutoring writing sessions. He demonstrated the greatest increase, among all participants, in: (1) the total use of all five heuristic search strategies in both tasks (from 29% to 75% of his total verbalizations in the technical description tasks; and from 9% to 65% of his total verbalizations in the argument tasks); (2) the use of strategies related to the word prompt (from 8% to 29% of his total verbalizations of strategies related to the prompts) in the technical description tasks, (and he showed careful and concerted deliberation over word choices, see section 4.6.3.); and (3) the total use of five configurations of the five heuristic search strategies in both post-tutoring tasks (from 25 % to 58% of his total verbalizations in the technical description; and from 7% to 53% of his total verbalizations in the argument task).
6.1.2. Profile of Lorraine

Lorraine, a predominant L2 user and an above average writer in this group, was an initial low strategy user. She demonstrated improvement in her remedial capacity to overcome her main writing problem -- inadequate elaboration of content. The tutoring helped to bring forth her skills in refining and expanding her substantial knowledge in writing. She learned to elaborate her content and appeared more competent in analyzing and discerning the adequacy and accuracy of her text in the last few tutoring sessions. Lorraine also demonstrated changes in her reflective processes while evaluating her written texts. She showed progress in developing not only her evaluative and remedial capacities but also diagnostic capacity (in detecting other writing problems in her texts).

Lorraine did not need to learn how to diagnose her problem of inadequate idea development. She had long perceived it. Her writing was very short, lacking development of ideas. Though she always planned in advance (with an outline), it rarely aided her in elaborating her ideas. Her priority was on remedial work.

In the beginning tutoring session, she immediately recognized the goals aspect as what she needed to tackle:

A company has produced material that caused ... that we have to find a way to produce different useful material. This is not a strong paragraph, but I don't know how to change it. I didn't give any examples because I don't know how to express it. It's basically the goals. I had two paragraphs. The first one is okay because it's long enough, I think. I like this. I used to give really short introduction. This one is long. The second paragraph is too short, I know. I should give examples. That's my problem. I have difficulty in elaborating things. The second paragraph is weak because it's not supported by examples ... Also, this conclusion is not in good ratio. There's just one sentence. (1st session: ozone depletion) (all spoken in L2)
From the third writing task onward, Lorraine's texts got longer, but she was still very conscious of this weakness in her writing in almost every tutoring session:

I don't know how to analyze it, but probably the writing is too short, the introduction and the conclusion are too short. I should write longer. I should add more examples to support, yeah, also to elaborate and give more examples on applications, before the concluding paragraph. The introduction in the present text fits the conclusion, but they are too similar. I have difficulty in summarizing and paraphrasing the writing. (4th session: statics) (all spoken in L2)

Other than the lack of idea development, Lorraine detected other writing problems (about grammar rules, word, and text coherence) in her texts during text evaluation:

I am not so sure of preposition. That's the weakest thing I have in English grammar. Usually I have to memorize them. (2nd session: material) (all spoken in L2)

What are the definitions of the word statics? Ah, I have problems with word and expression here. The expression here in the thesis statement is a kind of strange. I mean the second and the third sentences. What are the definitions of the word, yeah, that's too wordy. The word has one definition of, or statics is, but then it doesn't mean it's one of the definitions. One of the definitions of the word, one of the definitions is, one definition is, yeah, it's just stupid. This is a word problem. You know what? It's hard to find errors, but it's much harder to find a better way of expression. (4th session: statics) (all spoken in L2)

She also showed a growing awareness of her readers and how to accommodate her readers' needs:

The goal is to introduce what's calculus, integration and differentiation, to my readers who are high school students. I think I should add some math problems with applications. But if I explain the math problems, I bore them, better just give them dry ideas. Maybe this one, right, to find a slope of a tangent line or a curve, right. (5th session: calculus) (all spoken in L2)

I don't know, maybe this is not pointing to the same direction, like
one paragraph going everywhere. I just feel that way, especially the third paragraph. Yeah, I talked about the kind of love that is shallow in the previous paragraph and wanted to describe what true love is in this paragraph. But then I don't know how to explain it. Readers like you understand the true love I was talking about, but other people may not and they have never experienced it. So, it really depends on the people who read it. (6th session: happiness) (all spoken in L2)

Lorraine productively incorporated the text evaluation procedures from the tutoring into her writing processes in both post-tutoring writing tasks. As exemplified in the following protocol excerpt, she attended foremost to local aspects of lexical choices and linguistic accuracy, conceptually integrating the two with reader awareness, while simultaneously checking lexical redundancy. Then she attended to global issues of goals and coherence, making both conceptual and ideational changes by deleting and adding parts of the composition. Finally, she made further necessary lexical and syntactic changes:

Okay, now, I am attacking the grammar errors [made changes to grammatical errors and word choice -- making explicit references to the prompts] a recycled gas, the recycled gas. Do they make sense [to the readers]?... contains recycled steam, and give, and it ah, enter, it, what, what is another word for enter? I suppose not to repeat that word over and over again. Okay, enter./... is process [finished "attacking" grammatical errors and word choice]/ Okay, now, tech, technical, fit, um, efficient technology to control the amount of CO₂ to be emitted. Okay, that's thesis statement, and I explain that./ um, and I explain how it works. So,/ I want to emphasize how, how, why is it an efficient and ah, okay, efficient combined-cycle technology is (?) goal. Okay. [made further changes on grammatical problems and word choice] so, you, well, basically, no, because to, to minimize their emission doesn't show in the process though ... So, I think I should delete that. Okay./... I have to add out this. That will be widely used all over the world in the next few years, and in the next few years/ [added one phrase] because of its effective, because of its effectiveness,/ Okay, that's it. Ah, okay, I am finished. (Lorraine, post-tutoring technical description, 8:58-45:24, 45:25-4:25, 1st side to 2nd side of 2nd tape, post-drafting revision phase) (all spoken in L2)
Lorraine developed certain executive strategies over the period of the tutoring. Besides post-drafting revision (mentioned above), she also developed her advance planning and knowledge-transforming behaviors. She demonstrated the greatest increase, among all participants, in knowledge-transforming (from 6% to 25% of her total verbalizations of knowledge processing) in the pre-post argument tasks.

6.1.3. Profile of Simon

Simon, an L2 preference user and an above average writer in this group, was an initial low strategy user. He achieved considerable improvement in developing his evaluative, diagnostic, and remedial capacities, though throughout the tutoring sessions he constantly showed resistance to diagnosing his goal problems and unwillingness to reformulate his goals in his texts. In the last few tutoring sessions, he was still reserved in criticizing his texts, specifically the content.

Simon was a knowledge-teller, seldom pondering over any aspect of his writing while he composed. But the tutoring provided a routinized support for him to reflect upon his texts, so that he was able to work on not only one but multiple aspects of writing simultaneously. For example, during self-initiated revisions, as some goal problems arose, Simon suggested changes to be made (deleting a sentence and adding information) to adjust to his readers' needs and in light of his word choice:

One of the global pollutants is the depletion of ozone layer which is a layer of relatively high concentration of O3 located in the stratosphere. A goal problem here... I think the people will understand this. So, actually I do not have to write this sentence down. It can be excluded. The amount of ozone decreases sharply in recent years. The recent observation, repeating word, it's a word
problem. Therefore, it is relatively difficult to spread it. A major measure of fundamental importance is to reduce, minimize, and change the way of human’s industrial process. Fit or goals? I think I have to add something before this sentence because I said therefore it's relatively difficult to spread it, and after that, I think um, there's no, the relation between these two sentences are not clear. So, to add something. I don’t know. It’s a goal problem.

However, when it came to text evaluation, Simon had his own interpretation of the topic(s). He seemed very defensive about what he had written, and was reluctant to revise his text or ideas to any extent:

The goal is to tell people my understanding of happiness. I am not going to tell the specific stories of, I mean the happy stories because they are stories, not abstract definitions. I'll not tell people the stories, and then say look, this is happiness. I think happiness is abstract, not specific. Yeah, #the three# stories #I gave are not# abstract #either, but I think, okay, it is as if I used another person (in the story) to tell the conditions of this country. Actually I want to tell how’s those people’s characters and those countries’ conditions through different people’s narratives. #Usually people like to say# happiness means wealth, health, love, or whatever. #But I think those are# concrete, #not# abstract. #Are my three examples also about something# concrete, #rather than# abstract? #Well, but I have to talk about something abstract through something concrete. I think you can say# wealth is happiness, #but you can’t say# happiness is wealth. (5th session: happiness)

Have I written enough to fit the topic? Well, I think I don’t need to talk about the issue of greenhouse effect because I was talking about how it would affect our company’s operations and what measures can be taken, and I couldn’t find any discussion about greenhouse effect. Any information from the two pages of reading provided? Well, I hardly can find any... Are there enough supports to fit the goals? For the issue, well, my only knowledge of greenhouse effect is about global temperature, and I hardly can find anything else to support this. Besides, since my status is an engineer working for the company, I assume my senior colleagues have the same knowledge as me. So, I don’t have to talk about professional knowledge about CFCs. (10th session: greenhouse
effect) (all spoken in L2)

Nevertheless, under the routinized tutoring procedures, Simon learned to adjust his writing to his readers’ needs, assessing whether he had accomplished his goals, detecting problems in his texts, and resolving what to do if he had to revise his texts:

"I think this writing is too short. In writing the outline, I decided that the part I need to write more is: not moving, because it’s a body at rest, showing forces in equilibrium. So, maybe I should give readers an impression that statics concerns "not moving". But I haven’t accomplished what’s listed in the outline. There’s not enough elaboration on "not moving". I should say a few more sentences about it. I should also mention dynamics, just a few sentences, because this can give readers a comparison whereas dynamics is "moving", statics is "not moving". If I am going to revise this writing, I will add some more examples to illustrate applications. I know there’s not enough supports, e.g., on architecture such as building roofs and bridges. (4th session: statics)

As the tutoring sessions advanced, Simon noticed the problem of coherence between parts of his writing, especially the fit between his thesis statement and texts. He tried to resolve the problem, despite his reluctance in admitting the problem of coherence in his goals:

Thesis statement fit or not? There’s something unnecessary because I write longer, because I am talking about the expressions, that is, how humans react, yeah, there’s something unnecessary, not too fit, yeah, because there’s no support on these. If I follow my thesis statement, what am I supposed to focus on? Is it on chemical results of the working of the brain? Well, I mentioned this because I wanted to say it’s something subconscious. For example, you do a lot of things and you are expressing your feelings. It’s a chemical result. But I am not talking about all these chemical things in the body parts. Well, yeah, if I follow my thesis statement, I should be talking about these chemical things, yeah, the thesis statement does not fit. Okay, so if I have to revise the thesis statement, I will talk about different understanding, yeah, I mean different definitions of happiness, and everybody has something similar. (5th session: happiness)
In text evaluation, he suggested restructuring the text, adding sentences, or revising it in light of word choice:

This paragraph fit or not? Yeah, a bit longer #because I talked about# realization of their desires and the rewards. #Maybe I should divide it into# three paragraphs. #But I used the narratives of three people# -- the British, the Russian, and the French -- to define happiness. #Since I am talking about these different definitions of happiness, isn’t it# contradictory #to say that these three people have# similarities #in my# thesis statement? #Okay, yeah, it’s better to# state the three definitions of happiness in three topic sentences, #then use these three# stories to illustrate my points. The conclusion? #I want to add one more sentence, saying that# because everyone is different, so it’s impossible to define happiness. #How’s my# first sentence #in the writing#, fit #or not? Let me see#. Happiness is a big topic. Well, it doesn’t fit. (5th session: happiness)

The thesis statement fit or not? No, #I should# introduce, #I should use# the words unique, useful, and application. How about this topic sentence? Normally what ... of interest into the engine ... not scientific. #This one is not the# topic sentence. #I want to mention in the# topic sentence the efficiency of the new machine, #that means I have to add one more# sentence #to be the# topic sentence. The new product can improve the efficiency of production, the efficiency of our production. (9th session: machine)

Simon achieved noticeable improvement in his strategy use. He demonstrated the greatest increase, among all students, in the strategic use of: (1) goals (from 22% to 44% of his total verbalizations of strategies related to the prompts) in the technical description tasks as well as goals (from 7% to 32% of his total verbalizations of strategies related to the prompts), (3) fit (from 0% to 19% of his total verbalizations of strategies related to the prompts), and (4) double configurations (from 0% to 17% of his total verbalizations of strategies related to the configurations) in the argument tasks (see section 4.4.3. Case Study of Goals: Simon). He mentioned the prompts both explicitly and implicitly, and made progress from no initial planning
to having advance planning in both tasks, and from no post-drafting revision to having a distinct
post-drafting phase in the technical description task. Although Simon achieved significant
increase in his strategy use, he did not incorporate text evaluation procedures from the tutoring
into his post-drafting revision phases. His internalization of the five thinking prompts was mainly
manifested in his drafting phases.

6.1.4. Profile of Peter

Peter, an L2 preference user (but later he code-switched between the two linguistic
codes more often) and an above average writer in this group, was an initial low strategy user.
He participated in only four out of ten tutoring sessions. He made considerable progress in
evaluating his texts as well as in identifying and resolving problems in his texts. He also became
more aware of the use of the five prompts and more familiar with the tutoring procedures. The
tutoring provided a routinized support to enable him to pay attention to complex aspects of
writing. His reflective processes became more complex. Thus he achieved the most increase,
among all students, in the use of double configurations (from 8% to 37% of his total
verbalizations of strategies related to the configurations) in the technical description tasks (see
section 4.9.1.). He also developed the executive strategy of advance planning over the four
tutoring sessions.

In the first tutoring session, Peter's text evaluation was rather brief, but he

managed to offer some explanations and solutions:

Second paragraph, fit or not? Fit, #but I haven’t talked about#
how it’s made and how to make it more efficient. The next
paragraph, fit or not? #Not too# fit #because I haven’t mentioned
what it is. I should have mentioned it at the front, I mean in the#
topic sentence. #Here, the first# sentence #doesn’t tell what the following is about. That means it’s not a good# topic sentence, #not# fit. #I have to talk about# substituting the original vehicle. #Instead of referring back, I will say#, should be bla, bla, bla, #then talk about the# popular combustion engine produces less pollutants. #Yeah, now it is more clear and tells what this# paragraph #is about#.  (1st session: greenhouse effect)

In the second tutoring session, Peter became more accustomed to the text evaluation procedures. He assessed the coherence between parts of his writing from the first paragraph onward, and explained whether they fit or did not fit. In so doing, another problem came to light -- that his topic sentence was not concise enough; it looked like elaboration of ideas instead:

#Use# fit #to check the writing. I think the# thesis statement is quite# fit #because I have mentioned# the customer’s reaction. #Then I# explained, okay, #this# paragraph is only a description on how a calculator works and how it displays answers. #Then I talked about# how to use it, how easy to use it. The second paragraph, fit or not? #Can be considered# fit #because it gives# a general idea on what a calculator is, #that is, about# its uniqueness, #a little bit. But it doesn’t# show its usefulness and reliability. The next paragraph? #I talked about# how to use it #in this# paragraph #and# how easy to use. #I think this# paragraph fits. #How about this# paragraph [starting "Finally"]? #It’s about# its uniqueness -- small and handy, #but the# topic sentence #is not too good because it looks more like an# elaboration of ideas. #But I don’t know where to put this# sentence #because no other# paragraphs #mention about its# size. The conclusion? #Not# fit, #I think, because it doesn’t# summarize #the writing to# support why I am so confident about this new machine. (2nd session: machine)

In the third session, Peter code-switched between his L1 and L2 to resolve some word problems. He noticed that the introduction should not be written in great detail. This time he no longer needed the tutor’s prompting to detect this problem:

I have looked your report of your project. #This first sentence
seems a bit strange. I noticed this while I was writing. How to say in Chinese? It's: I've seen [meaning read] your report. How about in the written form [Mandarin]? Okay, you mean, I have read? Oh yeah, I have read. What other problems in this sentence? Which word has been repeated? Ah, it's "your". Which one should I use an article instead? Okay, this one, I have read the report of your project. Is this introduction too detailed? Did I mention all the things in this paragraph? Yeah, but sometimes I don't know whether the reader will know everything if I mention all I want to say in the first paragraph. (3rd session: letter to an engineer)

Compared with the previous sessions, Peter's responses in the fourth session (his last session) were the most detailed. He carefully checked the fit between his thesis statement, the introduction and the draft text:

Many people often refer statics to as a force of attraction between their clothes and body. Besides, statics has another meaning of which many people forget or have not heard of. Its other meaning defines statics as a field of study of physics. That explains its matters in stable state. Statics has played an important role in building, protecting environment for human to living. I think this whole paragraph doesn't fit, isn't related, because I shifted my focus suddenly, for example, the last sentence. Actually this [last sentence] is my thesis statement, telling what statics is, that it is very important. Did I talk about its important roles in the body parts? Yeah, a sort of. I defined it first, then talked about what importance roles it has in the following. (4th session: statics)

He also checked whether there was enough support to fit the paragraph(s) and what remedial work could be done:

Do I need to add some more examples? Because I mentioned only the building, not bridges or vehicles. I am afraid it might be too long. Actually I should add one more sentence, saying that vehicles and bridges have the same purpose or contact. Yeah, I think adding more supports would be better. At first, I wanted to talk about vehicles, but I didn't know how to write. (4th session: statics)
He showed reader awareness. He revealed how different the text could be, what elements to be entailed, and how to accommodate different readers’ needs, thus explaining why reader was of his priority concern:

