The Effects Of Learning Strategies (Algorithm And Checklist) On The Development Of Error-Correction Skills In Writing

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ABSTRACT

An Investigation of the Effects of Learning Strategies
(Algorithm and Checklist)
on the Development of Error-Correction Skills in Writing

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This study examined the effects of two learning strategies (algorithm and checklist) on error-correction in adult writing instruction. A control condition was used as a comparison group.

Levels of writing (high and low) relative to the main independent variable were investigated. Before the experiment began, the subjects enrolled in an Advanced English course were tested, using the Department of National Defence writing test to determine their writing abilities and to assign them to one of two equivalent ability groups. A pretest was administered at the beginning of the course. The subjects were then randomly assigned to one of three conditions: algorithm, checklist or learner-assigned.

The condition of testing (testing with and without the aid) and the effects of two orders (one in which the aid was introduced on the first posttest followed by no aid on the second posttest and one which was introduced on the second posttest, following no aid on the first) were investigated. Data were collected from end course tests to determine delayed effects of the learning strategies.

A regression analysis provided strong evidence that the pretest was an excellent predictor of the posttest scores. A four-way analysis of covariance revealed no significant interaction between order and test type. As a result, analysis centered on the Condition by Ability by Test Type interaction.

Results indicated that the strategy conditions benefitted low ability subjects, and that the algorithm treatment was effective over a time interval for them also.

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Chapter 1

Introduction

Historically, educators have often been concerned with emphasizing the knowledge aspect of lessons and have been less concerned with providing students the means of operating on or with the content and with how to think or reason as the content was being assimilated and applied. This fact, however, should not be interpreted simply as the fault of the teacher. The problem of establishing procedures of thought and reasoning and finding ways to instruct the student in these procedure was and is not sufficiently advanced. With the advent of technology and continual research in the psychological and pedagogical sciences, varieties of instructional strategies and learning theories have begun to emerge, causing teachers to question how students could be taught to not only acquire knowledge but also to think. As a result, many programs were changed to adapt to emerging technologies, instructional strategies, and educational trends. Many of these did not succeed, however, in making the best use of the student's learning style. Students were classified according to their abilities, placed in the appropriate graded classrooms and presented content organized by instructional designers to assure as close a fit as possible between it and the way a learner processes and represents information internally; that is, instruction was adapted to suit the learner by compensating for those skills he was weak in. The focus in teaching, thus became an attempt to improve the presentation of materials, to recognize learning differences in the student, and to encourage the learning of specific content. However, little emphasis was placed on the development of relationships between incoming and stored information. This important principle of learning was not integrated into the daily practice of subject matter teaching. Even though students were grouped according to their abilities, they often worked on the same activity at the same time to achieve the same goal with the effect of causing performance differences within the graded groups. Research is now showing that "individual aptitudes or strategies" or both may be the primary cause of performance differences (Dansereau, 1978). Hence serious discrepancies have resulted between educational research and educational practice.

Although teaching methods are important and have improved, exclusive emphasis on this point in the instructional process may, indeed, force a student to develop inefficient non-transferable strategies and retard motivation. By not stressing learning strategies, educators, in essence, may discourage a student from developing and learning new strategies with the consequence of limiting awareness of cognitive capabilities. This lack of awareness, of course, can limit an individual's ability in a situation requiring new learning strategies. Landa (1974) points out that "a person needs knowledge not so much for its intrinsic value, but mostly in order to solve problems arising in practical and theoretical activities" (p. 7). The formation of methods of thinking and reasoning is, therefore, one of the most important tasks of educators and instructional designers. Thus, a shift in emphasis from content to the coupling of content and of learning strategies is now apparently necessary in educational instructional strategies and design.

One area where too much time and effort have been placed on the learning and memorization of grammar rules and too little on the development and training of appropriate strategy skills is editing or more specifically, sentence error-correction. Error detection and correction in a sentence is a difficult process; and one that often is neglected by novice writers. Writing, in itself, is a complex task consisting of three generally accepted processes - planning and generating, translating, and reviewing - each of which contains subtasks that must be dealt with more or less simultaneously (Nold, 1982; Hayes and Flower, 1980). Consequently, a novice writer is often confounded by such subtasks as sentence error-correction and blames his reader when the written message fails to communicate.

A new perspective in writing and error-correction. Researchers and educators in the discipline of "writing" have continually searched to develop some understanding of the pervasive, time-consuming psychological process that takes years to master. Although no complete cognitive processing model of writing has yet been fully elaborated, several beginnings have been made. Participants have been videotaped while composing, and the results analyzed into the three previously mentioned processes. Hayes and Flower (1980) have extracted from protocols of writers the basic moves or strategic elements that writers use in written composition and have analyzed their results into task environment, long-term memory and the writing process. Researchers are attempting to understand these mentioned processes by asking experienced writers to explain "out loud" what they are doing at each level of the writing process. Cognitive psychologists are, in fact, developing procedures to identify strategies used by student writers. As is usually the case, application lags behind basic research. Only since the early 1970's have cognitive findings had a substantial impact on education; this impact has been relatively small compared to the possibilities. Emphasis on improving writing skills has been placed on the generating, planning and translating processes of writing but little on the reviewing process. Although research is taking place in all aspects of the writing process and teaching methods are improving, novice writers still do not edit their written texts. Novice writers tend to laboriously plod their way through the planning, generating and translating processes of writing, however, totally ignoring the reviewing process. It is generally accepted that reviewing a piece of writing is "not a spur of the moment activity" (Hayes and Flower, p. 18). Rather, it is a process in which writers consciously decide to devote a period of time to systematic examination and improvement of the written text. Moreover, it is time when they apply complex individually unique, highly flexible, recurrent and holistic revising strategies to their text. The reviewing process appears to be simple at first glance; however, it is a complex process which consists of subtasks, one of which being error-correction. Educators continue to teach grammar rules with the hope that students will apply them to their writing. If simple knowledge of grammar rules sufficed for grammatically correct writing, then there would be no need to dwell on the reviewing process. Much of the untapped potential in improving and developing error-correction skills in writing lies in the development and emprovement of learning strategies.

<u>Sentence error-correction as a problem</u>. Research has shown that experienced writers use some form of an implicit algorithm or rule-governed model when revising a written text (Nold, 1980; Sommer, 1980). Of course, the model varies for each writer, echoing to some extent the prescriptive and proscriptive advice of English teachers and of rhetoric and grammar textbooks. Their revision strategies are complex and highly automatized so that procedures in locating and correcting errors are often carried out with infrequent or slight conscious attention. The inexperienced writers over-loaded with grammar rules often show no noticeable strategies or application of what they have learned during the revision process, if in fact, they do revise. Generally speaking, novice writers do not revise, can not locate sentence errors unless they are blatant errors, and do not apply learned rules. Often the last period placed on the page is the final thing done to the text. Deemphasizing the teaching of grammar rules, reorganizing the writing programs, grouping students according to their abilities and adapting materials and instruction to complement styles of learning are all approaches which have been used to attempt to develop the skill of error-correction in novice writers. Yet the problem still exists. Teaching grammar rules is, of course, still a necessity since these are the tools or means of solving grammatical problems; the application of rules, particularly the recognition of situations where the rules are applicable, is achieved by means of operations. Landa (1974) states

that "problem solving in the broadest sense of the word comprises a large part of any activity - practical or theoretical" (p. 7). Error-correction is then a problem that must be solved by means of special operations. In order to develop revision skills (i.e. locate and correct sentence errors), a novice writer must be taught how to think, to reason, to apply the rules, to look at error-correction as a problem to be solved. The operations needed in error-correction are as important and as necessary a component of writing as the knowledge of grammar rules.