#The# goal #is# to tell how important statics is in construction. #Did I# define #it? Yeah, I did, but I don’t know whether people understand it. This is also my# goal -- to talk about its applications. #My# readers #are in the lower forms, because this writing really doesn’t have any# scientific content; it talks about things in general only. #The main thing I want to know is#: who is the reader? Engineering professors or professors teaching science subjects? #If it is# teachers teaching English, #for sure we just compose, because they won’t know whether it’s right or wrong. If it is# an engineering professor, #I will add more# content. (4th session: statics)

In assessing whether it was appropriate to add new goals or better just to focus on the main goal, he translated this concern to problems in word and expression choice, then related it back to the goals problem of what elements to be included. This may indicate that he had learned to integrate various concerns (goals and word here) after practising the evaluation procedures in the three previous sessions:

#But I think I shouldn’t say# how to extend (the definition) to dynamics. #Instead, I will talk more about# the definition of statics. #But now I’ve forgotten some; I won’t be able to write too long. I’ll say# statics is a branch of physics. It’s also a branch of mechanics. #At first I wanted to say this in one# topic sentence, #but I couldn’t find a way to express it. I also wanted to talk about# its analyses, #a lot of things, but then there might be too much. For# analyses, #I will only talk about# force distribution. #When I talk about# moving objects, #I need to mention# dynamics. (4th session: statics)

Likewise, his comments on coherence came more spontaneous. He could detect, evaluate, and resolve problems independently:

Fit, overall coherence? #It’s# okay, #but the only# paragraph #I
want to talk about is this one on dynamics. This one seems a bit off topic. There's not enough on the part talking about the importance of statics. I should elaborate more on the definition of statics and its limitations, applications. Oh well, I haven't talked about application, which means not enough supports on application. I should have developed two more paragraphs. (4th session: statics)

6.2. Profiles of Initial High Strategy Users

6.2.1. Profile of William

William, an L1 preference user, was initially a high strategy user. He demonstrated improvement in evaluating his texts, particularly by diagnosing his writing problems and resolving them. The most common problems he diagnosed in his writing were: (1) repeating details in the conclusion (in half of all his texts), (2) including unnecessary details in the introduction, (3) repeating information in his texts, (4) adding new elements in the conclusion, and (5) being too wordy (particularly in topic sentences and conclusions). In the beginning tutoring sessions, I had to prompt William to observe his problem of repeating details in the concluding paragraph. However, in the later tutoring sessions, he evaluated his text in greater detail and more independently. William realized that his problems with goals and coherence were interrelated. He used the goals and fit prompts to reformulate goals, to check repetition of elements, and to restructure his writing. William also tried to resolve his wordiness and repetition problems.

Though William tried to tackle high level problems of goals and coherence during self-initiated revisions in the beginning sessions, when it came to text evaluation, his responses
were limited:

#This writing? I think the# goal #is# to tell an engineer to work hard, and this is a warning. #Yeah, it's very short#. (3rd session: letter to an engineer)

In the initial tutoring sessions, William constantly needed the tutor's prompting (indicated by the questions below) to comprehend his writing problems:

#How to make the# conclusion less wordy? #To be# concise and clear? #Have I already# mentioned #all these in the text? Yeah. Not to# mention #these# details #again#? Yeah. (1st session: ozone depletion)

How about the conclusion? #Though it's a bit short, it# summarizes and paraphrases #all the above# points. #Did I add something new here in the# conclusion? #A little bit, actually they are not# new #and have been mentioned before, but I added some# calculation errors. (4th session: statics)

As the tutoring sessions proceeded, William was able to detect his coherence problems (e.g., not enough idea elaboration, repeating information in the conclusion or the first sentence of every paragraph, including details in the introduction) by himself:

#My# goals #are# to define calculus, is a kind of math, how many parts it has, and the use of each part. #My# readers #are# high school students. I think the overall coherence is quite good because #I# start #from the# basic, #first# define #it, then# classify #it, and then go into greater detail in the following three# paragraphs. #Any sentences in the# intro #do not# fit, #should be in the# body parts? #No, oh yeah, this sentence# "Inwards because of ...". #What else? The above sentence# "They ... steps" too. #Yeah, I have# a problem #of# including details and examples #in the# first paragraph. #These don't# fit #the# intro. #They belong to# the body parts. #And this one can be# moved to the conclusion. This topic sentence on finding a slope on a curve with a particular point fits #the# elaboration in #this# paragraph, #but I haven't# related #it back to# calculus. The next paragraph, #oh, this first sentence is used to# connect #the above sentence, that is#, to repeat #the last sentence of the previous paragraph. It doesn't# fit #to be the# topic sentence. #This second sentence is the# topic
sentence. #I should# delete #the first one; it’s not needed. The next paragraph has the# same problem. #The last one, yeah, the# conclusion #has missed something. I should talked about# limitation. #Yeah, something unnecessary here#, the sentence "It ..." should be moved to the body part. (6th session: calculus)

In subsequent sessions, he began to talk about how to resolve his writing problems (e.g., using appropriate word choices to synthesize or summarize ideas):

#Have# I accomplished #my# goals? Yeah. #My# goal #is# to talk about different definitions of happiness according to different people -- the rich, the middle class, and the poor. #But I can# add #more# content #to make the# definition of happiness more# clear. Fit between the topic sentence and this paragraph? #I haven’t talked about# who said this and who said that. #I should make the# topic sentence clear and concise. The conclusion? Fit #a little bit# the intro #because I’ve mentioned# happiness, how different people can get happiness, #but I haven’t mentioned enough for each part. I gave a# general statement about happiness, #which seems not# fit the thesis statement. #Oh yeah, the same# fit problem -- #I# repeated details #in the# conclusion. #Yeah, the first sentence# "People have different feelings about happiness" #is good because it’s a# synthesis, #a# summary. #But the following looks like# elaboration. #I should use# word choice #such as# "satisfy their dreams" #to# summarize #or# synthesize #what’s mentioned in the writing#. (7th session: happiness)

In the final tutoring session, William’s text evaluation was particularly detailed. He observed his writing improvement (thesis statement "more concise and clear"), his effort in tackling his writing problems ("tried to write less and to concentrate on the main point" to prevent adding inappropriate information, "keep the first part of the sentence and change the rest" to make the topic sentence fit, etc.), and his awareness of using word choice to convey meanings in topic sentences and to avoid idea repetition in the conclusion:

#I think# overall coherence #is# okay #because I’ve talked about the# three goals -- the issue, the operations, and the measures, and they are logical. The fit between thesis statement and intro #is also# okay. #It’s about the# three goals. #It also# fits #the# intro
William developed the executive strategy of advance planning over the period of the tutoring, and he efficiently merged specific tutoring procedures into his pre-writing phases. For example, he used the goals prompt to guide his planning and decision making overall. It is noteworthy that the limiting of goals, to avoid adding unnecessary elements in the text or repeating information in the conclusion, was one of the writing problems he highlighted in his tutoring sessions:

How to write it? Describe, technical description of this power plant. My goal has two things only: explain how it works and why efficient way to control CO₂ emission. My goals are only these two things, and there’s no use to write more.
Well, what to write in the conclusion? Conclusion, maybe paraphrase. Recommendation, no. Now it is to write technical description, not to recommend something. Synthesize, a synthesis; also can't repeat. How to conclude this description? Synthesize, conclusion, advantage, but I can't add some new information into the conclusion.

William achieved noticeable improvement in his strategy use. He demonstrated the greatest increase, among all participants, in: (1) the use of strategies related to the prompts fit (from 2% to 13% of his total verbalizations of strategies related to the prompts) and (2) rules (from 2% to 12% of his total verbalizations of strategies related to the prompts) in the pre-post technical description tasks; and (3) the use of word (from 8% to 21% of his total verbalizations of strategies related to the prompts) in the pre-post argument tasks, showing concerted deliberation over word choices. William also showed a steady increase in his self-initiated revisions (from 18% to 60% between the first & last tutoring sessions).

6.2.2. Profile of Henry

Henry, a predominant L1 user, and an academic achiever (he came third among all first year engineering students in the Fall semester), was an initial high strategy user. He made substantial progress in self-regulation and text evaluation as the tutoring sessions proceeded. He also made improvement in developing his diagnostic and remedial capacities. The most distinct changes emerging from the tutoring were his increasingly complex and profound reflective thinking and self-monitoring. He treated the writing process from a problematic perspective.

In the beginning tutoring sessions, Henry adopted specific tutoring procedures to evaluate his texts, but not extensively:
#I have two goals: first, how it affects operations, second, what measures [can be taken]. To discuss the issue? This goal is not of much use. I only mentioned it very briefly. (1st session: ozone depletion)

Fit, overall coherence? I think there’s coherence; for example, coherence between paragraphs. But the length is not too good, and there’s no coherence here. It started by talking about the products, then suddenly shifted the focus to the workers. I don’t know whether there’s any transitional words to link the two together. Also, the introduction and the conclusion fit. Why? Front part said if we can do these, then it’s okay. The last part too, if we can do these, the profit will be maximized. (1st session: ozone depletion)

Sometimes he showed avoidance of making remedial changes:

If I have to revise, what would I do to make the first paragraph fit the body parts? It’s rather difficult. To add one sentence? It is important to work hard because engineering is very important; oh no, it’s not good. Better not to make any changes. Yeah, maybe I can shorten the front part, yeah, because the front part is a bit off topic. (3rd session: letter to an engineering student)

As the tutoring sessions progressed, Henry became mindful of more aspects of writing. He was aware of lexical redundancy; he tried to relate goal accomplishment to reader awareness; and he began to analyze the coherence and incoherence between parts of his texts more systematically than he had in previous sessions:

Word choice? Always redundant, such as however, therefore, obtain, and since. The goal is to tell people what’s calculus. I don’t think I have achieved the goal because you don’t quite understand this writing, because the audience is supposed to understand what I am talking about. Fit or not? The first paragraph, quite good. Fit is to check thesis statement, introduction, topic sentences, whether coherent or not, right? Yeah, the first paragraph is quite good because it brings out what’s calculus. Thesis statement points out integration and differentiation. The following paragraphs explains each of them. Yeah, fit. The next topic sentence mentions what’s
differentiation and there are examples to support the topic sentence. Next paragraph first defines what's integration, then gives examples. Anything not fit in each paragraph? No. The conclusion is quite good, and it fits the introduction. They echo each other, yeah, fit. (4th session: calculus)

As Henry got accustomed to the tutoring procedures, he detected his word and expression problem in reference to goals and his coherence problems (e.g., elaborated topic sentence, idea repetition, unnecessary information, lack of idea elaboration/supports):

The goal is to tell people what happiness is -- luck, friendship, and contentment. The readers are the public. Fit? The first paragraph fits the writing because it sets the background by talking about emotions and it leads to the main point -- happiness. Thesis statement has included the goals. It fits the background, talking about what conditions would make people happy or sad. Each paragraph, the fit between topic sentences and elaborations? This topic sentence fits the second paragraph, is about happiness -- luck, giving examples, oh well, now the second paragraph has only a few lines left because a lot of repeated elements have just been deleted. I don't think I need to elaborate with more examples, oh yeah, but there are only three lines, one sentence. I think I need more examples to illustrate why being fortune means happiness, yeah, should be being fortunate. The next paragraph? The topic sentence fits, but the part from "sometimes" is not necessary. Again I need to add more examples to elaborate on this point. How about that part? I'll delete it. Actually it is within this paragraph, now I delete this part, add another paragraph to talk about "But others" ... And yeah, this sentence can be the topic sentence, indicating happiness as being contented. Yeah, I'll try to use examples to illustrate this point, particularly because I've deleted a lot of repeated information. The conclusion? It's quite clear and concise. It hasn't repeated the thesis statement, oh well, a little bit. Yeah, but unlike the previous composition, which has several sentences almost exactly the same as those in the body parts. (7th session: happiness)

Henry's text evaluations advanced. His evaluation of the coherence between parts of his writing was conceptually interrelated with other aspects of writing. He also offered
solutions to problems he diagnosed:

Conclusion, fit? #I think it's okay #because it echoes the whole piece of writing and it emphasizes once again the importance of statics. The fit between introduction and conclusion? #Not too good. I prefer to change the intro #to shorten it so that readers won't get bored at the very beginning. How to shorten it? I’ll delete the part on the Newton First Law #because I didn’t touch it in the following paragraphs; I just introduced it in the introduction. Newton’s Law #can be added to the conclusion, #no, to the second paragraph. Well, but then there’s another problem -- #no thesis statement. #How comes that after the introduction of statics, Newton’s Law #appears and then jumps to another point #concerning Vector operation? #It doesn’t make sense #and doesn’t fit the thesis statement. #So, better not to add the Newton First Law #in the second paragraph. Any other comments? #Yeah, I’ll lengthen the conclusion. #Besides summariz­ing the above, I’ll mention Newton’s Law ... #Yeah, better not to add all these because I haven’t mentioned anything about construction #in the body parts... (6th session: statics)

When Henry assessed the fit between parts of his composition, he translated from one concern to another, demonstrating various knowledge-transforming behaviors. He showed awareness of his "repeating" and "not enough elaboration" problems, reader expectations, as well as appropriateness in language use. He proposed remedial work to achieve text coherence; specifically, to restructure his text:

#This paragraph#, fit or not? #The first sentence says our company manufactures plastic balls, #but in this paragraph, I talked about profits instead#. #Actually I wanted to mention the importance of production engineers. #Add a topic sentence here? But that means repeating the information that production engineers are very important, right? #Maybe I can move this part to the front, saying that production engineers are very important because ... #Isn’t it better and more clear now? How about the last paragraph? Well, it isn’t too fit #because its ideas aren’t too clear; #people may not understand. Why? It isn’t too fit #because the idea suddenly jumps from here to there; people won’t be able to follow. It needs to be elaborated, #especially because something’s missing in the middle of the
paragraph. How to elaborate or to add? I will start by talking about ... And in order to make it fit, I will say his performance will affect productivity. Have I repeated? Oh, yeah, then I will just say the decline in productivity is closely related to one’s responsibility. How about the next paragraph? Quite fit because it’s all about giving advice. Oh yeah, but the first sentence is too long, five lines altogether. Add a sentence to summarize the paragraph? No, better put a full-stop here. Yeah, but these are supports, examples. Okay, add a simple sentence then -- I would like to give some advice. How about the conclusion? Fit. It’s quite good because it hasn’t repeated the beginning, it can be related to the end, and people will understand what it’s about. It’s a paraphrase, a prediction, and a summary. (8th session: letter to an engineer)

In the final session, Henry’s text evaluation became more comprehensive and extensive. His comments on the improvements he had made, weaknesses that still existed, problems he needed to heed, together with his text evaluation in light of the prompts, clearly indicated growth as well as maturity in his capacities to evaluate, diagnose, and resolve problems independently and efficiently:

Word choice? There’s less redundancy, but still not of much variety. For example, addition, in addition, additionally, that’s it; I still can’t think of many different choices. Have I accomplished my goals? Some yes, some no. I’ve defined the problem, discussed how it would affect our company and what measures can be taken. I think I’ve accomplished all these three goals, but I’ve mentioned only one method for the part on measures, so the last goal is not fully accomplished. I should add some more methods, such as manufacturing other kinds of paper, and installing some new machines for this new production.

Fit? Every sentence fits. There is a thesis statement. The operation of our company will be affected and it needs to take some measures. But it doesn’t include the first goal -- to discuss the issue of greenhouse effect. I tried but I didn’t know how to add this point in this thesis statement. Though I’ve mentioned "how our company will be affected by greenhouse effect", still it doesn’t relate to the first goal. How about the
topic sentence #starts with# "By greenhouse effect", ah #no#, "Because of greenhouse effect", #oh yeah, it# fits #because it has# included #the three# goals #and# sets the background #for the following paragraphs#. #How about this paragraph? This one doesn’t# fit #too well because it doesn’t talk about# all the measures. #And how about this# topic sentence? #It’s too long; I should make it shorter. Yeah, besides, it looks like an# elaboration #of ideas. I can add another sentence to be the# topic sentence. In order to overcome the problems, we can train the worker, find the machine. #Oh no, this is too long. I can’t think of a# topic sentence #now#. In order to overcome the problems, we can, we can consider another method, or the following measures. #Any other# word choice? Precautions, procedures, process, method? In order to overcome, to cope with, to deal with, to tackle with, in order to tackle with the problems, we can consider another measures, methods, we should consider the following measures. #So, this is a# goals, fit, and word problem. #Finally, how’s the# conclusion? #It# fits. #It mainly# summarizes #and gives# a prediction. #It’s quite good because it doesn’t# repeat #the wordings in the text. (10th session: greenhouse effect)

Henry effectively and efficiently incorporated the text evaluation procedures from the tutoring into his post-drafting revision phases. He proceeded through these phases with problem finding, problem evaluation and problem solving (not always all three present, though), alternating with text reading/reviewing. As he persistently worked backward with goals, he demonstrated an interactive two-way process of problem finding and/or problem solving transfer between his goals in the content space (the written elements) and the aspects of goals and fit in the rhetorical space:

#It’s like this#. Okay, #finished writing. Oh yeah, okay#, check #whether everything’s# fit #or not. I should start from the first paragraph, Okay, it’s# fit. #Then let me check the# topic sentence. The second paragraph, the first paragraph has# thesis statement, #then# topic sentence #should mention, mention it’s# not isothermal. #Okay, I’ve mentioned the# main point, also listed some examples to# support #it. Then the third paragraph has talked about the# differences. This has included it has a#
difference #which is problematic. Um, the fourth, it talked about the two# differences. This, the, aha, should have mentioned there's a# pressure #which isn't, which actually is (?), can't be functioned. Then, there's# conclusion. It has mentioned, actually it hasn't repeated the first paragraph. And it has praised his contributions. Okay, there shouldn't be any problem, um./ (Henry, post-tutoring argument task, 18:58-20:45, 1st side of 2nd tape, post-writing phase)

In these manners, Henry achieved significant improvement in his strategy use. He demonstrated the greatest increase, among all participants, in attention devoted to: (1) double configurations (from 20% to 39% of his total verbalizations of strategies related to the configurations) in the pre-post technical description tasks; (2) double-plus configurations (from 23% to 61% of his total verbalizations of strategies related to the configurations) in the pre-post argument tasks; and (3) knowledge-transforming (from 36% to 77% of his total verbalizations of knowledge processing) in the pre-post technical description tasks. Henry displayed more concerted deliberation over word choice and explicitly mentioned the tutoring prompts while he wrote. He also achieved significant increase in self-initiated revisions (from 34% to 64% between the first and last tutoring sessions)

6.2.3. Profile of Bernard

Bernard, a predominant L1 user, was an initial high strategy user. He demonstrated increased capacities in self-monitoring and text-evaluation as the tutoring sessions proceeded. At the beginning of the tutoring, Bernard always needed prompting to perform self-regulatory procedures. But eventually, he became more competent and independent in identifying and evaluating problems in his writing. Specifically, he demonstrated greater efforts in reflecting upon and explicating his text, greater confidence in offering suggestions to resolve problems, as
well as increased attention to word choice.