Main objective of the thesis. Very little has been done to adapt the learner to the materials in the field of writing. Most students graduating from high schools and universities are unable to write a clear, coherent and concise sentence, suggesting that the traditional approach of adapting materials to the students has proven ineffective. The emphasis in this thesis is placed on teaching students that error-correction is, in fact, a problem that must be solved by using specific operations or more specifically an algorithm or a checklist. As mentioned, inexperienced writers ignore the revision process for such reasons as "not knowing what to do, not wanting to mess up the test" or using random approaches to locate errors, all with little success. Therefore, activating mental skills or training students to use them by teaching learning strategies will bring about greater accommodation of schemata to new information (Winn, 1981).

Since inexperienced writers do not have the necessary processing skill in error-correction, it becomes necessary for the skill to be externally provided in the forms of learning strategies. The two learning strategies, the algorithm and checklist, emphasized in this thesis were chosen after a review of the literature as learning strategies most appropriate for teaching solutions for the problem of error-correction.

The notion of algorithm had its origins in mathematics and computer programs. Algorithm usually means a precise procedure for solving a problem that breaks the process into its simplest steps and arranges them in a sequence leading automatically to the right outcome. Since error-correction is not precise in the sense of mathematical logic, it, therefore, does not lend itself to an automatic execution of precise procedures leading to a correct outcome. Thus, the word "algorithm" will not be used in this thesis in the strict mathematical sense but as a synonym for "quasi-algorithm". A quasi-algorithm retains the same properties of an algorithm - specificity, generality and resultivity; however, it operates with objects not only of the symbolic nature but as well with their content and meaning. It is basically less precise than the notion of an algorithm.

It is the purpose of this study to show that activating or training students' mental skills with specific learning strategies (i.e. the algorithm or rule-governed checklist) can be applied in order to develop revision skills in writing, or more specifically error-correction skills. The literature has revealed that the algorithm has been applied in areas of solving syllogisms (Sternberg and Weil, 1980); solving problems (Newell and Simon, 1972); mathematics and the teaching of the Russian language (Landa, 1974, 1976).

Landa (1974) advocates that the instructional designer organize content so that first an algorithm for performing a mental task is taught. Once the algorithm has been taught and learned, the content can be presented provided it has been organized to fit the algorithm. The aim of this study is to apply learning strategies (i.e. algorithm and checklist to error-correction) without reorganizing the content or adapting it to the strategies, and to compare their effects to the traditional individual student assigned strategies. That is, the learner is encouraged to bring his own organizational skills and existing knowledge to the task. However, care must be taken that the learner knows which learning strategy is most appropriate to complete the task. Bovy (1981) offers a great deal of evidence in support of the suggestion that high ability learners are capable of deciding for themselves which strategy to use, while low and high ability learners with poor performance outcomes need to be told which strategy to use, and to have it modelled for them. Snow (1979) also reinforces this argument that learners do not necessarily know what is best for themselves. Thus, instructional designers and educators must not take for granted that "high ability" learners are capable of deciding the best strategy for the task. In that writing is a complex cognitive task which requires the understanding and application of a multitude of new concepts and the relationship among them, it seemed appropriate to determine students' writing ability.

A student's writing ability is an important factor affecting his attitude towards and performance in the subject matter. An individual with inadequate writing skills is much more discouraged by his inability to perform the task, ignoring subtasks (i.e. error-correction) than a skilled writer. In view of the fact that writing ability can be assessed and is an indicator of success, it was seen as a valid variable in examining its interaction with the instructional treatment. Since students with low writing ability and with high writing ability but poor performance encounter the most difficulty with error-correction, it was contended that providing them with learning strategies (i.e. algorithm or checklist) might prove to facilitate their learning, given that they use and apply the strategies.

Summary. This thesis attempts to integrate three main areas of inquiry which seems to be rationally related. Research in learning strategies has provided good theoretical rationale for adapting the student to the materials, by activating or developing mental skills in students so that they can order the materials in a meaningful manner. Since writing ability is an important factor, an interaction in student writing ability and the instructional treatment is also anticipated. It is expected that there will be an interaction between writing ability and instructional treatment with low ability students and high ability students with poor performance outcomes benefiting from the learning strategies, given that the students' mental skills were activated or developed.

In trying to focus upon the learner rather than the materials to be learned, this study has subscribed to the definition of educational technology which emphasizes the diagnosis of educational needs, the design of effective learning systems and the assessment of achievement through educational measurement and evaluation. In implementating learning strategies (i.e. algorithm, checklist and student assigned strategies), this study has attempted to satisfy the need for teaching error-correction, a subtask of the revision process, as a problem so that analytical and critical skills are developed in order to achieve effective written communication. Finally, through the application of several tests, the study has been able to monitor the progress of students, to form some useful judgments about the achievement of students, and assess the efficacy of the learning strategies.

Chapter 2

Review of the Literature

The major components investigated in this study are learning strategies (i.e., algorithm and rule-governed checklist), writing ability (i.e., high and low), and transfer of learning. These have not been integrated elsewhere within the confines of any empirical inquiry. The problem of teaching students learning strategies that will activate or develop their mental skills is currently attracting the attention of psychologists, pedagogues, and methodologists. It is becoming apparent that learners possess "metacognitive skills" or "cognitive strategies" (Gagné and Briggs, 1974) or "mathemagenic activities" (Greeno and Bjork, 1973) through which they can monitor and adjust consciously their own learning (Gauvarin, 1967). Although this intellectual process has been discussed in such terms as a learner's cognitive "self-control" (Landa, 1974), a learner's "self-directional capabilities" (Rigney, 1978), and a learner's "manipulation of strategies" (Thorndyke and Strasz, 1980), the bottom line is the belief expressed by Bovy (1981) that learners of low ability and those with poor performance outcomes need to be taught learning strategies that will enable them to accomplish the task, whereas those of high ability with good performance outcomes are quite capable of deciding which strategy to use on the learning task without being told. Adapting learners to instructional materials by activating or developing their mental skills by means of learning strategies enhances the chances of bringing about "greater accommodation of schemata to new information" (Winn, 1981) and producing cost effective instruction.

Since current research indicates that "individual aptitude or strategies" or both may be the cause of performance differences (Dansereau, 1978), special attention is given to the discussion of "learning strategies", and their function in basic information processing and of the effects of writing ability and the instructional treatments. It was also within the scope of this study to examine the transfer of learning and the use of specific learning strategies (i.e., the algorithm and the checklist).

Adaptive Instruction. Manipulating the way instructional content is organized within the constraints imposed by the objectives and the learner is a major task of instructional designers. Two philosophies, concerning the making of instructional content meaningful to a learner, have emerged. Approaches to adapting instruction can be classified, thus, into two broad categories: those approaches that adapt instruction to suit the cognitive idiosyncracies of individual learners, and those approaches that adapt the learners to the instruction, thereby enabling them to match their skills to different learning demands.

The first approach, aptitude-treatment interaction, which predominates among many designers and educators, assumes that the content will be better learned as Salomon states (1979) "if less mental translation is needed for it to become congruent with what the learner already knows" (p. 7). That is, the content is organized in order to compensate for the skills a learner is weak in or to activate the mental skills a learner is already adept at using. Although the guidelines and principles of this approach have been developed and expounded upon by such people as Merrill and Tennyson (1977), Fleming and Levie (1978), and Glaser (1977), for a number of reasons this approach has met with only limited success in accomplishing the goal of providing adaptive instruction. Part of this may be attributed to the difficulties in defining and measuring individual differences most related to the learning process (Tobias, 1981, 1982). When organizing content to suit the learner (i.e., compensating for his weak skills), the learner's existing schemata, preferred learning strategies and aptitudes must be taken into account. Accurate measurement of each of these factors is rather difficult. Tobias (1976) claims that the best predictor of learning is prior achievement. However, very little has been done to assess the nature or presence of a learner's existing schemata other than by pretesting. Although pretesting measures the amount of information a learner has, it is unable to provide insight into the state of a learner's progress (Thro, 1978). Preece (1976), Waern (1972), and Shavelson (1974) have attempted to measure the organization of schemata. However, techniques established by these researchers require complex analysis which are difficult for educators and designers to put into practice. Measures of intelligence were developed in order to predict which students were likely to profit most from instruction. As Glaser (1972) pointed out, there is no reason to expect that the same cognitive measure would predict with equal accuracy which strategy or instructional method is optimal for attainment of instructional objectives. The matter of organizing content to match learner aptitude also poses some difficulties. Studies of aptitude tests have shown empirical discrepancies, leading to the conclusion that perhaps the tests are not measuring what they are intended to measure. For example, Cattell (1971) and Horn (1968) regard verbal tests as measures of crystallized intelligence, whereas Hunt (1976) found that high scores on verbal tests related to short term memory ability. In his research, Jensen (1971) found no evidence to support the theory that auditory or visual preference is a reliable individual difference variable. Haskian and Cattell (1978), likewise, found that spatial ability is multi-faceted and complex. These difficulties associated with aptitude-interaction treatments have made the search for significant and generalizable adaptive instruction a time consuming and costly process, and one which some educators feel is not likely to lead to practical applications in the future (Cronbach and Snow, 1977; Snow, 1980).

An alternative adaptive-instruction approach, adapting the student to the content, focuses on the content. That is, the major learning objectives are identified and then analyzed and a hierarchy of "enabling objectives" leading up to the learning objectives is sought. Each objective represents some operation that the student will be able to eventually perform. Associated with each operation are skills that are needed to accomplish the task. Adapting the student to the content focuses on identifying the mental skills needed by the learner, which can be activated or developed by means of learning strategies and which can assist learners in adapting the content to their own learning needs. Content is not organized to make learning easier, but rather to help learners organize content for themselves. This approach assumes that the learner may possess the necessary mental skills which then need to be activated, or if not present, to be taught in order for the learner to organize the instructional content meaningfully. The activation of a learner's mental skills in order to organize information is supported by research on using mental imagery to learn to associate pairs of words (Pavio and Forth, 1970); using devices such as imbedded questions to improve comprehension and organization of content (Anderson, 1970); and training a learner to process content in particular ways (Dansereau et al., 1978; Landa, 1974, 1976; McComb, 1983). In essence, the goal of this approach, adapting the student to instructional content, is to give students the power to "reprogram their own biocomputers" (Dansereau, 1978, p. 3).

At least two problems have surfaced as a result of a review of the literature on learning strategies related to adapting the learner to instructional content. First, the materials and tasks used to examine the development of learning strategies have been, in most studies, artificial (e.g. nonsense syllables, unrelated words, serial and paired words). Second, specific components of the learning process have been studied in isolation (e.g. retention studies with no reference to their impact on retrieval). Consequently, it is difficult to generalize the findings of such studies to more meaningful educational situations. In any case, there is general agreement that strategies do improve learning and that instruction involves the control of cognitive processes by means of carefully selected learning strategies.

It has been suggested (Winn, 1982) that instruction operates externally to the learner, while learning involves internal processes.

The internal processes or cognitive processes are the psychological mechanisms which the learner uses to perceive, assimilate, interpret, store, and retrieve information. The recognition and classification of concepts, integration of pieces of information into large units, and creation and application of such mental skills as imagery, algorithms are examples of internal processes. Although all learners have the potential for using these processes, the degree of aptitude in each process varies from learner to learner (Winn, 1983). When a learner is capable of using these cognitive processes productively in a learning situation, these processes have reached the status of "mental skills". Even though learners may have particular mental skills, there is no guarantee that they will use them in a learning situation. Studies done by Thorndyke and Stasz (1980) and Winn (1982) have indicated that telling students what skills to use in learning situations improves performance, even when they are skilled in the processes. In this case, the cognitive processing is directed externally by the instruction, but the actual processing is conducted internally by the learner. In instances, where the learner does not possess the necessary skill, it would be appropriate, then, for the skill to be eventually provided by the instruction in the form of learning strategies. Rigney (1978) refers to this approach as an "Instruction System Assigned Learning Method" in which learning strategies assigned by means of instructional content direct the cognitive processing in an optimal manner. Landa (1974, 1976), for example, facilitated the solution of grammatical problems by teaching students algorithms in order to develop their metacognitive skills or reasoning procedures. When a learner applies particular skills to a learning task, whether consciously or unconsciously, these skills then function as "learning strategies". When learners use internal processes, their metacognitive abilities are involved. Rigney (1978) states that as learners gain control of their information processing, using "metacognitive abilities" or "cognitive strategies" they become capable of deciding on their own which strategy to use for the task. That is, learners use self-assigned strategies that originate within the learners. Bovy (1981) points out that the locus of information processing is inside or controlled by learners, and consequently no instructional strategies are required. In fact, the instructional strategies provide minimal cognitive processing support as evidenced in research done by Salomon (1979) and Cronbach and Snow (1977).

Adaptive instruction, then, involves the control of cognitive processes. It achieves this by inducing a learner to use strategies (i.e., apply mental skills) that are appropriate for the learning situation. Adapting a student to instructional content can intervene in the learning process in a number of ways. Learners can be helped to develop mental skills that will be needed to learn; they can be shown or told, directly or indirectly, which learning strategies to use in a learning situation; or they can be helped to develop their metacognitive skills. This approach is aimed at assisting the learner in progressing at a rate from maximum dependence on external instruction to reliance on information in long term memory, self-generated instructions and self-monitoring.

<u>Adaptive Instruction and Information Processing</u>. Understanding how a learner processes information may help to make it possible for both designers and educators to teach students to be more effective learners. The information processing model has been used to depict the stages of learning and memory. The central assumption of the model is that a number of operations occur between a stimulus and response, thus indicating that learners perhaps play an active role in controlling what and how they learn. Although models differ, the literature reveals that most general models of the human information processing system includes such components as sensory registers, short term memory, long term memory, and executive control processes. Basically, the stimulus presentation initiates a sequence of processing stages. Each stage operates on the information available to it. The operations transform the information so that the output of each processing stage is transformed information which is the input to the next stage. The actual stages of information processing during instruction and learning appear to vary considerably with both learner and learner task (Coop and Siegal, 1971). As a result, this has led to continuous research on cognitive processes by the cross-disciplinary sciences. In some cases, the focus is on exploring questions of how learning and memory might be organized (Anderson, 1976); schema theory and long term memory (Bobrow and Norman, 1975); previous experience and processing in determining learning outcomes (Rothkopf, 1978). The success or failure of learners depends on, according to Neches and Hayes (1978), whether they can successfully apply mental skills by means of learning strategies to solve specific

learning tasks. Bovy (1981) as stated, supports this idea by pointing out that a learner has control of the cognitive processes needed in a learning situation when he has acquired a skill and can then apply it. Determining whether or not learning strategies are necessary depends on the locus of control, that is, outside or inside the learner. The purpose of providing the learning strategies is, hopefully, to aid in shifting the learner's control externally to internally.