Bernard stood out as a deep thinker: he paused the longest, among all the students, in reflecting upon his text, pondering over nearly every problem during the tutoring. He had writing problems similar to those of William, Henry and Leo -- repeating information, including details in the introductory paragraph, adding new information in the conclusion, topic sentences too elaborated, and including too many goals. The tutoring provided a routinized support to enable him to develop capacities in diagnosing (and trying to resolve) these problems. But things did not come easily.

In the beginning tutoring sessions, Bernard needed the tutor's prompting to detect his problem(s) in text evaluation:

#If I have to# revise #the first paragraph, I'll talk about the# importance of the greenhouse effect, especially the influence on our company such as lowering our production, #but yeah, you are correct, it's not good to# include details #in the# introduction. #Maybe I'll put them in the second paragraph. The first paragraph will talk about# the seriousness of the greenhouse effect. #Am I going to talk about only the# greenhouse effect #in the first paragraph? Well, I think the# introduction #should include a bit# background of the greenhouse effect, #but not the whole paragraph. I'll also mention# the company, #yeah, not in great detail, but mention something like# we should take actions. (1st session: greenhouse effect)

Bernard still needed prompting to notice the same problem (including details in the introduction) in the second session. But this time his responses were different -- longer and they entailed what should be done:

#Use# goals #to check the writing. I think the# introduction #is too long, and the last sentence is not needed because I've already talked about# uniqueness and usefulness #in the previous sentence. Have I# mentioned the characteristics of the new machine #in the# introduction, #and is it correct to# include details #in this
paragraph? Aha, usually we just briefly mention the characteristics, and then every characteristic will be described in the following paragraphs. Also, I'll add the sentence which I mentioned before, because I have to say it's unique and useful from ... (2nd session: machine)

Bernard also learned to check the coherence between parts of his writing. But in the early tutoring sessions, his responses were short:

#Does every paragraph fit the goals? #Not too fit; #for example, the second paragraph. Why? Because there's no need to mention its usefulness and applications in this paragraph. How's the conclusion? Fit #of not? In this paragraph, it seems I have mentioned too much about profits and not enough on its uniqueness. #How about applications? Electrical design will model, #ah, this sentence talks about application. (2nd session: machine)

As the tutoring sessions progressed, Bernard's comments on coherence and goals became longer and were interrelated with other aspects of writing such as word choice ("transitional words"):

Fit, how's overall coherence? #I think it's okay. #But I am not too sure about the order, I mean whether I should talk about its classification or history first. I know its implications should be mentioned at the end. Besides, I think there's not much coherence between paragraphs because I haven't used transitional words to connect them. Yeah, I know it's not necessary to have transitional words to connect all the paragraphs. I said transitional words, #I mean not only "in addition", "moreover", etc., #but also something like "other than those mentioned before". (4th session: calculus)

Bernard diagnosed another problem (elaborating too much in the topic sentence) in his writing. He tried to resolve it, then related it back to the coherence problem before making a final decision:

Calculus was originated from Egypt and China, but the first person who formulated the concept was Issac Newton. #This topic
sentence is about history. But it looks like an elaboration of ideas instead. Maybe I should add a sentence after it. The concept was started and developed by many scientists. Oh yeah, this sentence should be put at the front, to be the (new) topic sentence. But then do I have enough supports to make this paragraph fit? Examples, history, no, not enough supports to fit the topic sentence because I only have Issac Newton as an example and no other scientists. Some? Yeah, some other scientists in general, but I didn’t specifically talk about any other. Maybe I can add how some scientists applied this concept.

(4th session: calculus)

After checking goals and coherence in successive sessions, Bernard detected another problem (having too many goals or ideas, thus lacking development in important ones) in his writing. Not only did he comment more extensively, he also suggested resolutions such as restructuring the text and elaborating on more consequential ideas:

Goals, what’s my definition of happiness? Happiness is a biological response to show a happy feeling. Or which one? Oh yeah, it should be the one below on pleasure, satisfaction, and contentment. That is, to describe all these. I think a biological response and the other three are quite different, I mean not too related. I haven’t talked about what’s a happy feeling, and I haven’t really explained what happiness is. Just now I changed the phrase to “when you are happy”, so it can be related to the three. But I am afraid there are too many goals and too much to explain. Delete some and concentrate on a few? Yeah, I have to. One of my writing problems is having too many goals (gist) to write. Yeah, I can say how happiness can be achieved and relate it to pleasure, satisfaction, and contentment; it’s difficult to write, though. Any other comments on goals? Well, I’ll delete the third and fourth paragraphs on the original last goal — how it affects us. It’s getting short, but I think it’s okay because it’s a definition writing. I have the definition, extended definition, yeah. Also, the last two paragraphs and the old definition can be moved to the part on examples, starting from “When you are happy”. In addition, I will elaborate more on pleasure, satisfaction, and contentment. The second last paragraph can be added to these paragraphs as elaborations on pleasure and satisfaction. Only after these changes are made will the paragraphs be fit. (7th session:
happiness)

In the last few sessions, Bernard independently evaluated and restructured his text during self-initiated revisions in light of the five thinking prompts, exhibiting numerous knowledge-transforming behaviors and complexity of thinking:

#This sentence in the# introduction #needs to be# deleted, #and the following too, from# "such as the seriousness ..." #It’s a# fit and topic problem #because it doesn’t# related to the topic, #and I haven’t# mentioned #them later in the# body parts. #Change it to#: Therefore, I wrote this letter to suggest you, to guide you, some of your existing problems and how to tackle them, no, to list some of your studying problems, and to suggest you how to tackle them, ah, to diagnose, to deal with, to discover, to discuss, but not some, only two problems, okay, to discuss your studying problems, study problems, and to suggest you how to tackle. #Yeah, I did# encourage #him in the following. I don’t need the# word "and" #here#, to encourage you, #actually I think I should# encourage #him at the end, that is, in the# conclusion. #Also because I don’t have much to talk about encouraging him, just one sentence in the# conclusion #will be enough. Okay, move it to the# conclusion. (8th session: letter to an engineering student)

During tutor-prompted correction phases too, Bernard attended to goals, word choice, coherence, and grammar rules interrelatedly. His references to word choices were distinct, and he learned to use word choices to summarize details in his texts:

#It seems the# goal #is not# clear #here. I’ve already# suggested some methods to him #and# pointed out what problems he has. #It would be# confusing #if here I ask him to find out his# problems. #Okay#, delete #this -- from# six solutions to difficulties, #and move the part on# encouragement #from the first paragraph to this# conclusion. #This is a# goal problem. #At the end, I will say# I highly, I strongly suggest, or sincerely hope that you consider, you should, you can, you would, you will consider your future, my suggestions, my recommendations, opinions, my advice. You have to consider what? #What have I# mentioned #in the text#? Future career, academic results. #Are these# details? #Yeah. Can I use one# word #to# include #all those I’ve# mentioned #previously? Ah, the# word consequences, yeah. Otherwise, you have to
consider, to decide, to think about the consequences, the bad consequences, the negative consequences, the serious consequences. I sincerely hope that you will consider my advice, listen to my advice, otherwise, you have to consider the negative consequences. #This is# word. #So#, delete #this# part. #Is it good to keep the previous sentence# "the important points that must be"? Yeah. Important points, important point, rules. (8th session: letter to an engineering student)

Other than incorporating specific tutoring procedures into his post-drafting revision, Bernard also developed his advance planning over the period of the tutoring. In addition, he modeled the use of the word prompt in his post-tutoring writing processes (see section 4.6.2.). Bernard displayed a dramatic increase in self-initiated revisions (from 12% to 86% between the first and last tutoring sessions).

6.2.4. Profile of Leo

Leo, an L1 preference user, was an initial high strategy user. He demonstrated progress in evaluating his texts, diagnosing his writing problems, and resolving them. In the beginning sessions, his text evaluation was short and consisted of many "do not know how to resolve it" remarks. But gradually he became more skilful and independent in analyzing his written texts, identifying and solving problems by himself. He was able to diagnose his wordiness problem in writing and conceptually to integrate different aspects of writing while evaluating his texts. Leo liked to craft his expressions so much that they often became too wordy and unclear. He came across this problem in the beginning sessions while using the five prompts to detect errors by himself. At this stage, he did "not know how to correct it":

It is the physical limitation unfavorable to the developing communication field. However, the discovery of optical fibre can optimize its work load by thousand times. #It seems the meaning
here is problematic. I don’t understand what it means, I mean I know there’s something wrong, but I don’t know how to correct it. I intended to say# the discovery of the fibre can solve the problem, the physical limitations #which I mentioned previously, but I can’t think of a better# word choice. It is considered to be a economical piece of material which is favorable to the upcoming future development. #There’s a# problem #here. I don’t want to use# "consider", #change it to# "recognized". #Why? Because of# redundancy; #it’s a# word problem. (2nd session: material)

Compared with his self-initiated revisions, Leo’s text evaluation was brief in the beginning tutoring session:

#How’s the whole piece of writing? Use# goals and fit [to evaluate it]. #Quite# fit, #can# meet #all the# requirement. #The# reader #will understand quite clearly. But the# introduction #has missed something# -- the issue of ozone depletion. #Others#, fit, #nothing is# off-topic. #Also, I haven’t used# difficult technical terms #which# readers #may not be able to understand#. (1st session: ozone depletion)

As the sessions progressed, Leo diagnosed the wordiness and repetition problems in his writing, and he realized how they could be resolved by careful word choice:

Unsatisfactory work done, #not# concise #enough, no need to have the# word "done". In order to make sure maintaining a normal rate of efficiency ... Words #unnecessary? Oh yeah, just say# in order to maintain, #no need to have the# words "make sure". A suspension of your current position will be considered to justify the situation if other things get worse. "To justify the situation" #can be# deleted #to make it# concise. (3rd session: letter to an engineer)

Basically, the stage of the birth of a child can be viewed as the beginning of a new life or the dawn of a day. #Oh yeah, no need to have# "the stage of", #should be simply# "the birth of". #This is a# word problem. (5th session: youth)

Similarly, he became more capable in evaluating his text(s) and offering suggestions for improvement:
If I revise this writing, maybe I will add some examples of application. I will explain more clearly the terms, and add a short paragraph on dynamics to make a contrast. How's this conclusion? Not good, yeah, the last sentence too, not fit. Yeah, I defined statics here, but I should do it in the introduction. Word choices? Because I am not familiar with this topic, so the use of words and expressions is a kind of mixed up. (6th session: statics)

Another distinct change was evident in how Leo tried to relate his problem with word choices to his writing goals. He realized the interconnection between the two ("I didn't explain and express clearly here and readers may not understand what I mean") and that his other major writing problem was not explaining his goals clearly to readers:

After that, it will need a long time for the care such as irrigation and fertilization. Is "care" the most important word here? Yeah, I mean to take care of the plant, the seed. Yeah, like a metaphor, it refers to the nurture of youth, that early care can determine the fate. But I didn't explain and express clearly here and readers may not understand what I mean. Goal and word problems. Also, this paragraph is too long. It would more or less determine the fate of a seed and that is the true meaning of life. There's a problem at the end. It's not logical... I want to open a new paragraph here, to explain why it is important. Here I have only one sentence and it's not clear at all. This is a goal problem. The main problem of this writing is goal. (5th session: youth)

The tutoring helped bringing into play Leo's executive strategies of post-drafting revision, which were initially absent in his pre-tutoring writing. He productively integrated text evaluation procedures -- such as checking the goals and fit of the whole text, from paragraph to paragraph -- into his post-drafting revision phases, and demonstrated various knowledge-transforming behaviors (see also section 5.2.3. for the post-drafting revision phase of Leo's technical description task):

//Now use those goal and fit to check whether the text is okay
or not. The whole piece of writing, the# goal #is/ whether agree or not it’s a# success. #Ah, whether the# theory #has# success (i.e., successfully) guide him. Ah, the first paragraph, thesis statement #said, it has mentioned# verify the truth .... #From this one, I brought out the following paragraphs. The first paragraph from# the thought of internal combustion is the first step to the completion of the Otto’s engine model. #I talked about all these in the first paragraph#. #The next, should be this paragraph. The# concept of #the# internal combustion #is# the notion of burning fuel. #This one is to explain, and this says# the theory of internal combustion process contribute #a# .../ Aha, #it can be said that this# fit #the first paragraph. The second paragraph said# the determination of stratified charge is definitely the pivotal moment to the realization of the engine model. #This# helps #the# development. #The last sentence said# as a result, the above beneficial concept is prove to, is proved to the sign of success of the engine,/ is proved to be the sign, ... #not# to the sign, to be the sign of success,/ success of the engine. #Right#/ Okay, #should# fit. #Okay, now the third paragraph, the fourth paragraph#, the design of 4-stroke cycle symbolizes its wide applications not just for the Otto’s engine but guides a way to the future developments in the various fields. #Also# fit. #But it seems the last part didn’t mention, yeah, should mention how, how it, what other special things about it. Um, something is missing here. Well, I haven’t talked about how# wide application in other field!/ #Um, um, actually I should add, but# conclusion #has mentioned it, maybe it’s# okay. But, really, something is missing, missing a sentence, that is# wide application, #unless I change this sentence#. Not just for the Otto’s engine but guides a way to the future development in Otto’s industry, Otto’s industry #should be okay. Okay#, Otto’s industry, #don’t say# various fields;/ Otto, Otto industry, #then I need to add a little bit more information at the end. I think I need to add a sentence before# therefore. Dramatic amount of efficiency for the en, for the engine, ah,/ this, ah,/ tendency,/ this ah,/ this leads to a tendency/ for the field/ to improve even more the,/ ah, this leads to a tendency for the field to improve even more um, even more the ah,/ ah, performance/ of its old/ engine./ #In this way, I’ve mentioned a little bit, and should be# okay #here#, okay./ (post-tutoring argument task, 38:14-44:41, 2nd side of 2nd tape, post-drafting revision phase)

In these ways, Leo demonstrated the most increase, among all students, in the use of L1-L2 (from 14% to 34% of his total verbalizations of strategies related to the prompts) (see
section 4.8.3.) and triple configurations (from 4% to 17% of his total verbalizations of strategies related to the configurations) in the pre-post technical description tasks. He showed concerted deliberation over word choices. He developed his executive strategies of detailed advance planning and post-drafting revision phases over the period of the tutoring. Likewise, he showed notable increase in self-initiated revisions (from 0% to 55% between the first and last tutoring sessions).

6.2.5. Profile of Charles

Charles, a predominant L2 user, was an initial high strategy user. He showed distinct changes in the perception of his own writing problems, particularly in deliberating over grammar rules and finding unexpected problems. In the first tutoring session, Charles was reluctant to evaluate the coherence of his writing, insisting that this was not a problem for him. He argued that grammar was his main problem. As the tutoring sessions proceeded, he displayed increased confidence in his own sense of linguistic accuracy; demonstrated more extensive analyses of rules; and gave less strict comments regarding the importance of his grammatical errors. Consequently, he paid less frequent attention to this priority concern. Simultaneously, he began to evaluate, diagnose, and resolve other problems which were of either minor or no concern to him initially. He demonstrated frequent and extensive evaluation and deliberation over goals and fit while drafting his texts, especially in the later tutoring sessions (see Section 5.2.2. above).