Human beings do not function as simple and passive receptacles in which associative bonds are imprinted and then remain available for later activation when proper stimulus is presented. Humans, apparently, use strategies to store and retrieve information (Weinstein, 1978; Gagné and Briggs, 1974; Melton and Martin, 1972). Research in memory strategies and information processing has produced a plethora of theories. The multistore theory (Atkinson and Shiffrin, 1968) involved the influence of reinforcement, a complex process, on control processes (i.e., transient phenomena under the control of the learner), taking the view that reinforcement is a means of controlling the control processes which include techniques used by the learner to remember. Their discussion illustrate possibilities for achieving better control over cognitive strategies. Craik and Lockhart (1972) focus on the encoding operators. They suggest that the permanence of memory is a function of depth of analyses, with the deeper levels of analysis resulting in more elaborate, longerlasting traces. According to the theory of levels of processing, repetition merely provides opportunities to learn; it does not necessarily, without the intervention of cognitive processing during the trials, result in storage in long term memory. They conclude that the burden of acquisition is placed on the kind of processing that is elicited by the learning strategy, either externally (i.e., system-assigned) or internally (i.e., self-assigned). Both of these theories recognize the role of "metacognitive skills" which can be developed or activated by means of learning strategies for effective learning.

How knowledge is represented and how that representation facilitates the use of the knowledge in particular ways in long term memory are topics which have been studied by Rumelhart (1981), Bobrow and Norman (1975), Anderson (1977), and Rumelhart and Ortony (1977) under the general term "schema theory". Broadly speaking, schemata are structural clusters of knowledge embedded within semantic networks. Their property of structure is derived from the fact that they specify both concepts and relationships among them (Anderson, 1977). Anderson emphasized the dynamic, constructive nature of schema use and described the active role of schemata in learning and how they serve as organizers for input. Without them, new experiences would be incomprehensible. Schemata direct the way in which information is interpreted and understood. According to Rumelhart (1980), schemata are the fundamental elements upon which all information processing depends. Schemata are employed in the process of interpreting, retrieving information from memory, in organizing actions, in determining goals and subgoals, in allocating resources, and in guiding the flow of processing in the system. Fiskel and Bower (1976) developed a theory of memory that utilizes local processing to accomplish retrieval. Bobrow and Norman (1975) proposed that memory structures are comprised of a set of active schema. Shimron (1975) pointed out that recall of knowledge may be strongly influenced by organization imposed by strategies. Thus the common denominator of all these theories on semantic long term memory is that acquisition, retention, and retrieval of information depends upon information processing under voluntary control of the learner or induced in the learner by external learning strategies and operates within the memory framework of the individual. The processing and storage characteristics of the memory system appear to influence the kinds of metacognitive strategies that can be effective during the stages of learning or processing. There is considerable evidence in the research on human information processing to indicate that learners can be adapted to the instruction by guiding their information processing operations with use of learning strategies which will develop or activate their mental skills (Weinstein, 1980; Rigney, 1978). It is mainly through adapting the student to the instructional content that educators can help a student learn. If instruction is to be considered as an efficient process, it should be able to attain the criterion of an exchange of factual information. In order to do this, students should be exposed to learning strategies that can greatly improve their ability to master the information and eventually allow them to take control of their metacognitive skills. The information processing model of learning and memory, thus, indicates that learning is composed of several phases. Hence, the information processing capability of learners and the mental skills needed by the learners to accomplish a learning task should be considered by educators and designers.

<u>Algorithm - an Effective Learning Strategy to Increase Information Processing</u>. According to Lefrançois (1979) the reason for learning rules is to solve problems. Problem solving, labelled by Gagné (1970) as "higher-order skills", is the thinking out of a solution to a problem. It entails the retrieval of stored information; cognitive operations on the retrieved information (induction, inference, extrapolation); and selection among alternative possible actions. In addition, a problem requires a learner not only to register information from the environment but also to operate on, modify or transform that information in some way in order to reach a solution. It requires retrieval of both factual and procedual knowledge from long term memory as well as processing and maintenance of current information in short term memory. Problem solving as in the case of error-correction is not a single cognitive process but rather involves a number of activities which need to be properly executed and organized to be successful. Not knowing these activities or not properly executing them will hinder learning. Thus, skills which should be mastered quickly and efficiently are learned slowly and painfully. People, in general, adopt strategies which minimize the load on the short term memory, typically with the result that problem solving is less efficient (Newell and Simon, 1972). Because all incoming data must be accounted for, they must fit into some schema. However, it does not matter if the fit is bad (Bobrow and Norman, 1975). As a result, a learner having a knowledge of the content but lacking in reasoning procedures of "higher-order rules" (Gagné, 1970) may randomly search for solutions with little or no success.

Experiments done by Eisentadt and Kareer (1975) and Newell and Simon (1972) both suggest that a learner searches through his problem space (information relevant to the problem) by means of strategies, efficiently or inefficiently. Gagné and Briggs (1974) state that learning requires the presence of several states in the learner. Among these are information storage and retrieval capabilities, intellectual skills and cognitive strategies. What a person does in a problem-solving situation, according to Scandura (1981) depends on two kinds of knowledge: knowledge of procedures or algorithms and knowledge of structure or rules. Research is continually emphasizing strategies are at work at all stages of the learning process. Cognitive learning strategies or metacognitive skills are needed for the learner to select and control his behaviour in a learning situation, to manage the information storage and retrieval processes, and to organize the problem solution (Weinstein, 1978). When students are taught algorithmic procedures for solving problems, they are not only being provided with the means to organize the learning situation but also with the means to control themselves: their own metacognition. It is the decision about the deployment of strategies that are involved in metacognition. In this way, strategies are logical prerequisites for metacognition; the strategies, therefore, must be present before the learner can make decisions about their deployment (Kirby and Biggs, 1980).

The algorithm provides step-by-step prescriptives for carrying out a defined sequence of operations in order to solve a problem. The solution of a problem lies ultimately in the transformation of object(s) from one state to another: an important process in the algorithm. The process of assimilating knowledge and solving problems are analyzed into direct operations; these operations must be specifically taught. An algorithm is, in fact, an analysis of a cognitive process into discrete operations. Training learners how to reason by using an algorithm is, in essence, training them in mental skills, directing them to select and use the algorithm as a strategy in problem situations. Training a learner to think or to reason out a problem by using an algorithm, as Landa (1974, 1976) noted in his studies on the algorithm, helps a learner to develop metacognitive skills; that is, algorithm training can help a learner to examine his own problem solving processes and to use the information by such examinations to improve his cognitive structures. At the level of metacognition, the learner is monitoring and adjusting consciously his cognitive processing activity to meet the needs of the learning task.

Checklist - a Possible Learning Strategy. Strategies for acquisition of information are concerned with helping a learner build internal knowledge structures that will mediate between stimulus conditions and appropriate responses. These strategies should have the goal of helping learners to increase their information processing; that is, they should be concerned with helping a learner locate and organize the subject matter, select necessary and useful information from the content, encode it by processing operations that efficiently transform it for storage in one or more forms of long term memory, and retrieve stored information. Keeping one's place in a long sequence of operations, knowing when subgoals have been attained, detecting and correcting errors and recovering from errors are examples of tasks that all require metacognitive skills or self-monitoring skills. Self-monitoring, necessary in most tasks, requires allocation of attention to the detailed operations of cognitive processing and of performance (Rigney, 1978). Initially, this is supplied by the instructional system through learning strategies, and later, it is retrieved from long term memory and supplemented by extended memories related to the learning task. Developing such skills internally in learners require providing them with strategies that will free them from their dependence on external monitoring.

Already popular among instructional designers and teachers is the use of a mathemagenic device: the checklist. Generally speaking, the checklist is useful for review purposes, helping students to organize their thoughts and recall stored information (Hartley and Burnhill, 1977). A review of the literature has indicated that most research to date on instructional strategies has been carried out on such related devices as summaries. In addition, most of the research on summaries tends to be related to prose passages and effectiveness of their position within the prose passages. Although the concept of a checklist and summary has a long history of acceptance among educators and designers, little formal inquiry seems to have been carried out. Research on the effectiveness of a checklist and a summary as a mathemagenic device are both scanty and varied. For example, Christensen and Stordahl (1955) found that summaries at the beginning or end of instruction had no significant effect on comprehension. Hartley, Goldie and Steen (1979), on the other hand, found that students recalled more when the summary was placed at the end of the instructional content. It had a recency effect and focused attention on the passage as a whole. This issue was also supported by Hartley and Burnhill (1977). Because empirical validity and data were scanty, as mentioned, this variable was included in order to add more evidence to the precept that the checklist, a potential learning strategy, may be particularly powerful in activating or developing mental skills in a learner when used as an aid in a learning task.