In the first tutoring session, Charles argued that the fit prompt would not be useful to him:
I want to improve my grammar, that's one thing I want to improve. Most of the errors are subject verb agreement. Fit? I don't think it's useful because I have the organization. Unless you can tell me why it's wrong, I can't see any reason why the fit prompt is useful. My first body talks about the issue of ozone depletion and the government intervention. The following paragraph is about the effects of government intervention ... and the third one I talked about the measures, the solution first taken by all companies and then my solutions to it. These are coherent, also they are important, or the orders logical. So, unless you prove me wrong, then I will say the fit prompt is useful to me. But of course if I say I don't need help, that's not true. Everybody needs help, but I need more help in the grammar than fit because I strongly believe that my grammar is terrible, comparing to the fit of my writing. (1st session: ozone depletion) (all spoken in L2)

As the sessions progressed, Charles seemed to make improvements in detecting and solving his problems with grammatical rules. He also tried to analyze them more extensively:

The society have, has, it's a rules problem. The problem is waste. It's not clear? The way of expression? The problem face is waste, not face, confronted? You don't like the word waste? No? What's an article? Ah, okay, the problem is the waste. Yeah, I've mentioned the waste before. It's a rules problem. (2nd session: material) (all spoken in L2)

The natural composition of these two gases found in the atmosphere and in the earth dictates, take off the s. Why? Because the natural composition, ah, composition in singular, so it's correct. Yeah, in the atmosphere and on the earth, the main thing I am talking about is the natural composition, the composition, okay, dictates, yeah. (10th session: greenhouse effect) (all spoken in L2)

Eventually, it seemed that "rules" became less of a menace to him. When he reflected on his own revisions, he even blamed himself for carelessly missing these should-be-manageable and easy rule problems:

Actually just now when I did (self-initiated) revisions with the five
prompts and checked the grammar, I should have cut many of these (errors). Did I check the rules after writing? Ah yeah, except that I was a bit tired. No, because I know some of these, I should have corrected them myself. Also because some of these are really simple, like verb tense and plural, not verb tense but plural. Yeah, see, all these errors are singular and plural. Oh yeah, some of them belong to subject verb agreement. Some of them are very easy; I should have learned them. (10th session: greenhouse effect) (all spoken in L2)

Charles also began to notice and pay attention to the wording of his writing:

Yeah, I haven’t used the word measures at all in the writing. Right. I can use word choice to make a good summary. (10th session: greenhouse effect) (all spoken in L2)

Charles was aware of his readers. He puzzled over whether his word choice was adjusted to his reader’s expertise, and he was curious to know who his readers were:

The end results of the disintegration process will yield the pure atoms of its composition. Ah, okay, I don’t know if this is clear to the reader because will the reader know that it’s the plastic? For sure the reader knows it’s the plastic, but is it better somehow to put the word plastic? My readers are my boss and colleagues ... I don’t know, who else reads this? Just you? (3rd session: letter to an engineer) (all spoken in L2)

There were profound differences between Charles’ comments about coherence in his first tutoring session and those in his last tutoring session -- in both quantity as well as quality. They also echoed the procedures he had practised and the progress he had made over the period of the tutoring:

Fit, overall coherence? I think it fits, except the length is not too good. The second paragraph is too short. The first paragraph may be a bit longer, but I think I have enough support. I could have divided it into two paragraphs, or actually I can delete something, but it may not be so clear. Maybe I can delete some processes and concentrate on the human activities. The first paragraph fits the writing? Yeah, the introduction, yeah, remember my goals? It’s the issue, the operations, and the measures. Basically I incorporate
all these into the introduction. Thesis statement, fit? Yeah, but that’s not just the thing. Besides the two goals, I also need to discuss greenhouse effect. That means the first sentence is also the thesis statement; the whole thing is the thesis. No, not that long. Yeah, maybe I can add something to the thesis statement, I mean the last sentence here, so that it fits the whole and the goals. Yeah, I can start by saying due to the regulations on greenhouse effect bla bla bla, oh yeah. This paragraph, fit? Topic sentence: The government has tightened regulations to restrict individual companies from upsetting the equilibrium. Did I talk about the government tightening regulations? Ah, okay, change it. It doesn’t fit. I should have kept the first half of the sentence, the government has tightened regulations that affected our company’s operations. No, no, it goes like this, okay, since the cause of the greenhouse effect is due to mankind activities, the government has tightened regulations that affected our company’s operations. I need to have the word (expression) affect the operations of our company in it. But as I mentioned before, this paragraph is too short and I need to add some information. The same for the next paragraph, the topic sentence fits, but there’s not enough support to fit. I just mentioned one alternative method. The next paragraph too. However, there are few issues. This is just an extension of the previous paragraph. This topic sentence fits the paragraph but is too short. Conclusion, fit or not? Conclusion is about, since I am working for the company, of course I need to talk about money and things like this. So, I emphasized more on profit. I guess it fits, fits the audience. You know, like propose wise, it fits. This conclusion doesn’t fit too well? It fits the previous paragraphs for sure. It just doesn’t fit the thesis statement. The thesis statement talked about three different issues that are related. But then the conclusion tie everything together. How can you tie things together? Except in terms of money. Can I add something to this conclusion to make it fit the topic and the introduction? Well, maybe a sentence to summarize the problem of greenhouse effect, the government tightening the regulations, and that it affects the operations and that we take the measures. I guess it’s too long, yeah. (10th session: greenhouse effect) (all spoken in L2)

Charles modeled specific tutoring procedures into the post-drafting revision phases of his post-tutoring writing by referring to particular prompts at instances where problems arose:

Is that enough? Doesn’t seem like. Okay, maybe I should do
some ah checking./ Okay, I am going to do the ah five prompts (i.e., for text evaluation and revision). Ah, [Reread from the beginning of text, but made word and rule changes only] (post-tutoring technical description, 0.51-13:00, 2nd side of 2nd tape)

Charles achieved the greatest increase, among all participants, in the use of strategies related to rules (from 16% to 33% of his total verbalizations of strategies related to the prompts) in the pre-post argument tasks. Also, he came second in demonstrating the greatest increase of use in strategies related to rules (from 19% to 25% of his total verbalizations of strategies related to the prompts) in the technical description tasks (see Section 4.7.3.).

6.3. Summary of Common Trends and Individual Differences

For all participating students, these case study profiles suggest that procedural facilitation provided a support to enable individual students, over the period of the tutoring, to develop evaluative, diagnostic, and remedial capacities, which were not previously brought into play or not yet matured in their writing processes. Second, procedural facilitation provided a simplified routine to help lower individual students' cognitive burden in performing reflective processes, so that more independent and efficient self-regulation and text evaluation, as well as executive strategies (e.g., advance planning, revision, knowledge-transforming), developed as the tutoring sessions progressed. Third, procedural facilitation provided a routinized procedure to help individual students bring forth certain executive procedures in evaluating their texts, particularly in tackling higher level problems, which they did not usually do or had difficulty in doing. Fourth, procedural facilitation assisted individual students in breaking down their complex writing processes into manageable subprocesses to control themselves. For example, William did not use post-drafting revision in his writing processes, but he employed the executive support to
develop his planning skills.

For the initial low strategy users (Edward, Lorraine, Simon, and Peter), their progress in self-regulation and text evaluation over the period of the tutoring indicated that procedural facilitation enabled them to understand, to reflect, and to comment on their writing in ways that might have helped them to change from initial low strategy users to high strategy users, and from knowledge-tellers to knowledge-transformers. Specifically in the case of Lorraine, the tutoring helped bring forth her skills in refining and expanding her substantive knowledge in writing. In the case of Simon, procedural facilitation helped him to evaluate his writing, which he did not usually do or had been reluctant to do to tackle high level problems.

For the initial high strategy users (William, Henry, Bernard, Leo, and Charles), procedural facilitation helped them in assessing their competence as well as incompetence in writing. These initial high strategy users demonstrated greater complexity of thinking or strategy use as well as more sophisticated knowledge-transforming behaviors after the tutoring. Specifically in the case of Charles, the change in his perception of the *fit* prompt indicated that procedural facilitation provided an executive procedure that would otherwise not have come forth.

Despite these common trends, many differences among individual students appeared. Table 6.1 summarizes the individual students' unique writing problems, characteristics, behaviors or patterns of learning, as well as their unique development over the period of the tutoring.
### Table 6-1. Differences Among Individual Students Observed During Tutoring

<table>
<thead>
<tr>
<th>Students</th>
<th>Writing Problems</th>
<th>Unique Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edward</td>
<td>-in every aspect:</td>
<td>-achieved greater confidence in self-regulation</td>
</tr>
<tr>
<td>(stood out as a big achiever) (L1 low strategy user)</td>
<td>(1) goals</td>
<td>-began to tackle and evaluate higher level problems</td>
</tr>
<tr>
<td></td>
<td>(2) text coherence</td>
<td>-demonstrated more self-awareness and confidence in his own sense of linguistic accuracy</td>
</tr>
<tr>
<td></td>
<td>(3) word choice, &amp;</td>
<td>-analyzed language use more extensively</td>
</tr>
<tr>
<td></td>
<td>(4) grammar rules (particularly grammar rules -- according to his ESL teacher's comments)</td>
<td>-demonstrated greater deliberation over word choices</td>
</tr>
<tr>
<td>Lorraine</td>
<td>(1) inadequate content development (perceived before tutoring)</td>
<td>-improved in her remedial capacity to overcome her lack of idea development in texts: refining &amp; expanding her substantive knowledge in writing</td>
</tr>
<tr>
<td>(stood out as a content elaborator) (L2 low strategy user)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simon</td>
<td>(1) had different interpretation of topic</td>
<td>-learned to evaluate his texts, especially content</td>
</tr>
<tr>
<td>(stood out as a resister) (L2 low strategy user)</td>
<td>(2) had goals and coherence problems</td>
<td>-detected problems in his topic interpretation &amp; goal formulation</td>
</tr>
<tr>
<td></td>
<td>(3) did not like to criticize his content</td>
<td>-learned to revise his content despite his reluctance</td>
</tr>
<tr>
<td>Peter</td>
<td>(1) mainly reader concerns (perceived before tutoring)</td>
<td>-became more familiar with the tutoring procedures &amp; the use of five thinking prompts</td>
</tr>
<tr>
<td>(participated in 4 sessions only) (L2 low strategy user)</td>
<td></td>
<td>-detected problems:</td>
</tr>
<tr>
<td></td>
<td>(1) idea repetition, esp. in the conclusion (20 including details in the introduction (3) thesis statement &amp; topic sentences too wordy (4) adding unnecessary information (detected in tutoring sessions)</td>
<td>(a) ideas not clearly stated</td>
</tr>
<tr>
<td>William</td>
<td></td>
<td>(b) topic sentences too elaborated</td>
</tr>
<tr>
<td>(stood out as a problem finder) (L1 high strategy user)</td>
<td></td>
<td>-detected problems (listed in the left column)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-learned to resolve problems:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(a) wrote more concisely</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) avoided adding unnecessary information</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) used word choice to summarize ideas in the conclusion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-showed greater capacities in detecting, evaluating and resolving his discourse coherence problems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-demonstrated more knowledge-transforming behaviors</td>
</tr>
<tr>
<td>Henry</td>
<td>(stood out as a complex thinker &amp; knowledge transformer) (L1 high strategy user)</td>
<td>(1) idea repetition in the conclusion (2) topic sentences too elaborated (3) redundancy of word choice (detected in tutoring sessions)</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Bernard</td>
<td>(stood out as a deep thinker) (L1 high strategy user)</td>
<td>(1) including details in the introduction (2) topic sentences too elaborated (3) including too many goals (detected in tutoring sessions)</td>
</tr>
<tr>
<td>Leo</td>
<td>(stood out as a word crafter) (L1 high strategy user)</td>
<td>(1) too wordy, not clear to readers (2) topic sentences too elaborated (detected in tutoring sessions)</td>
</tr>
<tr>
<td>Charles</td>
<td>(stood out as a rule-fit contender) (L2 high strategy user)</td>
<td>(1) grammar rules (perceived before tutoring) (2) goals and coherence problems (detected in tutoring sessions)</td>
</tr>
</tbody>
</table>

Slightly different tutoring experiences appeared for each individual student because of the unique writing problems they had to tackle or according to their perceived individual needs. While some students worked more on fostering their evaluative capacities, others focused more on developing their diagnostic or remedial capacities. For example, among the initial low strategy users, Edward and Peter had to work on developing all three (evaluative, diagnostic, and remedial) capacities; Lorraine mainly focused on fostering the remedial capacity...
to overcome her inadequate development of ideas; and Simon needed to emphasize evaluating the goals of his writing. Among the initial high strategy users, students focused on specific capacities according to individual needs -- often referring to their unique writing problems or lack of particular skills. Thus these indicated clearly that this procedural facilitation with five thinking prompts worked within students' "zone of proximal development" (Vygotsky, 1978).

While procedural facilitation provided an executive structure for planning and revision so that individual students could easily access and manipulate their cognitive strategies, it also allowed them to assimilate the executive procedures to their established way of writing or evaluation, using them to make their writing more efficient and effective (Bereiter & Scardamalia, 1987a). For example, while some students incorporated the procedural prompts into their planning and drafting processes (e.g., William), and some modeled them in their drafting processes (e.g., Simon and Peter), others integrated them into their planning, drafting, and post-drafting revision processes (e.g., Henry, Bernard, Edward, Lorraine, Charles, and Leo).
Chapter 7

Discussion and Implications

In this final chapter of the dissertation, I consolidate and interpret the various findings from the previous chapters by addressing two issues of theoretical significance: What does the present study provide in the way of new information about procedural facilitation? Why were there consistent differences in the students’ achievement between the technical description tasks and argument tasks? Then I suggest implications for future research and second language writing instruction.

The major contribution of the present study lies in its documentation and analysis of the relations between procedural facilitation of strategic knowledge and writing development in a second language, particularly in the context of Chinese-background ESL students of engineering. The study produced equivocal findings about the effects of procedural facilitation in this context. Nonetheless, the research represents a crucial first step in attempting to analyze how cognitive processes, text production, and tutoring procedures can be combined in second language writing instruction through procedural facilitation. To date, there has been little empirical research employing such an integrative approach for cognitive strategy training in ESL writing, particularly in academic contexts. The present study, therefore, serves to raise a number of important issues concerning the viability and validity of procedural facilitation as an approach to ESL academic writing instruction as well as to demarcate variables that play important roles
What does the present study provide in the way of new information about procedural facilitation? The research design I used and the data I collected were insufficient to make any strong claims about whether procedural facilitation may, or may not, be an effective instructional model for second language academic writing. Nonetheless, the present study contributes a more thorough understanding of procedural facilitation methodologically, pedagogically, and theoretically.

7.1.1. Research Methods

Compared with previous studies, the present study provides new information on the research methods that can be used to study procedural facilitation. As suggested in Table 7-1, the present study supports the importance of conducting "constrained" training studies (Mellow, 1992) in contrast to the multicomponent nature of most studies of procedural facilitation to date. A constrained focus on certain prompts can help research to analyze precisely the effects of procedural facilitation of strategic knowledge. I tried to address these effects in regards to the students' thinking processes, written texts and progressions over time (during tutoring), providing a complementary perspective on how these interact and relate to each other. Moreover, I investigated the relations between cognition and writing and teaching contexts by analyzing not only the students' compositions and think-aloud protocols, but also by closely inspecting audio-taped tutoring data. Doing so has helped to document how cognitive development involves a
process of appropriation of contextual resources, and to provide a better understanding of individual differences in the "zone of proximal development", that is, both students' "capacities" in strategy learning and students' enhanced "abilities" in their subsequent writing performance (Smagorinsky, 1995). Furthermore, unlike most previous studies which investigated writers' metacognitive changes by using questionnaires, I analyzed students' concurrent think-aloud data, eliciting direct evidence of their decision making while composing. I also restricted the research to writing in a specific discipline and population of learners, which helped to isolate procedural facilitation from possible intervening effects related to students' knowledge, education, or cultural backgrounds. Likewise, I designed the research to highlight performance as well as developmental aspects, exploring relationships between them, in light of task variables. Finally, the case study approach I adopted provided an indepth study over a period of time and the opportunity to investigate in greater detail how individual differences corresponded to learning results. However, the findings would be more informative had I been able to compare the think-aloud data of writing tasks among the tutoring sessions (but the differing topics in these tutoring sessions prevented me from making such comparisons), had I been able to solicit a full control group to tutor without procedural facilitation (as a basis for comparisons), or had the ESL teacher in the experimental class incorporated strategy use into her regular classroom instruction (and I thus been able to see how procedural facilitation might operate outside of one-to-one tutoring). These considerations would all be worth inquiring into future studies. A major limitation of the research design, however, was the lack of a comparable control group, who for instance might have been tutored with error correction, rather than procedural facilitation. Without such a control, it is virtually impossible to say exactly what the effects of procedural facilitation really
were, as opposed to development that might have occurred with the students' maturation or experience. These design issues all seem important to consider in future research on procedural facilitation.

Table 7-1: The Present Research With Respect to Previous Studies of Procedural Facilitation (cited in Section 1.4.3.)

<table>
<thead>
<tr>
<th>Nature of Study</th>
<th>The Present Research</th>
<th>Previous Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focus</td>
<td>constrained</td>
<td>mostly multicomponent</td>
</tr>
<tr>
<td>Tools</td>
<td>whole writing process</td>
<td>mostly writing subprocesses</td>
</tr>
<tr>
<td>Language</td>
<td>simple cue questions</td>
<td>elaborated cues</td>
</tr>
<tr>
<td>Points of Inquiry</td>
<td>development &amp; performance aspects</td>
<td>L1 (English)</td>
</tr>
<tr>
<td>Data</td>
<td>processes &amp; products</td>
<td>performance aspect</td>
</tr>
<tr>
<td>Measures</td>
<td>think-aloud protocols, tutoring data &amp; text analyses</td>
<td>products</td>
</tr>
<tr>
<td>Scope</td>
<td>discipline-based</td>
<td>questionnaires &amp; text analyses</td>
</tr>
<tr>
<td>Ultimate Goal</td>
<td>knowledge-transforming processes &amp; products</td>
<td>mostly expository writing</td>
</tr>
<tr>
<td>Indicators of Fundamental Change</td>
<td>problem solving effort internalization of strategies cognitive change</td>
<td>ratings of text quality</td>
</tr>
</tbody>
</table>

(Items in bold were absent in previous studies to date.)