Learning Strategies: Implications for Revision in Writing. The general objectives for emphasizing strategies are to reduce the deficiences in processing resources that result in discontinuities and to facilitate transitions that will make the learner an expert. Rigney (1980) refers to discontinuities as breakdowns in the linkages between conscious and unconscious processing. Conscious processes sometimes are not capable of organizing sequences of processing resources that cope effectively with non-routine events. These processes, thus, can prevent a learner from keeping his place in along sequence of operations, operations such as detecting and correcting grammatical errors in sentences. Stallard (1974) has noted that the number of things that must be dealt with simultaneously in the revision process in writing is overwhelming: spelling, punctuation, word choice, syntax, purpose, organization.... Revision requires a system capable of operating iteratively, using its own outputs as inputs. An executive mechanism for switching between the forward process of text generation and error avoidance and the backward process of evaluation is a requirement of an iterative productive system (Bereiter and Scardamalia, 1982). Rigney (1980) suggests that teaching a student effective sequencing or processing operations in the form of algorithms will develop self-monitoring skills and will develop looking ahead skills (i.e., generating text, avoiding errors) and looking back skills (i.e., detecting and solving problems), in other words, metacognitive skills. Landa (1974) found that when his subjects did not know and use the algorithm for solving grammatical problems, they often used intuition and guesswork, strategies which led to errors. As previously mentioned, information processing refers to the ways a learner handles stimuli from his environment, organizes data, senses problems, generates concepts and solutions to problems and employs verbal and nonverbal symbols. Although the algorithm and the checklist do not claim to help in all these areas, the algorithm does maintain that it can stimulate intellectual functioning with students' individual differences in mind and help them to gain eventual control of their cognitive processes. The checklist, it is hypothesized, can stimulate intellectual functioning in students' when used as an aid in the learning task.

Writing Ability. Writing ability seemed to be a useful variable because it is a good indicator and perhaps one determinant of the nature and extent of learning strategies needed by a learner. It is a nonverbal skill that plays a substantial role in much of academic learning and training. In addition, the development and deployment of metacognitive skills appear to be related to ability (Bovy, 1981). Basing her argument upon research by Salomon (1979), she discusses relationships between ability and the type of instruction learners require. Salomon (1974) found that zooming in on a detail modelled the cognitive process of moving from a general view to scrutinizing a detail, a process which improved the performance of low-ability students. Winn (1982) also found that low-ability student performance improved when a strategy was modelled for them. Research results confirm that appropriate learning strategies can be taught to low-ability learners so that their performances will improve, a factor that has been noted frequently (Thorndyke and Stasz, 1980; Weinstein, 1978; Dansereau, 1978). There is some evidence in the literature that high ability learners are capable of applying strategies to learning tasks even when they are not the best strategies (Winn, 1982; Bovy, 1981; Snow, 1979). Snow reports that learners do not necessarily know what is best for the learning task, and even when they do know learners may not act on that knowledge. Thus a student's ability should not be taken for granted, and special skills should be developed or activated in the learner by means of learning strategies. There tends to be a wide range of abilities among individuals regarding the processes they use to mediate the acquisition, organization, retention, and generation of knowledge. The general consensus among researchers is that these differences may not be due to dissimilarities in abilities and aptitudes, but rather to differences in schemata, knowledge and strategies students bring to the learning environment (Rumelhart and Ortony, 1977; Scandura, 1977; Federico, 1980).

This implies that identifying the cognitive processes needed in revision and activating or developing a learner's mental skills may be more conducive to task mastery. It was then hypothesized that the incorporation of this variable within the parameters of the study should help in making better predictions of what learning strategies a student would need in order to master a task. That is, in the case of low-ability learners, the learning strategy should model the cognitive processes that could be used in the task. For other learners, it may be simply sufficient to tell them which strategy to use. Teaching a strategy, in this case the algorithm and checklist, in order to activate or develop mental skills, such as organizational and retrieval procedures needed to solve grammatical problems will aid in building a repertoire of strategies needed eventually by the learner to develop his metacognitive skills. Low-ability writers are usually confronted with more difficulty when faced with the revision process in writing. Hence, the algorithm and checklist, it was hoped, would be relatively more effective for this level of student.

Transfer of Learning and the Revision Process. Retrieval of what is learned does not always occur in the same situation or within the same context that surrounds the original learning. An educator expects the student learner, for example, to be able to apply the grammar rules to various types of written communication in real life, not simply in the context of his English class. In essence, there must be generalization of the learning that has occurred. Gagné (1974) refers to this generalization of learning as transfer of learning, that is, recalling what has been learned and then applying it to additional tasks.

Learning how to learn represents a permanent kind of learning manifested for long periods after practice has stopped by teaching learning techniques that improve learning efficiency. This study has, therefore, proposed to pursue further investigation in the domain of transfer of learning in order to add more evidence to the precept that an inexperienced writer can develop revision skills in writing by learning and applying strategies which will aid in the transfer of learned grammar rules to his writing.

Researchers have attempted to measure differences between the revising strategies of inexperienced and experienced writers with the purpose of understanding the cognitive processes involved in writing. Hayes and Flower (1980) have been extracting from protocols the strategic elements that a writer uses when writing. They describe the writing of inexperienced writers as "writer-based" as opposed to "reader-based". Sommer (1980) used a case study approach to study revision. She demonstrated that writers of different abilities make different kinds of revisions. Stallard (1974) found that good writers spend more time editing than inexperienced writers. Novice writers spend a great deal of time recopying, and as a result are often reluctant to mar a page for any kind of change. Faigley and Witte (1981) experimented with inexperienced and experienced writers. Their results tended to support the conclusions of Sommer's study that experienced writers revise in different ways from inexperienced writers. Although it is difficult to find a method to completely measure the strategies used by both types of writers because of their idiosyncracies, research results have confirmed that there is a noticeable difference between the two types of writers in regard to operations used when revising.

Because no complete cognitive processing model of writing has yet been developed, several assumptions related to cognitive functioning which could inhibit inexperienced writers from adopting a set of revising strategies that experienced writers have are shared by such researchers as Nold (1980), Bereiter (1980), and Flower and Hayes (1980). One assumption is that cognitive resources are limited. Short term memory appears to be able to hold only four or five separate items; however, long term memory has no such limitations. When a writer is writing, the short term memory is drawing on the long term memory as the words appear on the page. One of the limitations is the number of words, expressions, ideas that may be held at one time in the short term memory. Thus revision procedures, automatized by experienced writers, may overstrain an inexperienced writer's conceptualizing powers, which are already taxed to some extent by such matters as diction, generation of ideas. The experienced writer has, in fact, learned to learn; that is, according to Harlow (1949), he has acquired a "learning set" for in this case, revision. Learning-set implies that important aspects of learning how to learn to solve problems consist of a series of problems that are presented to the learner. DiVesta and Walls (1968) found that individuals exposed to a number of anagram problems developed a facility in looking for new rules to solve the problems and also a repertoire of rules that could be applied. Postman (1969) points out that learners may acquire not only rules that simplify the task of acquisition, but they may also invent ways of prompting recall. The development of learning sets as suggested by Travers (1977) involves the learning of appropriate strategies and the application of them. Training inexperienced writers learning strategies and providing practice in error-correction, it was hypothesized, would aid in the development of a learning-set for revising sentences, thus allowing the transfer of learning to result.