7.1.2. Pedagogical Issues

Pedagogically, the present study supports the contention that procedural facilitation using simple cue questions, as opposed to the more detailed and elaborated ones employed in most previous studies, is feasible to use in tutoring and it can easily be internalized by ESL writers. Overall, the heuristic strategies, as formulated into the five thinking prompts used for
tutoring here, represent procedural knowledge that can be learned and should be taught (Bereiter, 1985; Glaser & Chi, 1988; Simon, 1980). For instance, some of the students’ evident internalization of strategies and their significant increase in complexity of strategy use in at least one writing task after procedural facilitation of heuristic strategies suggest possible pedagogical advantages of the succinctness, integratedness, and effectiveness of the five thinking prompts. In addition, the students’ progression toward independence in managing self-regulation and text evaluation in the tutoring sessions indicates that these five simple heuristic strategies can promote self-questioning and can help fostering problem-solving executive processes that were initially absent in these inexpert writers’ approaches to writing. These five thinking prompts, deriving from Cumming’s (1989, 1995a; Cumming & So, 1996) research on writing expertise in second languages, appear to be feasible pedagogical tools for second language writing instruction (e.g., in a tutoring situation). They are theoretically- and empirically-based, related to the uniqueness of second language writing (Silva, 1993), and can be adapted to suit inexpert ESL writers’ ”zone of proximal development”.

7.1.3. Second Language Writing Development in This Context

The present research studied procedural facilitation from the premise that the ability to do knowledge-transforming is the ultimate goal of procedural facilitation (Bereiter & Scardamalia, 1987a). Knowledge-transforming involves a dialectic process between dual problem spaces, internalization of new feedback loops or strategies explicitly taught, problem solving efforts, and cognitive as well as developmental changes. I tried to investigate how knowledge-transforming in students’ writing processes might relate productively to their transformation of
knowledge in their written texts, using as criteria higher content and global quality ratings and more extended parallel progressions in the written texts, as well as increased evidence of dialectic processes in the think-aloud data. However, the design of the present study could only point to some ways in which new knowledge is constructed in students' written texts. For example, I have documented particular types of thinking strategies that could be associated with improvement in content and topical progression as indicators of knowledge transformation in written texts. Likewise, I tried to account for knowledge-transforming as a cognitive process (in people's mental activities at one time) as well as a developmental process (increasing over time). Training in writing expertise may help to counter the problem of "monitoring deficiency" and to foster knowledge-transforming. Further research needs to assess changes in students' writing approaches from knowledge-telling to knowledge-transforming, how these two writing models are comprehensive representations of the cognitive-developmental nature of writing, and how students actually shift from one to another as they learn.

The present research has emphasized a problem solving approach to writing (Bereiter & Scardamalia, 1987a; Cumming, 1989, 1995a; Flower & Hayes, 1980). The ESL engineering students I studied showed many signs of developing a problem solving approach toward their writing, demonstrating more complex, profound and reflective thinking on certain consequential aspects of their composing, such as goals and coherence, after procedural facilitation with five heuristic strategies. Not only did they pose and solve problems encountered in their writing processes more frequently, but they behaved in more expert-like ways, constructing more challenging problems for themselves. Thus they engaged in a "process of tackling problems at higher and higher levels", which Bereiter and Scardamalia (1993) described
as "the process of expertise" or "progressive problem solving" (p. 120). That the ESL engineering students treated their writing from a problem solving perspective "builds on proceduralization" of the five heuristic strategies they were taught during the tutoring. For instance, the ESL engineering students explicitly mentioned the five thinking prompts, effectively modeled specific utilization procedures for thinking while composing, and productively incorporated them into their writing processes, particularly in the technical description task.

Interpretations about the exact kinds of ESL writing development that appeared in this context are hampered by the fact that improvements in the ESL engineering students' writing processes and written texts were significant only in the technical description tasks (to be discussed below). Nonetheless, certain tendencies appeared in both pre-post-tutoring tasks that may be related to the students' improvement in ESL writing or to the procedural facilitation. There were some indications that the nature of the students' writing changed from a "think-say" (Bereiter & Scardamalia, 1987a, p. 304) mode to a multifaceted, reflective, self-regulatory and transformative mode. For instance, there were significant increases in students' strategic use of the fit prompt and in their complexity of strategy use (as complex configurations), suggesting that over time they came to attend more extensively to the coherence of their writing and were engaging in more interactive and conceptually integrated thinking processes. These findings are consistent with well-established findings that expert writers attend to complex task representations in their writing processes (de Beaugrande, 1984; Bereiter & Scardamalia, 1987a; Burtis, Bereiter, Scardamalia & Tetroe, 1983; Cumming, 1989; Flower & Hayes, 1984). In addition, there was a significant increase in the total time these students spent writing, suggesting they exerted greater effort and case study data show how they seemed to incorporate executive systems such
as planning and evaluation into their writing processes. Similarly, qualitative changes appeared in the students' L1-L2 code-switching while writing. In their post-tutoring writing, students appeared to code-switch frequently while engaging in metacognitive and metalinguistic thinking processes, shifting back and forth between their second language for retrieving content and first language for contemplating text production in a way which was initially absent in both pre-tutoring writing sessions. Nonetheless, the students' strategic uses of word choices and L1-L2 code-switching remained relatively consistent in all tasks, implying that the present strategy training may not have immediate significant effects on these two aspects of writing or simply that word choices predominate as the aspect of writing to which students devote most of their attention to while composing in a second language, as other research has observed (Cumming, 1989; Jones, 1985; Raimes, 1987).

In the written texts, topical structure analysis showed a significant increase in complex sentence types (types 4-plus and 3-plus in the technical description and argument task, respectively), suggesting that the students increased their syntactic complexity and topical depth as their writing skills developed over the period of the tutoring. Indications of knowledge-transforming in the written texts for both tasks were very limited, however, manifested only as a significant increase in extended parallel progressions and the total number of sentences they produced. It may be that a significant increase in the students' use of the fit prompt could have contributed to this increase in extended parallel progressions, as both are related to the issue of topical structure and text coherence.
7.2. Task Variation

Why were there consistent differences in the students' achievement between the technical description tasks and argument tasks? My interpretation is mainly that task demands differed greatly between the technical description and argument genres. However, the indications of writing development which appeared in the technical description tasks (outlined below) suggest that various process factors may account for the significant variance in the qualities of composing and texts produced in the two sets of tasks.

The main reason for profound differences in students' writing performance between the two tasks probably lies in the cognitive demands of each task, their familiarity for these students, and the students' interests. Generally speaking, technical description is the genre that engineering students tend to write most often in their academic courses (Bridgeman & Carlson, 1984), which most interests such students, and which does not require their having to cope with new or unfamiliar reading material. Argumentative writing usually requires more analysis and synthesis. Specifically, the argument tasks used in the present study consisted of a major reading component; the two reading articles on theories of engines are technical in their content and sophisticated in their language (both were originally published in the Scientific American). The technical description tasks were conventional kinds of student engineering writing regularly practised in their courses, whereas the argument tasks were intellectually demanding and added a major component of reading onto the writing. The argument task also derived from a course that these students had not yet taken, so they may not have yet practised this type of writing, nor may they have known how to put it into context. Moreover, in my discussion with the students during the tutoring, they seemed far more interested in becoming proficient engineers, especially
at writing brief technical tasks, than they were interested in writing expository or persuasive prose.

Table 7-2: Summary of Findings with Statistical Significance on Two Sets of Pre-Post Tasks

<table>
<thead>
<tr>
<th>Text Ratings</th>
<th>Technical Description Tasks</th>
<th>Argument Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topical Progression Analysis (in %)</td>
<td>Global quality (ESL Ratings)</td>
<td>Extended parallel progressions (increase)</td>
</tr>
<tr>
<td></td>
<td>Language Accuracy (ESL Ratings)</td>
<td>Total sentence counts (increase)</td>
</tr>
<tr>
<td></td>
<td>Language Appropriacy (ESL Ratings)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Content (Engineering professor A’s ratings)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Language Use (Engineering professor B’s ratings)</td>
<td></td>
</tr>
<tr>
<td>Topical Structure Analysis (in %)</td>
<td>Parallel progressions (increase)</td>
<td>Sentence type 3 (increase)</td>
</tr>
<tr>
<td></td>
<td>Extended parallel progressions (increase)</td>
<td>Sentence type 3-plus (increase)</td>
</tr>
<tr>
<td></td>
<td>Sequential progressions (decrease)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total word counts (increase)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total sentence counts (increase)</td>
<td></td>
</tr>
<tr>
<td>Process Data Analysis on the Use of Strategies (in %)</td>
<td>Total protocol statements (increase)</td>
<td>Total protocol statements (increase)</td>
</tr>
<tr>
<td></td>
<td>Total writing time (increase)</td>
<td>Total writing time (increase)</td>
</tr>
<tr>
<td></td>
<td>Pre-writing time (increase)</td>
<td>Drafting time (increase)</td>
</tr>
<tr>
<td></td>
<td>Use of Goals (increase)</td>
<td>Post-drafting revision time (increase)</td>
</tr>
<tr>
<td></td>
<td>Use of Fit (increase)</td>
<td>Use of Fit (increase)</td>
</tr>
<tr>
<td></td>
<td>Use of Rules (decrease)</td>
<td>Use of Single configurations (decrease)</td>
</tr>
<tr>
<td></td>
<td>Use of Single configurations (decrease)</td>
<td>Use of Single configurations (increase)</td>
</tr>
<tr>
<td></td>
<td>Use of Double configurations (increase)</td>
<td>Use of Triple-plus configurations (increase)</td>
</tr>
<tr>
<td></td>
<td>Use of Triple-plus configurations (increase)</td>
<td></td>
</tr>
<tr>
<td>Process Data Analysis on Knowledge-transforming (in %)</td>
<td>-Knowledge-telling (decrease)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Knowledge-transferring (increase)</td>
<td></td>
</tr>
</tbody>
</table>

In sharp contrast to the argument tasks, the students’ performance on the technical description tasks showed significant improvement in ratings of most aspects of their written texts (content, global quality, language accuracy/language use, and language appropriacy) (displayed in Table 7-2). The discrepancies between the ESL and engineering ratings probably reflect different expectations and perspectives on what constitutes "facility" in writing in English as a second language among members of different disciplines, a finding common in most prior research addressing this issue (Bogdanowicz, 1983; Hamp-Lyons, 1990; Kobayashi & Rinnert,
In previous studies involving writing in engineering (Bogdanowicz, 1983; Mendelsohn & Cumming, 1987; Nelson, 1988), engineering professors have unequivocally considered language use as the most important aspect of students’ effective academic prose. This may help explain why the chemical engineering professor A’s ratings on language use were consistently lower than the ESL instructors’ ratings and those of engineering professor B (who teaches humanities courses).

Despite these differences, the findings summarized in Table 7-2 make clear that the students performed more effectively in the post-tutoring technical description task than they did in the post-tutoring argument task. The data I have cannot explain exactly why this happened. But consideration of trends in all of the data collectively may indicate how it did, pointing toward important relations between composing processes, knowledge-transforming behaviors, and text qualities. The possible links between these elements are shown in Figure 7-1. In the technical description tasks, these students seem to have increased the problem-solving effort they devoted to (a) knowledge-transforming behaviors, (b) complex representations of the writing tasks, (c) advance planning of their texts, (d) a goal-directed approach while composing (i.e., throughout the writing process), while (e) reducing their attention to rules about the second language. As a consequence, these behaviors appear to be associated with their producing written texts that raters uniformly agreed were more effective and which displayed indications of greater topical depth and semantic text cohesion (as increased parallel progressions, increased extended parallel progressions, increased total number of words, and decreased sequential progressions in the topical progression analysis, as well as increased uses of sentence types 2, 4, and 4-plus in the topical structure analysis). These complexassociations point toward certain correspondences
between students' cognitive processes and quality of their written texts (cf. Cumming, 1989; Jacobs, 1982), and suggest where future inquiry may look to find causal relations between the two in reference to learners' development in ESL contexts (Cumming, 1989, 1990a, 1995a). The precise nature of these relations, however, cannot be derived from the main analyses I undertook, but rather are suggested by some of the case study data and trends in the technical description task only. Moreover, these interpretations need to be qualified by considerations of variability in individual students' prior experiences and abilities as well as their relative lack of experience with the genre of writing associated with reading then composing an argument.

Figure 7-1: Effective Process Components in the Technical Description Tasks

![Diagram of Effective Process Components in the Technical Description Tasks]
7.3. Implications

7.3.1. Implications for Future Research on Second Language Writing

Three limitations of the study need to be highlighted and resolved in future research. First, discrepancies in text rating criteria and academic expertise between members of the same or different faculties pose the question of which set of rating results reflects more accurately the quality of texts produced by ESL engineering students. Such discrepancies in rating criteria could be resolved by having different faculty members rate compositions according to their expertise (i.e., engineering professors rate content, and ESL teachers rate language use), though this would probably still produce variation related to readers’ interpretive processes and prior experiences.

Second, the five sentence types in Lautamatti’s (1978) topical structure analysis present only a general, not a comprehensive, view of syntactic complexity in students’ written texts. These five sentence types do not include all sophisticated sentence types evident in authentic texts (Connor & Farmer, 1990; Witte, 1983). Although this limitation was resolved, for short term uses in the present study, by achieving consistency in coding between two coders, future research needs to expand on these five sentence types to give a more accurate picture of syntactic complexity in students’ texts (e.g., to differentiate and analyze sentences with relative clauses embedded). Accordingly, a need for modification also applies to Lautamatti’s topical progression analysis, as both kinds of analysis are closely related to identification of topical subjects and mood subjects in sentences.

Third, there are limitations in using concurrent think-aloud protocols to analyze
changes in students' cognitive processes during interventions such as procedural facilitation. Their obvious advantage is to provide concurrent information on the thinking processes that people use while they compose. However, instead of reflecting a comprehensive manifestation of students' cognitive processes while composing, thinking aloud may also exhibit the following shortcomings: slowing down students' writing-thinking processes (Ericsson & Simon, 1984), creating reactivity problems (Janssen, van Waes & van den Bergh, 1996; Stratman & Hamp-Lyons, 1994), or eliciting "a hidden social dialogue" between students and researchers or instructors (Smagorinsky, 1997). However, as some researchers have noted, these problems can be addressed by taking caution that the reactivity of thinking-aloud varies with tasks, and noting that knowledge-transforming tasks tend to elicit more informative protocols than do knowledge-telling tasks (Janssen, van Waes & van den Bergh, 1996). The fact that the present study utilized two sets of writing tasks that required high levels of knowledge-transforming might have helped to amend any alterations in students' cognitive processes while composing aloud. Likewise, it was difficult for me to perceive if the problem of "a hidden social dialogue" appeared in the present study, but the very few "dialogues" evident in the students' thinking-aloud mainly referred to non-writing procedures (e.g., "Excuse me, let me have a sip (of the drink) first"). But of course, the fact that I was both the researcher as well as the tutor and that I had maintained a very friendly relationship with the students might have introduced some uncontrolled variables such as researcher expectancy and subject expectancy into the study, and as a consequence, might have affected the internal validity of the findings. Regarding the problem of "reactivity", the present findings obtained from both think-aloud data and tutoring data cannot tell for certain whether the students were really improving in their thinking about the writing, or if they were
just getting better or more adept in verbalizing the use of heuristic strategies. This is an inherent difficulty with such data, particularly in a longitudinal study.

In the future, alternative research designs or analyses should be considered. For instance, further research can usefully be undertaken to verify the effectiveness of procedural facilitation of five heuristic strategies by considering: first, the unique contributions of individual prompts in different phases of writing, to inform and verify how certain aspects of ESL writing development may be amenable to individual prompts; second, the effects "with" procedural facilitation and "of" procedural facilitation (Englert et al., 1991), to understand the efficacy of procedural facilitation with different levels of provision and under different conditions; third, to assess the issue of transferability (extending to situations for writing in which a researcher is not present), a generally contentious issue in disputes over domain-general and domain-specific orientations to writing (Carter, 1990; Smagorinsky & Smith, 1992); and fourth, the issue of strategy retention or durability, another point of theoretical contention (Carter, 1990; Smagorinsky & Smith, 1992). Likewise, alternative analyses of students' written texts should be pursued. One alternative could be to collaborate with engineering experts to assess important pre-post changes in students' writing (as in Bogdanowicz's, 1983, study).

Despite its limitations, the present research reveals the importance of conducting constrained, longitudinal studies with a case study approach. To see the effects of procedural facilitation, it is imperative to trace students' learning processes and writing development over lengthy periods, such as an academic term. More case studies are required to examine thoroughly the effects of procedural facilitation and to provide detailed information on individual differences. The present study also highlights the importance of using constrained training
studies to permit precise and conspicuous assessment of the effects of procedural facilitation of heuristic strategies.

Another methodological implication pertains to the importance of using multiple genres, tasks and assessment measures. The present findings regarding task variation have important implications. Foremost, for assessment purposes, it is necessary to ask students to write more than one genre of task to sample accurately their writing development and learning, or to include more than a single task to assess adequately effects of intervention studies like the present research (Peyton et al., 1990). Regarding measures for assessing writing performance, the results of the present study imply that it is necessary for future research to use a combination of measures to assess ESL writing development. On the one hand, a combination of measures provides converging evidence about ESL writing performance and development, and on the other hand, it meets increasing concerns about what measures can adequately account for writing assessment in a second language (Cumming, 1990b, 1990c, 1995b, in press).

7.3.2. Implications for Second Language Writing Instruction

Theoretically as well as empirically, the present study suggests and documents the importance of adopting a comprehensive, holistic perspective on the textual, cognitive, and contextual nature of writing. Little, if any, previous instructional research has tried to embrace all three in respect to second language writing. Existing research has mostly focused on only one of these issues, and is, as a consequence, too partial to inform how instruction, either in a classroom situation or in a tutoring situation as in the present study, can enhance both the processes and products of ESL writing development (see discussion on approaches to instruction
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in second language writing in section 1.2.).

Though there are distinctions between instruction in a classroom situation and in a tutoring situation, and in the present study the ESL teacher failed to incorporate this strategy training into her regular classroom instruction, I have assumed that second language writing instruction should avoid exclusively teaching isolated, discrete skills, making the writing process fragmented, or simply embracing ESP (English for Specific Purposes) regardless of learners' academic levels and second language proficiency. Instead, I suggest that second language writing instruction should attend to all three aspects, focusing not only on the written product (e.g., by including heuristics on knowledge of form such as "rules" and "word"), but also the writing process (e.g., by embedding the teaching of cognitive strategic processes, the five thinking prompts, in the writing process) and the literacy context (e.g., by using writing tasks and topics pertinent to the students' disciplinary knowledge, in this case, engineering, and relevant to their interests and writing abilities). This kind of instruction is akin to the "generalized ESP" approach to second language writing instruction. On the one hand, it recognizes the importance of general English skills which many faculty members regard as crucial for effective academic writing performance and competent professional development (Braine, 1995; Johns, 1981; Mendelsohn & Cumming, 1987; Nelson, 1988; the present study). On the other hand, it addresses the needs of learners who are both inexpert ESL writers and novice learners in a new discourse community.

Another theoretical as well as empirical implication of the present study pertains to disputes over strategies in second language writing instruction. The present study exemplifies that instructional efforts should be made to embed the teaching of strategies in specific academic contexts (e.g., engineering). Also, learners need to be cognizant of the applicability of different
strategies. For ESL inexpert writers, task-general heuristic strategies probably have to be made accessible in some way. Based on the present findings, there appear to be strong reasons to promote the teaching of heuristic strategies like the five thinking prompts to ESL inexpert writers. These five prompts are simple, effective, and easily internalized. They embed modeling of cognitive, metacognitive, and self-regulatory processes which are seminal to cognitive competence and effective writing performance in academic studies. But as learners progress, more sophisticated knowledge of form, either domain-general or domain-specific, should be embedded in such heuristic strategies. In other words, second language writing instruction needs to be comprehensive and tailored to writers' "zones of proximal development".

Empirically, an important implication of the present study is to augment our understanding of procedural facilitation as a potentially valuable instructional method for ESL writing. Despite equivocal findings in my main analyses related to task variation, inspection of my case study data show tendencies for students to engage in sophisticated self-regulation, problem finding and solving, and knowledge-transforming in their post-tutoring writing processes. My case study profiles also show tendencies for students to develop greater diagnostic, evaluative and remedial capacities over time. Importantly, since the present findings indicate that students made varied improvements (according to individual differences) in their writing as well as in their strategy use during their tutoring procedures, it appears that procedural facilitation has the potential to be an effective instructional tool, depending on individual needs. The present study also shows that cognitive processes such as reflective thinking and self-monitoring can be minimal or non-existent without prompting. Thus, simply setting tasks that may require writing to learn may not have transforming effects on students' writing-thinking processes (Ackerman,
1993), such as procedural facilitation. Prompting may be necessary, or other forms of direct instruction called upon.

A final implication for teachers of ESL writing pertains to the need to collaborate with other academic faculties. The interviews with engineering professors who were first-year course coordinators in the present study showed that it is both beneficial and necessary for ESL writing teachers (in a one-to-one instruction setting or in a classroom situation) or ESL writing tutors (in a university setting like the present study) to collaborate with disciplinary experts to gain information on what general English writing skills ESL students most need, what domain-related writing topics are relevant and feasible, and what criteria are used in judging students' disciplinary texts. Such information can certainly help ESL teachers and ESL tutors in creating suitable writing contexts to foster in ESL inexpert writers their development of writing expertise.
References


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and Communication, 36, 404-413.


presented at TESOL 1992, Vancouver, Canada.


# Appendix A

## Scale for Rating Texts

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<table>
<thead>
<tr>
<th>Global scale</th>
<th>Band descriptor</th>
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<tbody>
<tr>
<td>9</td>
<td>The writing displays an ability to communicate in a way which gives the reader full satisfaction. It displays a completely logical organizational structure which enables the message to be followed effortlessly. Relevant arguments are presented in an interesting way, with main ideas prominently and clearly stated, with completely effective supporting material; arguments are effectively related to the writer's experience or views. There are no errors of vocabulary, spelling, punctuation or grammar and the writing shows an ability to manipulate the linguistic systems with complete appropriacy.</td>
</tr>
<tr>
<td>8</td>
<td>The writing displays an ability to communicate without causing the reader any difficulty. It displays a logical organizational structure which enables the message to be followed easily. Relevant arguments are presented in an interesting way, with main ideas highlighted, effective supporting material and they are well related to the writer's experience or views. There are no significant errors of vocabulary, spelling, punctuation or grammar and the writing reveals an ability to manipulate the linguistic systems appropriately.</td>
</tr>
<tr>
<td>7</td>
<td>The writing displays an ability to communicate with few difficulties for the reader. It displays good organizational structure which enables the message to be followed without much effort. Arguments are well presented with relevant supporting material and an attempt to relate them to the writer's experience or views. The reader is aware of some errors of vocabulary, spelling, punctuation or grammar, and/or some limitations in the writer's ability to manipulate the linguistic systems appropriately.</td>
</tr>
<tr>
<td>6</td>
<td>The writing displays an ability to communicate although there is occasional strain for the reader. It is organized well enough for the message to be followed throughout. Arguments are presented but it may be difficult for the reader to distinguish main ideas from supporting material; main ideas may not be supported; there may be significant errors of vocabulary, spelling, punctuation or grammar, and/or some limitations in the writer's ability to manipulate the linguistic systems appropriately, but these errors occur occasionally.</td>
</tr>
<tr>
<td>5</td>
<td>The writing displays an ability to communicate although there is often strain for the reader. It is organized well enough for the message to be followed most of the time. Arguments are presented but may lack relevance, clarity, consistency or support; they may not be related to the writer's experience or views. The reader is aware of errors of vocabulary, spelling, punctuation or grammar which occur frequently, and of limited ability to manipulate the linguistic systems appropriately, but these errors occur occasionally.</td>
</tr>
<tr>
<td>4</td>
<td>The writing displays a limited ability to communicate which poses strain on the reader throughout. It lacks a clear organizational structure and the message is difficult to follow. Arguments are inadequately presented and support; they may be irrelevant; the writer's experience or views are presented in a way that may be difficult to see. The control of vocabulary, spelling, punctuation and grammar is inadequate, and the writer displays inability to manipulate the linguistic systems appropriately, causing severe strain for the reader.</td>
</tr>
<tr>
<td>3</td>
<td>The writing does not display an ability to communicate although meaning emerges through occasionally. The reader cannot find any organizational structure and cannot follow a message. Some elements of information are present but the reader is not provided with an argument, or the argument is mainly irrelevant. The reader is primarily aware of gross inadequacies of vocabulary, spelling, punctuation and grammar; the writer seems to have no sense of linguistic appropriacy, although there is evidence of sentence structure.</td>
</tr>
<tr>
<td>2</td>
<td>The writing does not display an ability to communicate. No organizational structure or message is recognisable. A meaning comes through occasionally but it is not relevant. There is no evidence of control of vocabulary, spelling, punctuation or grammar, and no sense of linguistic appropriacy.</td>
</tr>
<tr>
<td>1</td>
<td>A non-writer who has not produced any acceptable usage of English writing. An answer which is wholly or almost wholly copied from the input text or test is in this category.</td>
</tr>
<tr>
<td>COMMUNICATIVE QUALITY</td>
<td>ORGANISATION</td>
</tr>
<tr>
<td>------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>9. The writing displays an ability to communicate in a way which gives the reader full satisfaction.</td>
<td>The writing displays a completely logical organisational structure which enables the message to be followed effortlessly.</td>
</tr>
<tr>
<td>8. The writing displays an ability to communicate without causing the reader any difficulties.</td>
<td>The writing displays a logical organisational structure which enables the message to be followed easily.</td>
</tr>
<tr>
<td>7. The writing displays an ability to communicate with few difficulties for the reader.</td>
<td>The writing displays good organisational structure which enables the message to be followed throughout.</td>
</tr>
<tr>
<td>6. The writing displays an ability to communicate although there is occasional strain for the reader.</td>
<td>The writing is organised well enough for the message to be followed throughout.</td>
</tr>
<tr>
<td>1. A text non-writer who has not produced any assessable marking of English writing. An answer which is wholly or almost wholly copied from the input test is in this category.</td>
<td></td>
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<td>---</td>
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<tr>
<td>2. The writing displays no ability to communicate.</td>
<td></td>
</tr>
<tr>
<td>No organisational structure or message recognisable.</td>
<td></td>
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<tr>
<td>A meaning comes through occasionally but it is not relevant.</td>
<td></td>
</tr>
<tr>
<td>The reader sees no evidence of control of vocabulary, spelling, punctuation or grammar.</td>
<td></td>
</tr>
<tr>
<td>There is no sense of linguistic appropriacy.</td>
<td></td>
</tr>
<tr>
<td>3. The writing does not display an ability to communicate although meaning comes through spasmodically.</td>
<td></td>
</tr>
<tr>
<td>The writing has no discernible organisational structure and a message cannot be followed.</td>
<td></td>
</tr>
<tr>
<td>Some elements of information are present but the reader is not provided with an argument, or the argument is mainly irrelevant.</td>
<td></td>
</tr>
<tr>
<td>The reader is primarily aware of gross inadequacies of vocabulary, spelling, punctuation and grammar.</td>
<td></td>
</tr>
<tr>
<td>There is little or no sense of linguistic appropriacy, although there is evidence of sentence structure.</td>
<td></td>
</tr>
<tr>
<td>4. The writing displays a limited ability to communicate which puts strain on the reader throughout.</td>
<td></td>
</tr>
<tr>
<td>The writing lacks a clear organisational structure and the message is difficult to follow.</td>
<td></td>
</tr>
<tr>
<td>Arguments are inadequately presented and supported; they may be irrelevant; if the writer's experience of views are presented their relevance may be difficult to see.</td>
<td></td>
</tr>
<tr>
<td>The reader finds the control of vocabulary, spelling, punctuation and grammar inadequate.</td>
<td></td>
</tr>
<tr>
<td>There is inability to manipulate the linguistic systems appropriately which causes severe strain for the reader.</td>
<td></td>
</tr>
<tr>
<td>5. The writing displays an ability to communicate although there is often strain for the reader.</td>
<td></td>
</tr>
<tr>
<td>The writing is organised well enough for the message to be followed most of the time.</td>
<td></td>
</tr>
<tr>
<td>Arguments are presented but may lack relevance, clarity, consistency or support; they may not be related to the writer's experience or views.</td>
<td></td>
</tr>
<tr>
<td>The reader is aware of errors of vocabulary, spelling, punctuation or grammar which intrude frequently.</td>
<td></td>
</tr>
<tr>
<td>There is limited ability to manipulate the linguistic systems appropriately which intrudes frequently.</td>
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Appendix B


(A) **Topical Progression Analysis** is for analyzing topical development in written discourse: According to Lautamatti (1978, cf. Conner & Kaplan, 1987), "sentences in discourse can be thought of as contributing to the development of the discourse topic by means of sequences that first develop one sub-topic, adding new information about it in the predicate of each sentence, and then proceed to develop another (Connor & Kaplan, 1987, p. 88)."

(B) **Topical Structure Analysis** is for analyzing 5 sentence types:

Type 1. Initial sentence element (ISE), mood subject and topical subject coincide.

Type 2. Initial sentence element (ISE) is separated from mood subject and topical subject, which coincide.

Type 3. Initial sentence element (ISE) and mood subject coincide while topical subject is separate.

Type 4. Initial sentence element (ISE) and topical subject coincide, while mood subject is separate.

Type 5. Initial sentence element (ISE), mood subject and topical subject are all separate.

According to Lautamatti (1978, cf. Connor & Kaplan, 1987), a *topical subject* "is structurally in the position of the subject in a thematically unmarked affirmative clause; it is a lexical subject as opposed to a mere structural dummy, and it is the psychological subject of the clause in the sense that it represents what the clause is about" (Connor & Kaplan, 1987, p. 88); "if a lexical subject is related directly to the discourse topic, we shall call it the topical subject while subjects that are not directly related to the discourse topic are called non-topical subjects" (p. 89). A *mood subject* can be "structural dummies, such as there is an existential clause, and lexical or notional subjects" (Connor & Kaplan, 1987, p. 89). The term *initial sentence element (ISE)* refers to "the initially placed discourse material in sentences, whatever its form or type" (Connor & Kaplan, 1987, p. 91).

The following is the original text/example from Lautamatti, showing topical subjects (*in italics*) and sentence types (*in bold numbers)*:
(4) When a human infant is born into any community in any part of the world, it has two things in common with any other infant provided neither of them has been damaged in any way either before or during birth. (2) Firstly, and most obviously, new born children are completely helpless. (5) Apart from a powerful capacity to draw attention to their helplessness by using sound, there is nothing the new born child can do to ensure his own survival. (2) Without care from some other human being or beings, be it mother, grandmother, sister, nurse, or human group, a child is very unlikely to survive. (1) This helplessness of human infant is in marked contrast with the capacity of many new born animals to get to their feet within minutes of birth and run with the herd within a new hours. (4) Although young animals are certainly at risk, sometimes for weeks or even months after birth, compared with the human infant they very quickly develop the capacity to fend for themselves. (3) It would seem that this long period of vulnerability is the price that the human species has to pay for the very long period which fits man for survival as species. (3) It's during this very long period in which the human infant is totally dependent on others that it reveals the second feature which it shares with all other undamaged human infants, a capacity to learn language. (5) For this reason, biologists now suggest that language is species specific to the human race, that is to say, they consider the human infant to be genetically programmed in such a way that it can acquire language. (3) This suggestion implies that just as human beings are designed to see three-dimensionally and in colour, and just as they are designed to stand upright rather than to move on all fours, so they are designed to learn and use language as part of their normal development as well-formed human beings.

Topical Progression in Lautamatti's Original Text

<table>
<thead>
<tr>
<th>Sentence No. &amp; Topical Depth</th>
<th>Sub-topic No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. human infant</td>
<td>1</td>
</tr>
<tr>
<td>2. children (II)</td>
<td>1</td>
</tr>
<tr>
<td>3. child (II)</td>
<td>1</td>
</tr>
<tr>
<td>4. child (II)</td>
<td>1</td>
</tr>
<tr>
<td>5. this helplessness (S)</td>
<td>2</td>
</tr>
<tr>
<td>6. animals (S)</td>
<td>3</td>
</tr>
<tr>
<td>7. this period of (S)</td>
<td>4</td>
</tr>
<tr>
<td>8. it (Ex)</td>
<td>1</td>
</tr>
<tr>
<td>9. learning language (Ex)</td>
<td>3</td>
</tr>
<tr>
<td>10. human beings (Ex)</td>
<td>1</td>
</tr>
</tbody>
</table>
The following lists five sentence types with examples extracted from the texts of participants in my research:

Type 1. ISE = topical subject = mood subject

Greenhouse-gas emission and more advanced fossil-energy technology (ISE = topical subject = mood subject) are under development in Canada.

Type 2. ISE ≠ topical subject = mood subject

Recently (ISE), a new system (topical subject = mood subject) is just being applied.

Type 3. ISE = mood subject ≠ topical subject

It (ISE = mood subject) is proved by practice that the content of CO₂ (≠ topical subject) reduces quickly in the cycle.

Type 4. ISE = topical subject ≠ mood subject

When the water (ISE = topical subject) is heated enough to become steam, it (≠ mood subject) goes to the steam turbine.

Type 5. ISE ≠ topical subject ≠ mood subject

Therefore (ISE), it (mood subject) can be say that Diesel's engine (topical subject) is partially successful.
Appendix C

Operational Definitions and Protocol Examples of The Five Configurations

Single Configurations. Single configurations are the basic categories of the coding scheme - five mutually exclusive categories representing the five strategies/thinking prompts or discrete aspects of writing participants make references to while composing. In some instances, participants actively apply a particular strategy/thinking prompt during their writing process - for planning, structuring or assessing the written discourse, in identifying a problem encountered while writing, for making heuristic searches or reaching resolutions. Explicit mentioning of one of the five thinking prompts is apparent; and issues addressed in this manner involve both global and local aspects of writing. In other instances, participants implicitly attend to one of the five aspects of writing instead of explicitly mentioning or actively applying a particular strategy. Participants either demonstrate the use of directed mental effort and heuristic searches, or implicitly identify and solve a problem automatically while planning, composing, or revising their written discourse. Issues addressed in this manner involve more often local aspects of grammatical conventions or lexical expressions than global concerns of writing.