A second assumption is that each subtask of a complex cognitive task demands a portion of the total attention available (Nold, 1980). The attention given to error-correction, a subtask of a complex cognitive task, revision, is determined by how well the writer has learned the grammar rules and how much time he decides to give to the task. Since in writing there is more to attend to than the writer has capacity for, what is more salient will usurp attention that ought to be directed to locating and correcting sentence errors. Inexperienced writers will reduce their workload by simply ignoring the laborious task of revision, but with poor performance results (Scardamalia, 1975; Nold, 1980). Results from an experiment at Drexel University Pennsylvania indicated that inexperienced writers spend too much time recopying; as a result, they have little motivation to spend on the important tasks of critically reading and revising their written texts. In order to induce transfer, both an understanding of the principles being taught (Ellis, 1965) and direct practice of these principles play a necessary role (Harlow, 1949). According to Ellis (1965), transfer is greater if the learner understands the general rules or principals which are appropriate in solving problems. In addition, transfer is maximized when students receive extensive practice on the original task (Harlow, 1949). Ellis (1965) suggests that direct practice in solving problems should be given rather than simply expecting the student to solve problems when first faced with them. Practice will serve to strengthen students' understanding so that they will see the application of the concept. It is, then, hypothesized that providing students with strategies will help them understand the principles being taught, thus aiding in the transfer of learning to the practice.

A third assumption is that novice writers do not lack ability to evaluate, but they do not have an internal feedback system that allows evaluation to become part of the writing process; they lack the know-how. That is, they simply do not have the repertoire, experience, arrangement, good vocabulary (Loftus, 1977). Because writing is a difficult process for novice writers, they are often reluctant to make alterations in their text for such reasons as not wanting to destroy it, not knowing how to improve it, or not wanting to spend time recopying it. Revision often means adding, reordering, substituting, altering and recopying: a process seen by most novice writers as time-consuming, requiring an exhausting amount of time and effort (Faigley and Witte, 1981; Stallard, 1974). To the extent that motivational variables influence learning, they are also likely to influence transfer. Although it is difficult to make over-all generalizations about motivational factors, because not enough information is known about them, it can be assumed that attitudes are essentially important. People who can make a response will not make it if they are not alert to the possibility of using their past learning. Ellis (1965) points out that a poorly motivated student will tend to learn less, with the result of reducing the chance of transfer. Both the algorithm and the checklist provide learners with a system for revision, allowing them to understand the principles and the methods of revision. The learning strategies, it was hoped, would release writers from mindless recopying and give them a sense of control over the writing process.

The major sections of this thesis have been devoted to learning strategies, their relation to information processing, to revision in writing and to the transfer of learning. The analysis of writing ability was considered in light of the effects that the learning strategies (algorithm and checklist) would have on it. The conviction that learning strategies can be a valuable tool in curriculum instruction and design, has stemmed from the preliminary research studies; however, empirical validity was scanty. This thesis has attempted to add more evidence to the precept that a learner can be taught by means of learning strategies to be a more effective writer by being able to effectively detect and correct sentence errors.

Chapter 3

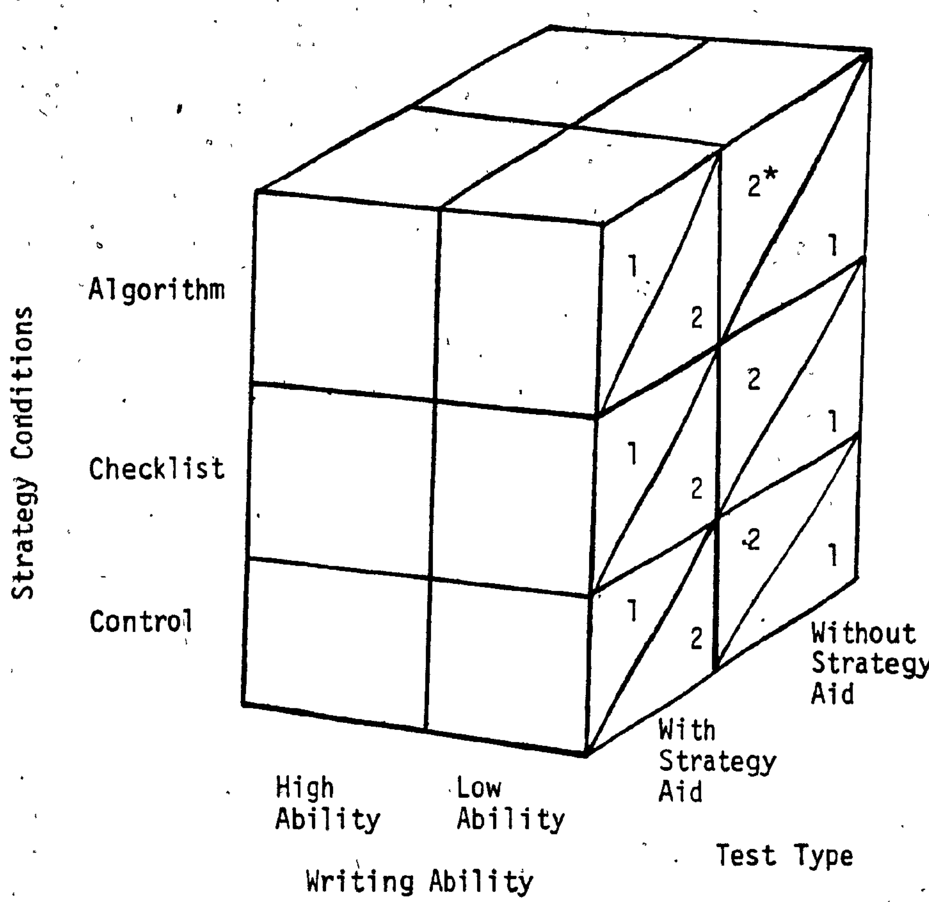
Method

Sample

The experimental sample consisted of 180 male French-Canadian military carrer personnel between the ages of 18 and 45 enrolled in a fifteen week Advanced English Writing Course at the Canadian Forces Base, St. Jean, Quebec. Sujects were of mixed ranks - captain, 2nd and 1st lieutenant, master and warrant officer, sergeant, corporal, master corporal and private- and were representative of fifty-two trades such as lawyer, technician, driver, instructor, engineer. Educational level of the subjects ranged from high school (grade 8) through completion of university (16 years of schooling). Subjects' first language was French; however, they were, in fact, considered by the military to be bilingual or fluent in English. All subjects were highly motivated and interested in both the course and the experiment.

Experimental Design

The design of the experiment was a 3 x 2 x 2 x 2 factorial (see Figure 1). The factors were learning strategy aid (algorithm vs. checklist vs. no strategy), writing ability (high vs. low), test type (with learning strategy aids vs. without learning strategy aids), and order of testing conditions (aid introduced on first test vs. aid introduced on second test). Subjects were counter-balanced so that levels of the variable test type could be compared to determine the relative effects of presence or absence of the strategy aid. The dependent measures consisted of sentence-error-correction tests which



*Order of Presentation: 1 = with strategy aid first;
2 = with strategy aid second

Figure 1. The Experimental Design.

were used to assess student skill in correcting errors in written assignments.

Materials

Instrumentation. The Department of National Defence (D.N.D.) writing test was used to determine the subjects' writing abilities and to assign them to one of two equivalent groups. Writing ability was included as a variable to determine if the instructional treatments would differentially influence subjects with high and low writing abilities. The D.N.D. test measures levels of grammar, vocabulary, knowledge and organizational skills. Writing ability is designated in six levels: zero level (no significant proficiency), level one (elementary proficiency), level two (fair proficiency), level three (good proficiency), level four (very good proficiency), and level five (excellent proficiency).

The pretest consisted of sentences with 25 grammatical errors that were selected from the areas of grammatical importance in relation to the Advanced English Writing course. The two posttests each contained 25 errors that were, again, selected from areas of grammatical importance and from areas that had been taught (see Appendix B). In order to prevent recognition of the errors and to vary the testing format, one test consisted of 13 sentences with 25 errors, and the other test contained the same type of error hidden in a short passage. The two posttests were designed in order to evaluate the subjects' abilities to apply, form or internalize learning strategies to correct sentence errors.

Reliability of the two measures of error correction was calculated (Cronbach Alpha) and found to be .78 and .79 respectively. The instruments were judged to be of sufficient internal consistency (i.e., extent to which items measure the same construct) to warrant further analysis of the data.

The final grammar examination of the course was a three hour exam consisting of twelve sections. In order to test delay effects of the treatment groups, data were collected on the error-correction section which consisted of 25 items.

Learning Materials

This study compared three learning strategies for teaching error-correction in an Advanced English Writing course: an algorithm, a checklist, and a learner-assigned strategy control condition (Rigney, 1978). In the learner-assigned strategy control conditions, subjects themselves were expected to internally organize and then apply the grammatical rules learned in order to correct sentence errors. They were expected to develop or choose their own strategies for correcting errors. No help on the part of the teacher was given in forming appropriate strategies. Also, these subjects were given no materials over and above the regular course materials. In this way, a baseline condition was established against which other groups could be compared.

A checklist of grammar topics (see Appendix C), the first administered strategy, was developed as a guideline or aid for correcting sentence errors. Since the checklist was primarily constructed by the subjects with the teacher's guidance, the items were not listed in order of grammatical importance. Instead, the checklist items were ordered according to their usefulness to the subjects. Grammatically incorrect sentences were used to demonstrate and to practise the application of the checklist. It was expected that subjects would use the checklist to aid in retrieving the grammar rules previously learned and in applying them. In this condition, subjects were encouraged to memorize the checklist.

The algorithm, the second administered strategy (see Appendix D), was developed and discussed by the subjects and the teacher. Since the algorithm was a new concept for the subjects, it was necessary for the teacher to play an active role in guiding the subjects through the process. It was, again, expected that subjects would use the algorithmic process to solve the problem of error-correction. Subjects in this condition were encouraged to learn the algorithmic procedure. The algorithm strategy group received a blank flowchart and with the teacher's help developed an algorithm consisting of grammar rules taught in the course; the algorithm procedure which when followed would facilitate the detection and correction of errors in a sentence. They also received the same amount of practice time and the same number of practice exercises as the other two groups.

Procedure

The D.N.D. writing test was administered to all subjects just prior to the beginning of the fifteen week Advanced English course. Scores on the test ranged from 1 to -4, indicating two writing abilities: high and low. Scores of 1, -2, 2, +2 were categorized as low writing ability, and scores of 3, +3, -4 were catagorized as high writing ability. Subjects were then randomly assigned to the experimental or control conditions. Each condition consisted of two groups of high and low writing ability with fifteen subjects in each group. Each condition, then, had a total of thirty subjects. On the first day of class, a pretest was administered in order to determine the subjects' error-correction skills. All subjects showed a lack of error-correction knowledge.

In the sixth week of the course, the experimental treatments (i.e., the algorithm and the checklist) were presented. Fifty minutes was designated to develop and instruct each of the strategies. In the checklist strategy condition, it was stressed that using a list of grammar rules would help subjects locate and correct errors in sentences. In the algorithm group, the teacher approached error-correction like a problem-solving exercise, emphasizing that a systematic approach was necessary in order to solve a problem quickly, correctly and efficiently (Landa, 1972). The learner-assigned control group received no help or instruction in developing error-correction strategies. They were allowed to truely identify and choose their own strategies. All groups received one week of error-correction practice. After the week of practice, the first posttest was administered to all groups. In order to determine delayed effects of the strategies, the algorithm and the checklist groups were divided in half. One half of the subjects were tested with the use of the algorithm or checklist aid, and one week later tested without the aids; the other half was tested in the reversed manner, without the aids and then with the aids. Hereafter, the orders (i.e., posttests with aids and without aids) will be referred to as PA and PWA, respectively.

The learner-assigned control group received the same two posttests as the other groups. For convenience, however, their groups were not split, and they did not have any aids to use.

Subjects, at the end of the course, were administered three final examinations-reading, grammar and composition. The three hour examinations were held on three consecutive mornings. The error-correction section on the grammar exam was the only section of interest to this experiment.

It is important to note that all groups covered the same classroom instructional materials, were taught by the same teachers, received the same amount of time on the presentation of the learning strategies and on the practice, and were introduced to the strategies by the same teacher. The experiment took place over fifteen weeks. This time period included three weeks of student holidays; three weeks of instructing, practicing and testing the strategies; and three days of end of course exams.

Chapter 4

Results

Introduction

The purpose of this study was to examine the effects of training in the use of two learning strategies (i.e., the algorithm and the checklist) on error-correction in adult writing instruction. A learner-assigned control condition was used as a comparison group. In addition, levels of writing ability (i.e., high and low) and condition of testing (i.e., testing with and without the strategy prompt) were investigated relative to the main independent variable. It was also necessary to test the effects of two orders (i.e., one in which the aid was introduced on the first posttest followed by no aid on the second posttest and one in which the aid was introduced on the second posttest, following no aid on the first). It was expected that orders would not be significant, but that a two-way interaction would be found between levels of writing ability and training conditions, with high ability and low ability with poor performance in error-correction benefitting from training conditions, but with low ability students benefitting more from the training than high ability students. It was also hypothesized that differential performance would result depending upon whether or not testing conditions were accompanied by an aid (i.e., checklist or algorithm). It was planned that these hypotheses would be tested with a four-way analysis of covariance.

Test of Immediate Effects Design

Homogeneity of Regression. Analysis of covariance assumes that a single regression coefficient can serve to explain the relationship between predictor (i.e., pretest) and the dependent variable across the design of the study. In other words, the regression slope of the treatments should be parallel (within error) so that no interaction exists. When the interaction (α = .25) of the pretest by treatments was tested across the average of PA and PWA, no significant differences were detected, F(1, 168) = .78, p = .46. As a result of this analysis, the pretest was deemed appropriate as a covariate in the subsequent analysis.

Analysis of Covariance. A four-way analysis of variance was conducted on the data. PA and PWA served as levels of the repeated factor. Treatments (i.e., control, algorithm and checklist), writing ability (i.e., high and low) and the order of presentation (i.e., PA then PWA or PWA then PA) were between-group factors. Means, adjusted means and standard deviations for PA and PWA across the design are shown in Table 1. Table 2 shows the outcome of the four-way tests of significance. A follow-up analysis centered on the Condition by Ability by Test Type interaction. The other three-way interactions were not analyzed because order (O) had been originally included as a control factor in the design and was viewed to have no educational relevance. If the four-way interaction had been significant the analysis would have, by necessity, included both order of testing and test type. An indication that order of presentation did not jeopardize the interpretation of the PA and PWA results (i.e., order could be dismissed) is provided by the non-significant order by test type interaction, F(1, 168) = 2.56, p = .11.

Table 1

Means, Adjusted Means and Standard Deviations for Order of Presentation of the Repeated Measures (PA)

Order	Writing Level: High	Writing Level: Low
	Control	
PA first		
M[a]	17.13	8.60
M adj[b]	15.33	9.82
SD	3.38	2.50
PA second		
M	17.47	8.93
M adj	15.80	10.69
SD	2.50	3.39
	Checklist	
PA first		
M	17.60	13.40
M adj	16.38	14.80
SD	2.95	3.25
PA second		
M	19.40	12.87
M adj	18.67	14.36
SD	2.69	3.22
	Algorithm	
PA first		
M	18.13	11.13
M adj	16.42	12.71
SD	3.15	4.34
PA second		
M	18.67	10.87
M adj	17.09	12.13
SD	2.13	3.40

Note. PA first refers to posttest with strategy aid administered as the first posttest.