Goal - These protocol statements indicate participants are either attending to something they want to achieve through their writing - in respect to the global purposes of their writing and/or to the local goals of formulating, considering, and structuring content in their written discourse; or trying to set and monitor goals to accommodate readers of their writing:

Ah, so, my goal is ah, explain how it works and ah, why it is an efficient way for controlling CO₂ emission./ (Peter, post-tutoring technical description, 2:14, 1st side of tape)

Ah, the introduction should be, of course, adjust to the reader, and um, but um, what does it tell the reader? What should I tell the reader in the first paragraph? Of course, I need to mention that it’s a./ (Charles, post-tutoring technical description, 22:18, 1st side of 1st tape)

Fit - In these statements participants are focusing on assessing the relationship between parts of their written discourse, often ideas forming the substantive content of their writing, either individually or collectively by attending to the overall coherence of text in
reference to goals, discourse organization, or the relationship between text and diagram/figure:

The conclusion is, don't have to tell if the theory is, ah, does this part fit the whole piece of writing? (Simon, post-tutoring argument task, 43:15, 1st side of 1st tape)

I can't see how it can relate it back to the figure on the ah, back to the schematic figure./ (Charles, post-tutoring technical description, 15:53, 1st side of tape)

**Rule** - In these statements participants are focusing on grammatical, punctuation or orthographic conventions. They either resolve the problem automatically or by engaging in more extensive thinking processes with explicit or implicit reference to a grammar, punctuation, or spelling rule. In some cases, no resolution is made:

One is leading to the chimney, and how to spell the word chimney? Ah, is it m m e y? One is leading to the chimney./ (Charles, post-tutoring technical description, 15.36, 2nd side of 1st tape)

by the burner, by the burner, by a burner/ (Simon, post-tutoring technical description, 42:50, 1st side of tape)

**Word** - In these statements participants are attending to the semantics of particular vocabulary items or lexical expressions, either explicitly or implicitly evaluating their appropriateness, qualities, or desirability, or checking their redundancy:

ah, will be disposed. Is there a better word for disposal? disposal/ (Simon, post-tutoring technical description, 4:38, 2nd side of tape)

contains recycled steam, and give, and it ah, enter it. What, what is another word for enter? I suppose not to repeat that word over and over again./ (Lorraine, post-tutoring technical description, 29:12, 1st side of 2nd tape)

**L1-L2** - In these statements participants use direct translation or code-switching for finding, generating, structuring, or assessing an element or elements in the text. Sometimes they focus on the lexical, comparing equivalent word or expression choices in their first and second languages. In many instances, they simply code-switch to express their thoughts or ideas forming the content of
their writing:

has fewer chance has left, has left #fewer chances#, few chance has, #fewer chances, what's that? Let me try to say in Chinese#, has less/ (Henry, post-tutoring technical description, 26:42, 2nd side of tape)

four step mixing compressing and# explode, #and# reacting/ (William, post-tutoring argument task, 0:47, 2nd side of 1st tape)

**Double Configurations.** In statements showing double configurations participants attend to two of the five strategies or discrete aspects of writing defined and exemplified above.

**Goal/Fit** - In these statements participants assess the relationship between parts of their written discourse, either individually or collectively by attending to the overall coherence of text in reference to the global or local goals of their writing:

(Read article) I think, not, the first, the first thing I am going to write is about the theory, the theory itself, itself. It's very, at, after all, um, after all, I compare the two engines. I think, and from that, I control, I can tell clearly that whether if, if ah, effective in, and ah, in the engine or not. Okay, um, how’s, better, okay fit. Okay, I think that the device from.../ (Lorraine, post-tutoring argument task, 11:00, 1st side of 1st tape)

**Goal/Rule** - In these statements participants' attention focuses on the linguistic code - grammatical, punctuation or orthographic conventions - in conjunction with the global and/or local objectives of the written discourse they intend to achieve. They either resolve the grammatical problem automatically or by engaging in more extensive thinking processes with explicit or implicit reference to a grammar rule:

now um, now I have to make it the same. Okay, um, okay, now the first thing to do is say introduction. Um, first, thesis statement here, the success of Diesel’s engine meant partial success of the, of the theory that guided him because some of his theory based on Carnot were too ideal to be put in reality, that is, there must be some differences between his ideal machine and there are, there were some major/ (Lorraine, post-tutoring argument task, 16:20, 1st side of 1st tape)

**Goal/Word** - These statements show participants making references
to the objectives of their writing and choices of lexical expression simultaneously. In some instances, participants’ attention to the aspect of goals is interacting with their attention to word and expression choices:

the introduction should be, of course, adjust to the reader. Um, adjust to the reader, and um, but um, what does it tell the reader? What should I tell the reader in the 1st paragraph? Of course, I need to mention that it’s a, the power plant is a efficient and say it’s a, and I have to mention about the ah, the process, the stage of the power plant. So I have to to have the word efficient in it, and the stage and something to do with the operation of the power plant. So you are working as an engineer in the research in greenhouse bla, bla, bla ah development. CEO asks you to write a technical description on the schematic of an advanced coal ah. (Charles. post-tutoring technical description, 22.20, 1st side of 1st tape)

Goal/L1-L2 - In these statements participants express in both L1 and L2 specific global or local goals they wish to achieve in their written discourse, setting and monitoring goals to accommodate readers of their writing:

Oh yeah, if this technical description is written to the# boss, "he must know this (power plant) is an# efficient way. #But if I am going to# explain #this to the# colleagues, #I must explain some (reasons why it is an efficient way for controlling CO₂ emission), um#. (Henry, post-tutoring technical description, 10:20, 1st side of 1st tape)

Fit/Rule - In these statements participants attend either explicitly or implicitly to the linguistic code and the fit between some units of discourse simultaneously:

I think there should be the point here, add to there; stay hot and not quite, to a fluid, with the fluid so that they make it.../ (Lorraine, post-tutoring argument task, 44:44, 1st side of 1st tape)

Fit/Word - In these statements participants compare individually or collectively different units of discourse, while attending simultaneously to the desirability of some vocabulary items or lexical expressions. In some instances, participants’ attention to the fit between parts of the written discourse is interacting with their attention to the lexical choices. They try to justify their word
or expression choices on the basis of the content they intend to express:

It can be seen that the green, that the chemicals, ah it can be seen that the, okay, no, that’s not such a good opening paragraph sentence. Ah, the opening paragraph sentence must relate back to the ah, must relate back to the 1st paragraph, introduction; and it must ah, contain the word efficient in it. This ah system/ (Charles, post-tutoring technical description, 39.55, 1st side of 2nd tape)

Fit/L1-L2 - Here participants code-switch as they attend to the coherence of text by comparing units of discourse individually or collectively to make a decision:

Nowadays the greenhouse effect has become one of the major concerns in human society. #This is completely out of topic, can’t be connected to the following, um, not coherent#. (William, post-tutoring technical description, 46:26, 1st side of 1st tape)

Rule/Word - These statements indicate participants’ attention focus on grammatical/orthographic conventions in conjunction with the semantics of particular vocabulary items or lexical expressions:

filter, okay. How is filter spell? F i l t e r, I think. Ah, I guess so. The chimney is screened by a filter that only ah, that, is screened by a filter that only allows, that only permit/ (Charles, post-tutoring technical description, 20:20, 2nd side of 1st tape)

Rule/L1-L2 - In these statements participants code-switch as they attend to grammatical, orthographic or punctuation conventions. They either automatically resolve the grammatical error or explicitly identify the problem in reference to a grammar rule before engaging in more extensive thinking processes:

Ah, #should use# can, can themselves, #don’t use# could, #wrong#, present tense, can themselves work as a shock-absorbing function in order to avoid the effect of undesirable explosion, um./ (Leo, post-tutoring argument task, 37:04, 1st side of 2nd tape)

Word/L1-L2 - In these statements participants code-switch in attending to the semantics of particular vocabulary items or lexical expressions, searching for alternatives, evaluating their appropriateness, or checking any redundancy:
success, #any other word with the same meaning? This writing has a lot of redundancy (in word choices)#. (Referred to a dictionary) success, s u c c, success/ (Bernard, post-tutoring argument task, 15:51, 1st side of 1st tape)

*Triple Configurations.* In statements demonstrating triple configurations participants refer to three of the five strategies or aspects of writing. Verbalization of thoughts in these statements is usually longer, and hence involves a wider range of references. Only one example is provided for each category below since the five fundamental categories have been defined and exemplified in the preceding configurations.

**Goal/Fit/Rule**
Diesel ideal engine and his real one/ um, is that all? This made Diesel’s engine successful, although there were some major differences between Diesel’s ideal engine and his real one. Okay, that’s very short. Now um./ (Lorraine, post-tutoring argument task, 23:52, 2nd side of 1st tape)

**Goal/Fit/Word**
okay, so, this paragraph somehow connected to the first one, but haven’t to be, but is better to be. So I should say, this process, this process of ah converting, this process of converting ah coal into electricity is ah, is an efficient, an efficient ah, is an efficient method to, this process of converting coal into electricity is an efficient method of ah, is an efficient method of ah, I want to say that it’s an efficient method of ah, of outputting, is an efficient way of ah producing electricity and at the same time an efficient, no, I should not mention about the electricity, since in this paragraph I, I will be only mentioning CO₂ emission. Okay, so, this process of converting coal into electricity is an efficient method of ah controlling, of controlling ah CO₂ emission. (Reread the sentence) I should say this, let’s see./ (Charles, pre-tutoring technical description, 20:04, 2nd side of 1st tape)

**Goal/Fit/L1-L2**
#Oh yeah. I can write one more# point, #to say it is a# way of reaction #which would# increase, #because it uses# reducing gas. #Um, um, if it’s this one, it would achieve a high effect; but#, people, #would people understand what I say? yes, they would#, because those reader #is the# boss #only. He knew so much. Um um, but can I skip one step in the process? No. It’s# okay. In conclusion, it is better to use the new system because/ (Henry, post-tutoring technical description, 16.00, 1st side of 1st tape)
Ah, what's the terminology for the start of the cycle has two distinct requirements. Ah, at the start, has two distinct requirement. The first require, first, the start, forward thrust of the piston with the piston must ah, okay, hang on. I want to say that ah a large heat reservoir is in contact with the cylinder head and heat follow, flowing from it into the working fluid causes the fluid to expand isothermally. Ah, okay, the theory that Diesel hope to incorporate into his engine has two distinct requirements. The first, has two distinct requirement. Ah, in the start/ (Charles, post-tutoring argument task, 16:20, 1st side of 1st tape)

#and# why it is an efficient way to control, for controlling CO emission. #This one is very important# - CO₂ emission. #Let me erase and rewrite it#. Um, okay, reader, boss and colleagues, technical description. (Bernard, post-tutoring technical description, 2:45, 1st side of 1st tape)

After the cleanup process, the hot-gas, #how to say this? This# step #can# produce electricity. #I want the following to mention things about# electricity. (William, post-tutoring technical description, 6:30, 1st side of 2nd tape)

into, updating the current electric power plant, the proposed, into, no, no, if I change it to updating, I will have to change too much of, of the rest of the writing. So, push our company has a, push our company into um, okay, who care, redesigning, redesigning ah, the, has, redesigning the, has pushed our company into redesigning ah the entire power, electric power plant, power plant, okay. The pose, proposed design utilizes an advanced flue-gas desulphurization system, this particular system was highly efficient for reducing CO₂ gas emissions, um, the stages that ah, the stages are very, there are three stage, the proposed design utilizes an advanced flue-gas desulphurization system/. (Charles, post-tutoring technical description, 35:32, 1st side of 2nd tape)

#Then, this last paragraph, does it# fit? #Would there be anything (unfit)? Um, the# thesis statement #is not yet finished. But I don’t
Quadruple Configurations. These statements where participants attend to four of the five fundamental categories appear less frequently in the data.

Goal/Fit/Rule/Word
before it, okay, but I will tell this to the reader and, could the reader relate this back to the ah, to the 1st paragraph of the description of its stages? That's the problem. That might be a problem. It might be, the reader may find this too confusing. But I'll just leave it for now. Thus a great percentage of ah, of bla, bla gases and all gases are capture, are captured before it ah finds its way, before it is disposed of, posed of, disposed of, okay. (Charles, post-tutoring technical description, 8.11, 1st side of 2nd tape)

Goal/Fit/Rule/L1-L2
#Actually don't need the word# and. The full operation of this new technology and its efficiency will be, will be, um, described as follows. Okay, #this, should be okay if it is for senior colleagues. It# fit #the whole piece of writing. Then, um, now write# topic sentence #to get into the second paragraph. Um#,/ (Charles, post-tutoring technical description, 42:08, 1st side of 1st tape)

Goal/Rule/Word/L1-L2
Okay, #finish writing. Okay, now let me check if there's anything wrong here. Um, it starts with# greenhouse effect is one of the worst environmental problem in the world. #Ah, should be# problems. #Um, um#, okay, #nothing wrong#. The carbon dioxide, mainly produced in the, in generating, in the power plant generating because/ (Henry, post-tutoring technical description,
16:50, 2nd side of 1st tape)

**Goal/Fit/Word/L1-L2**
Okay, ah, um, inside the gasifier, coal is partially combusted and ash is separated and deposited to, to, to somewhere, #it seems too many these words# - gasifier, gasification, and gas. Ah, maybe I can use some other words or rephrase the sentences so that I don’t have to use so much gasifier, gasification stuff. Actually I can ah, omit inside the gasifier. I can say coal is partially combusted during process and the ash is separated, and ah, by saying deposited, I can say disposed. So people understand it is dumped and they don’t have to know where it goes and ah, it’s not the principle of this system. Then okay, and ah/ (Peter, post-tutoring technical description task, 23:20, 1st side of tape)

**Fit/Rule/Word/L1-L2**
will brings more revenue than before. #This one, um,# will brings more revenue than before. #Oh no. It can’t, it can’t be like this# - than the past, #I haven’t mentioned anything about how it was# in the past. #This part seems not connected. How’s the methodology in the past? I better say# the improved method is a rich investment, okay, is a rich investment. #This seems better. In this way, I don’t need to mention anything about# how it was in the past; #and it is coherent, and it’s really quite fit#. And it is important to the environment, the desulphurization system in the improved method, #no, should be# of, of the improved method, #should be# of. Can reduce rich gas, #not# will, #should be# can. Like SO\textsubscript{2} during the combustion process of coal, SO\textsubscript{2} can reduce for sulphur recovery. #No#, can be processed, #right#. By this reduction, each year, #not# each year, each year #is only# by this reduction. #Two hundred and sixty-six tons# of sulphur can be recovered each year. By this reduction, #two hundred and sixty-six tons# of sulphur can be recovered each year. #Should be like this, not# each year, #is after# each year. And it brings annually thirty million to whom possessed this system. (Henry, post-tutoring technical description, 0:50, 1st side of 2nd tape)

*Quintuple Configurations.* Only a few instances of these complex interactions between all five categories are evident in the protocol data:

**Goal/Fit/Rule/Word/L1-L2**
and reliable engine did not appear until #1920# when the fuel is perfect. However, the success of Diesel’s theory, #okay, this way is better, and people will understand more clearly#. Diesel’s theory...
that guided him did not mean. #ah, yes, I can use# the word# his since #I've already mentioned it. Diesel's engine meant or did not mean, did not mean the success of his theory that guided him because the combustion of Diesel engine is not isothermic, it is not reliable and economic, and some technical difficulties, #should be# technical difference, #Ah, no, how to say it#? Have some, have some technical differences, and are #extreme. No, don't talk about# technical; and some difference, and some differences, #okay#, differences, #don't talk about# difficulties, differences between the/ (Henry, post-tutoring argument task, 44:50-46:35, 1st side of 1st tape)
Appendix D

Operational Definitions and Protocol Examples of Knowledge-telling and Knowledge-transforming

Knowledge-telling. In these statements there is no indication of thinking which involves knowledge-transforming. Participants just tell their knowledge. They either (1) tell the knowledge they have about a topic (Cumming, 1988, p. 92), including reading information provided, or (2) restate/reread what they have written or any information provided. No process of higher level thinking such as problem solving behaviors, heuristic searches or decision making is apparent in these protocol statements, possibly because some participants use this immature strategy for generating content (Scardamalia & Bereiter, 1985; Cumming, 1989); or such higher level thinking has been called upon to deliberate over the search of content but has not been reported by some participants in their thinking-aloud while composing; hence they are not recoverable for the present analyses (Cumming, 1989).

**tells knowledge of a topic**

which is used in place of limestone, is distributed in the channel to absorb CO₂. It is proved by practice that the content of CO₂ reduces quickly in the cycle, in the cycle. (Simon, post-tutoring technical description, 29.45, 2nd side of tape)

**restates knowledge of a topic**

(Rereads this sentence) The reason is because there are two generators in this kind of plant instead of one. That means more power is generated. (William, post-tutoring technical description, 31.45, 1st side of 2nd tape)

Knowledge-transforming. In these statements participants engage in problem solving, heuristic searches and/or decision making while attending to the substantial content of their writing. Often conceptual and/or textual changes are apparent. Thus, extensive mental effort is applied to: (1) recognizing the topic/purposes of writing, (2) planning and/or structuring content, (3) processing and exploiting the topic (or diagram) for understanding, (4) making changes in domain-specific vocabulary or expression choices, (5) making conceptual changes by evaluating, adding or deleting possible content in reference to purposes of the written task, or (6) making conceptual changes because of ideational changes like adding, deleting or reordering sentences or paragraphs in reference to the relevancy, adequacy or coherence of content, (7) reviewing
content, or (8) making self-explanations or self-monitoring to justify conceptual changes made. Statements coded under this category show participants engaging in a dialectic process between conceptual and textual concerns (Bereiter & Scardamalia, 1987a), such that their attention to the substantive content is interacting with their attention to the rhetorical concerns of their written discourse.

recognizes the topic/purposes of writing

Okay, it doesn’t mean yes or no. So, first, I choose to say no. It doesn’t mean the success of the theory. So, we choose thesis statement/ (student 2, argument A, 13:18, 1st side of tape) This is a schematic of an advanced pulverized coal plant with an advanced flue-gas desulphurization system. #Actually I should also explain what that# flue-gas #means. I know how to explain it#. Flue-gas, #that means I don’t need to explain it#/ (Edward, post-tutoring technical description, 5:35, 1st side of 1st tape)

processes or exploits the topic, article or figure for understanding

The diagram, there’s some coal. This coal enters the burner. There’s air in the burner. Air, what does the ash do? (Henry, post-tutoring technical description, 4:42, 1st side of 1st tape)

plans and/or structures content

Um, then the second paragraph, about description, describe this thing. Um, yeah, topic sentence will say, ah, consists of two systems, one is the power plant, the other is this flue-gas cleanup, cleanup. Then discuss this/ (Henry, post-tutoring technical description, 24:34, 1st side of 1st tape)

makes surface changes in domain-specific vocabulary or expression choices

... now only called absorbed? Not absorbed, are/ filter, no, I’ve already used the word filter. Thus a great percentage of NOx, N₂O, CH₂ and CO₂ gases are absorbed,/ (Charles, post-tutoring technical description, 7:20, 1st side of 2nd tape)

makes conceptual changes by evaluating, adding or deleting possible content in reference to purposes of the written task

#Oh yeah, I can write one more# point, #to say it is a# way of reaction #which would# increase, #because it uses# reducing gas.
Um, um, if it is this one, it can achieve a high effect. But#, people, #will people understand what I say? Yes, they will, because the# reader #is a# boss #only. He knew so much. Um, in this way have I skipped one step of the process? No, it's# okay. In conclusion, it is better to use the new system because/ (Henry, post-tutoring technical description, 16:00, 2nd side of tape)

makes conceptual changes because of ideational changes like adding, deleting or reordering sentences or paragraphs in reference to the relevancy, adequacy or coherence of text

Oh no, this point should be put in the front, and that# economic point #should be there#. Today compression, ignition is considered a well defined characteristic. Um, ah, is it good? Ah, #addition, Diesel, ah, always insisted that/ (Henry, post-tutoring argument task, 24:44, 2nd side of 1st tape)

reviews content

(reread from beginning of text)/ the energy conversion from that into work was more or less the same. This made Diesel's engine more successful. Okay, I think it's okay. Thesis statement and the whole piece of writing, um, yeah, I think it's okay./ (Lorraine, post-tutoring argument task, 11:52, 2nd side of 2nd tape)

makes self-explanations or self-monitoring to justify conceptual changes made

okay, so, this paragraph somehow connected to the first one, but haven't to be, but is better to be. So I should say, this process, this process of ah converting, this process of converting ah coal into electricity is ah, is an efficient, an efficient ah, is an efficient method to, this process of converting coal into electricity is an efficient method of ah, is an efficient method of ah, I want to say that it's an efficient method of ah, of outputting, is an efficient way of ah producing electricity and at the same time an efficient, no, I should not mention about the electricity, since in this paragraph I, I will be only mentioning CO₂ emission. Okay, so, this process of converting coal into electricity is an efficient method of ah controlling, of controlling ah CO₂ emission. (Reread the sentence) I should say this, let's see./ (Charles, pre-tutoring technical description, 20:04, 2nd side of 1st tape)
Appendix E

Examples of Topical Progression Analysis in Students' Texts

Argument Task B  (Pre)  William

<table>
<thead>
<tr>
<th>Sentence No.</th>
<th>Topic Depth</th>
<th>No. of subtopics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2. Diesel's theory (S)</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>3. This theory (/)</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>4. Diesel (S)</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>5. Diesel's theory (Ex)</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>6. his theory and the invention of Diesel's engine (/ &amp; S)</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>7. Diesel's theory (/)</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>8. two major German firm (S)</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>9. Diesel's book (S)</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>10. This promotion (S)</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>11. Diesel's engine (S)</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>12. Diesel's engine (/)</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>13. Diesel's engine (/)</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>14. Diesel's engine (/)</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>15. most of them (/) &amp; S</td>
<td></td>
<td>6/7</td>
</tr>
<tr>
<td>16. the success of Diesel's engine (Ex)</td>
<td></td>
<td>1</td>
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</tbody>
</table>

(/) parallel progression
(S) Sequential progression
(Ex) Extended parallel progression
Argument Task A (Post)       William

<table>
<thead>
<tr>
<th>Sentence No.</th>
<th>Topic Depth</th>
<th>No. of subtopics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Nicolaus August Otto</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>This kind of engine</td>
<td>2</td>
</tr>
<tr>
<td>3.</td>
<td>The success of Otto's engine (S)</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>Otto's theory (S)</td>
<td>4</td>
</tr>
<tr>
<td>5.</td>
<td>Otto's engine (Ex)</td>
<td>2</td>
</tr>
<tr>
<td>6.</td>
<td>The whole cycle (S)</td>
<td>5</td>
</tr>
<tr>
<td>7.</td>
<td>Otto (Ex)</td>
<td>1</td>
</tr>
<tr>
<td>8. 5000 Otto's engine (Ex &amp; S)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Otto's engine (//)</td>
<td>2</td>
</tr>
<tr>
<td>10.</td>
<td>Otto's engine (//)</td>
<td>2</td>
</tr>
<tr>
<td>11.</td>
<td>The heavy piston (S)</td>
<td>6</td>
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<tr>
<td>12.</td>
<td>The ignition device (S)</td>
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<tr>
<td>13.</td>
<td>An explosion (S)</td>
<td>8</td>
</tr>
<tr>
<td>14.</td>
<td>The gases (S)</td>
<td>9</td>
</tr>
<tr>
<td>15.</td>
<td>The cooled gases (/ &amp; S)</td>
<td>9</td>
</tr>
<tr>
<td>16.</td>
<td>That (S)</td>
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</tr>
<tr>
<td>17. Otto (Ex)</td>
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<td>18. Otto's theory (Ex)</td>
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<tr>
<td>19.</td>
<td>the principles and theories [theory] (//)</td>
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<tr>
<td>20. Modern engine (S)</td>
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<tr>
<td>21.</td>
<td>That (S)</td>
<td>12</td>
</tr>
<tr>
<td>22. Otto’s engine (Ex)</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>23. he (Ex)</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>24. his engine (Ex)</td>
<td></td>
<td>2</td>
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(/) parallel progression
(S) Sequential progression
(Ex) Extended parallel progression
### Technical Description Task B (Pre)  Simon

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<tr>
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<th>Topic Depth</th>
<th>No. of subtopics</th>
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<td>This kind of technology (S)</td>
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<td>3.</td>
<td>The centre of the cycle (S)</td>
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<tr>
<td>4.</td>
<td>it (S)</td>
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<tr>
<td>5.</td>
<td>Coal (S)</td>
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</tr>
<tr>
<td>6.</td>
<td>a solid or liquid fuel (S)</td>
<td>6</td>
</tr>
<tr>
<td>7.</td>
<td>The process (S)</td>
<td>7</td>
</tr>
<tr>
<td>8.</td>
<td>an exit (S)</td>
<td>8</td>
</tr>
<tr>
<td>9.</td>
<td>3 streams (S)</td>
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<tr>
<td>10.</td>
<td>Steam (S)</td>
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</tr>
<tr>
<td>11.</td>
<td>The middle steam (S) &amp; (//)</td>
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</tr>
<tr>
<td>12.</td>
<td>The purpose of the gas/steam turbine (S)</td>
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<tr>
<td>13.</td>
<td>The combustion of the coal (S)</td>
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</tr>
<tr>
<td>14.</td>
<td>This process (//)</td>
<td>13</td>
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<tr>
<td>15.</td>
<td>another exit (Ex) &amp; S</td>
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<td>Cyclotron (S)</td>
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<td>The solid waste (S)</td>
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<tr>
<td>18.</td>
<td>The main advantage (S)</td>
<td>16</td>
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<tr>
<td>19.</td>
<td>coal (Ex)</td>
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<tr>
<td>20.</td>
<td>no significant additional released CO2 (S)</td>
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<tr>
<td>21.</td>
<td>the level of CO$_2$ (S)</td>
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</tr>
<tr>
<td>22.</td>
<td>The annual release of CO$_2$ (S)</td>
<td>19</td>
</tr>
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</table>

//) parallel progression
(S) Sequential progression
(Ex) Extended parallel progression
Technical Description Task A (Post) Simon

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<th>Sentence No.</th>
<th>Topic Depth</th>
<th>No. of subtopics</th>
</tr>
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<tbody>
<tr>
<td>1.</td>
<td>more advanced fossil-energy technologies</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>a new system (S)</td>
<td>2</td>
</tr>
<tr>
<td>3.</td>
<td>It (//)</td>
<td>2</td>
</tr>
<tr>
<td>4.</td>
<td>it (//)</td>
<td>2</td>
</tr>
<tr>
<td>5.</td>
<td>The primary component of this system (S)</td>
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</tr>
<tr>
<td>6.</td>
<td>the heat (S)</td>
<td>4</td>
</tr>
<tr>
<td>7.</td>
<td>the water (S)</td>
<td>5</td>
</tr>
<tr>
<td>8.</td>
<td>The steam (S)</td>
<td>6</td>
</tr>
<tr>
<td>9.</td>
<td>an exit (S)</td>
<td>7</td>
</tr>
<tr>
<td>10.</td>
<td>It (//)</td>
<td>7</td>
</tr>
<tr>
<td>11.</td>
<td>The secondary part of the system (Ex &amp; S)</td>
<td>3</td>
</tr>
<tr>
<td>12.</td>
<td>fines, and the CO₂ rich gas (S)</td>
<td>8</td>
</tr>
<tr>
<td>13.</td>
<td>a channel (S)</td>
<td>9</td>
</tr>
<tr>
<td>14.</td>
<td>Lime (S)</td>
<td>10</td>
</tr>
<tr>
<td>15.</td>
<td>the content of CO₂</td>
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</tr>
<tr>
<td>16.</td>
<td>The main advantage of the system (S)</td>
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<td>17.</td>
<td>Improvement (S)</td>
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(//) parallel progression
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Appendix F

William's Argument Tasks

Argument Task B (pre-tutoring)

"Success of Diesel's engine meant success of his theory that guided him." Diesel's theory is based on Nicolas Leonard Sadi Carnot's theory of carnot cycle. This theory gave Diesel an idea to invent this kind of engine. During the next 10 years, Diesel spent his time on research of the ideal carnot cycle theory. This was very important for the following decades because Diesel's theory was published 10 years after he had started his research. Therefore, his theory became very interesting to European engineers and the invention of Diesel's engine started.

In 1893, Diesel's theory was published. After his books reached Europe, two major German firm, Krupp and Maschenenfabrih, was interested in this idea of inventing Diesel's engine. Diesel's book acted like a promotion to European about thermal efficiency. This promotion helped to gain more financial aided which helped Diesel to continue his research. For that reason Diesel's engine was invented which was widely used in the following decades.

In the following century after his theory had been published, Diesel's engine has replaced the position of steam engine. Diesel's engine was used in warships and submarines in the World War 1. Even nowadays, there are still Diesel's engine. However, most of them are replaced by fuel-rejection engine which is still based on Diesel's theory. Therefore, the success of Diesel's engine meant of his theory that guided him.
Argument Task A (Post-tutoring)

In the middle of the 18th century, Nicolaus August Otto developed a new concept on building a special kind of engine called Otto engine. This kind of engine became popular in the late 18th century. The success of Otto's engine meant success of Otto's theory that guided him.

Otto's theory on internal combustion engine is divided into four parts. Otto's engine is basically an internal combustion of fuel and air in a cylinder. The whole cycle takes four steps: mixing a proportion amount of fuel and air; compressing the mixture; combusting the mixture by some kind of ignition device, nowadays a spark plug; and removing the exhaust gas.

Based on his theory, Otto had made a successful four-stroke atmospheric engine. In 1866, 5000 Otto's engine were sold. The reason was because Otto's engine were three to four more efficient than steam engine. Otto's engine contained a heavy free piston inside the vertical cylinder. When the mixture of fuel and air was injected into the cylinder, the heavy piston compressed the mixture. Then the ignition device would cause the mixture to explode. An explosion drove a heavy piston up the vertical cylinder as far as it would go. The gases then cooled and contracted to form a partial vacuum, atmospheric pressure, assisted by the weight of the piston, did the work on the way down. The cooled gases or the exhaust gases were pushed through the exhaust valve. That completed a four-stroke cycle, intake, compress, combust and exhaust. Otto had followed his theory to complete this successful engine.

Otto's theory not guided him but also guided engineers in nowadays automobile industry. Since modern automobile engines are more sophisticated and compact than atmospheric engine, the principles and theories are the same. Modern engine utilizes the four-stroke cycle first demonstrated by Otto. That causes over 10 million new engines a year employ this mode of operation. It tells us that Otto's engine was successful because of his theory.

Otto's engine was so successful because he constructed the atmospheric engine by following his theory which is still used as a fundamental principle by many engineers in the world. If Otto did not invent this theory, his engine would not have been so successful and the automobile industry would not have developed so quickly in the 19th century.
Appendix G

Simon's Technical Description Tasks

Technical Description Task B (pre-tutoring)

This is a technical description about the integrated gasification combined-cycle technology. This kind of technology is new and more efficient for controlling CO₂ emissions.

The centre of the cycle is called a gasifier, in which the main reaction is. It is a kind of oven of reaction. Coal is loaded and will be combusted in it. During the reaction, a solid or liquid fuel is converted into a material which is gaseous at standard temperature and pressure. The process involves contact with a solid catalyst at elevated temperature and pressure in presence of hydrogen. There is an exit for ash after the combustion.

There are 3 streams for the oven. Steam comes from a turbine which connects the generator and the electric power, and then enters into the lowest stream. The middle stream is for the air, which has already been processed in a compressor powered by a gas turbine which is further linked to the electrical generator. The purpose of the gas turbine and the steam turbine is to convert the stored mechanical energy in fluid into rotationals mechanical energy. The combustion of the coal releases a great amount of heat which boils water into steam. This process increases the pressure of the steam and it will expand through the blades on the turbine rotor causing them to rotate, and hence power is supplied.

There is another exit for the gas turbine. Cyclotron, which is produced after the combustion in the oven, will pass the highest stream and then is cleaned up by the hot gas which is from the exit of the gas turbine. The solid waste on the sulphur byproduct will loaded to the truck after the clean-up.

The main advantage of this technology is that a special solvent is used to absorb H₂S and COS along with some CO₂ and H₂O. Moreover, coal is grounded to a small particle size and fed into the burner so that the efficiency of combustion is higher. Thus, there is no significant additional released CO₂ associated with SO₂ control. The level of CO₂ releasing is lowered. The annual release of CO₂ would be down to approximately 2.42 Mt.
Technical Description Task A (post-tutoring)

Today, more advanced fossil-energy technologies are under development. Recently, a new system is just being applied. It is an advanced pulverized coal plant with an advanced flue-gas desulphurization system. People are paying attention to this system because it is an efficient method to control CO₂ emissions.

The primary component of this system is a boiler which delivers heat to a steam turbine, which is further linked to electric generator. In the boiler, the heat, produced by a burner, in which coal and air are mixed and combusted, is transferred to water. When the water is heated enough to become steam, it goes to the steam turbine. The steam expands through the blades on the turbine rotor causing them to move, and hence, electric power is produced. There is an exit for the boiler. It allows ash to be disposed by trucks after the combustion.

The secondary part of the system is made up of three devices. In the coarse separator, fines will be disposed and delivered by trucks and flue gas exits from here and then enters into the contactor, which is linked to the boiler, and the SO₂ rich gas is processed for sulphur recovery in the reducer. There is a channel connecting both the reducer and the coarse separator for gas recycling. Lime, which is used in place of limestone, is distributed in the channel so as to absorb CO₂. It is proved by practice that the content of CO₂ reduces quickly in the cycle.

The main advantage of the system is the idea of the recycling of the reducing gas. Improvements in this kind of system are achieved through greater utilization of the sorbent materials and using noncarbonate sorbents. Comparing with other technologies, the rate of CO₂ emission is relatively low. That is why it is considerable.
## Appendix H

Pre-Post Comparisons of Individual Participants’ Uses of Five Heuristic Search Strategies in the Technical Description Task

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## Appendix I

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Pre-Post Comparisons of Individual Participants' Uses of Five Configurations in the Technical Description Task

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