PA second refers to strategy aid on the second posttest.

[a]Based upon 15 subjects. [b]Regression coefficient = .67.

(table continues)

Table 1

Means, Adjusted Means and Standard Deviations for Order of Presentation of the Repeated Measures (PWA)

Order	Writing Level: High	Writing Level: Low
	Control	
PWA first		
M[a]	17.27	8.00
M adj[b]	15.46	9.22
SD	3.28	2.17
PWA second		
M	17.53	10.07
M adj	15.86	11.83
SD	2.10	3.61
	Checklist	
PWA first		
M	17.53	11.27
M adj	16.31	12.67
SD	3.44	3.33
PWA second		
M	17.73	9.73
M adj	16.99	11.22
SD	2.31	2.37
	Algorithm	
PWA first		
M	18.40	10.60
M adj	16.69	12.18
SD	2.92	4.39
PWA second		
M	18.73	9.13
M adj	17.15	10.40
SD	2.05	3.23

Note. PWA first refers to posttest without strategy aid administered as the first posttest.

PWA second refers to without strategy aid on the second posttest.

[a]Based upon 15 subjects. [b]Regression coefficient = .67.

Table 2

Summary of Four-Way Analysis of Covariance

Source	df	MS	F	$p <$	ω^2
Conditions (C)	2	106.23	6.05	.003	.05
Ability (A)	1	5175.63	294.95	.001	.62
Order (O)	1	2.67	.15	.70	-
C x A	2	41.20	2.35	.10	-
C x O	2	7.81	.45	.65	-
A x O	1	14.80	.84	.40	-
C x A x O	2	17.48	1.00	.40	-
Covariate	1	605.32	51.11	.00	-
Error	168	17.55			
Test Type (T)	1	42.03	31.64	.001	.15
T x C	2	28.93	21.78	.001	.19
T x A	1	21.03	15.83	.001	.08
T x O	1	3.40	2.56	.11	-
T x C x A	2	7.63	5.75	.005	.05
T x C x O	2	9.08	6.83	.002	.06
T x A x O	1	1.23	.92	.40	-
T x C x A x O	2	3.70	2.79	.10	-
Error	168	1.33			

Figure 2 shows the interaction of Condition, Ability and Test Type. In order to further investigate this interaction, separate two-way analyses were conducted at each level of ability. Figure 3 demonstrates the over-all analytical plan that was used. The results of these component factorial analyses are shown in Table 3. Both two-way tests were significant. Since both interactions appeared to implicate the relationship between the checklist and the algorithm conditions, a two-way partial factorial was conducted.[1] In this analysis, only test type and order were compared. Results of this analysis appear in Table 4. As a result of these, pairwise analysis of means was conducted using Scheffé contrasts. The significant interaction of Treatment and Test Type appear to have occurred as a result of a significant difference between checklist and algorithm at PA, but not at PWA (α = .05). This suggests that for low writing ability subjects, the checklist outperformed the algorithm as a job aid (i.e., when the aid was present at testing), but that the two performed equally effectively, albeit at a lower level when the aid was not present at the testing session. When the combined checklist and algorithm groups were compared with the control group at PWA, no difference resulted. This suggests that the shortterm effects of training in the use of writing aids is limited, at least as far as low writing ability subjects are concerned.

For high ability subjects, no significant differences were found between the algorithm and the checklist conditions at either PA or PWA,

[1] Each of these component and partial factorials use the appropriate error terms from the overall analysis (Table 2).

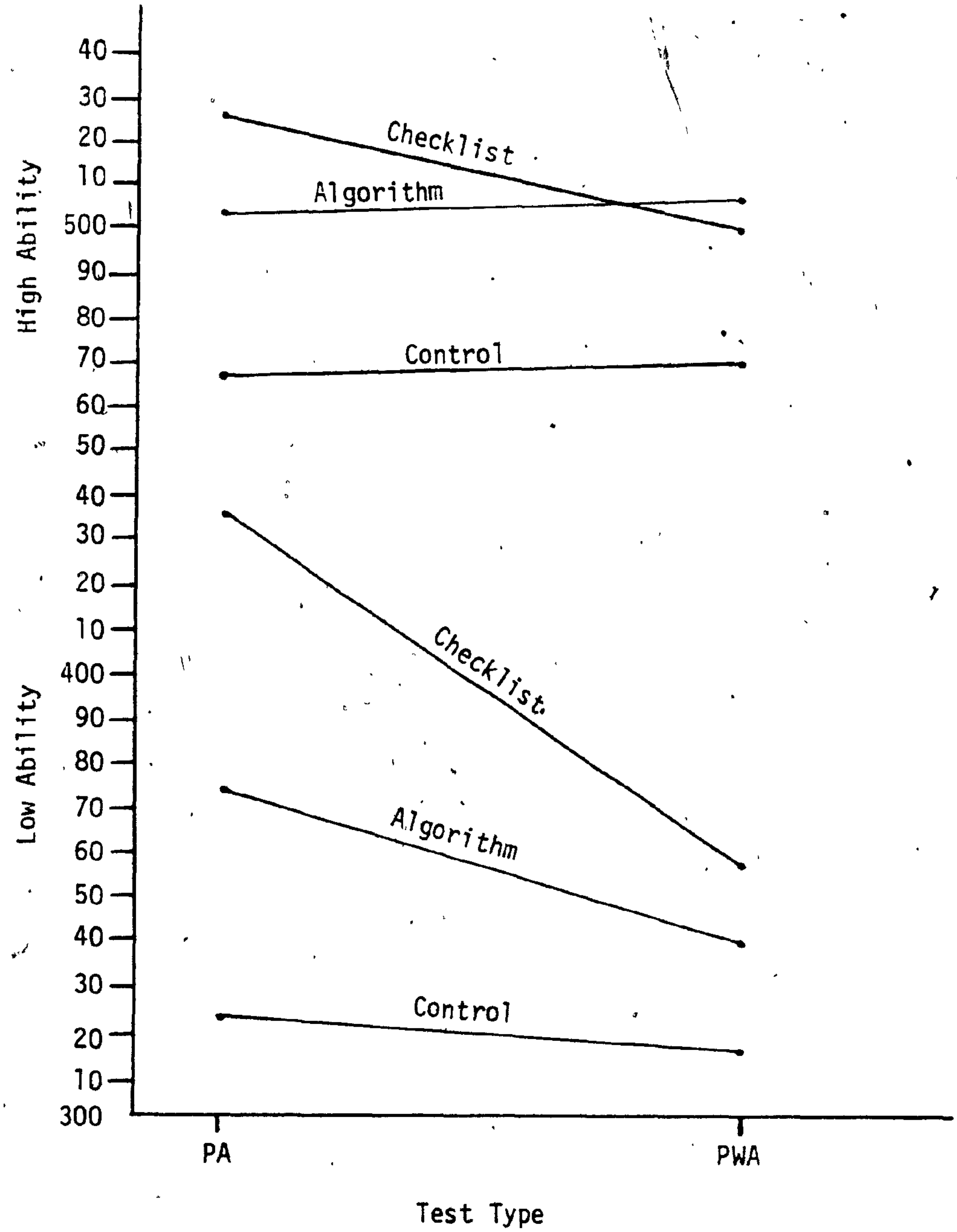


Figure 2. Interaction of Condition, Ability, Test Type.

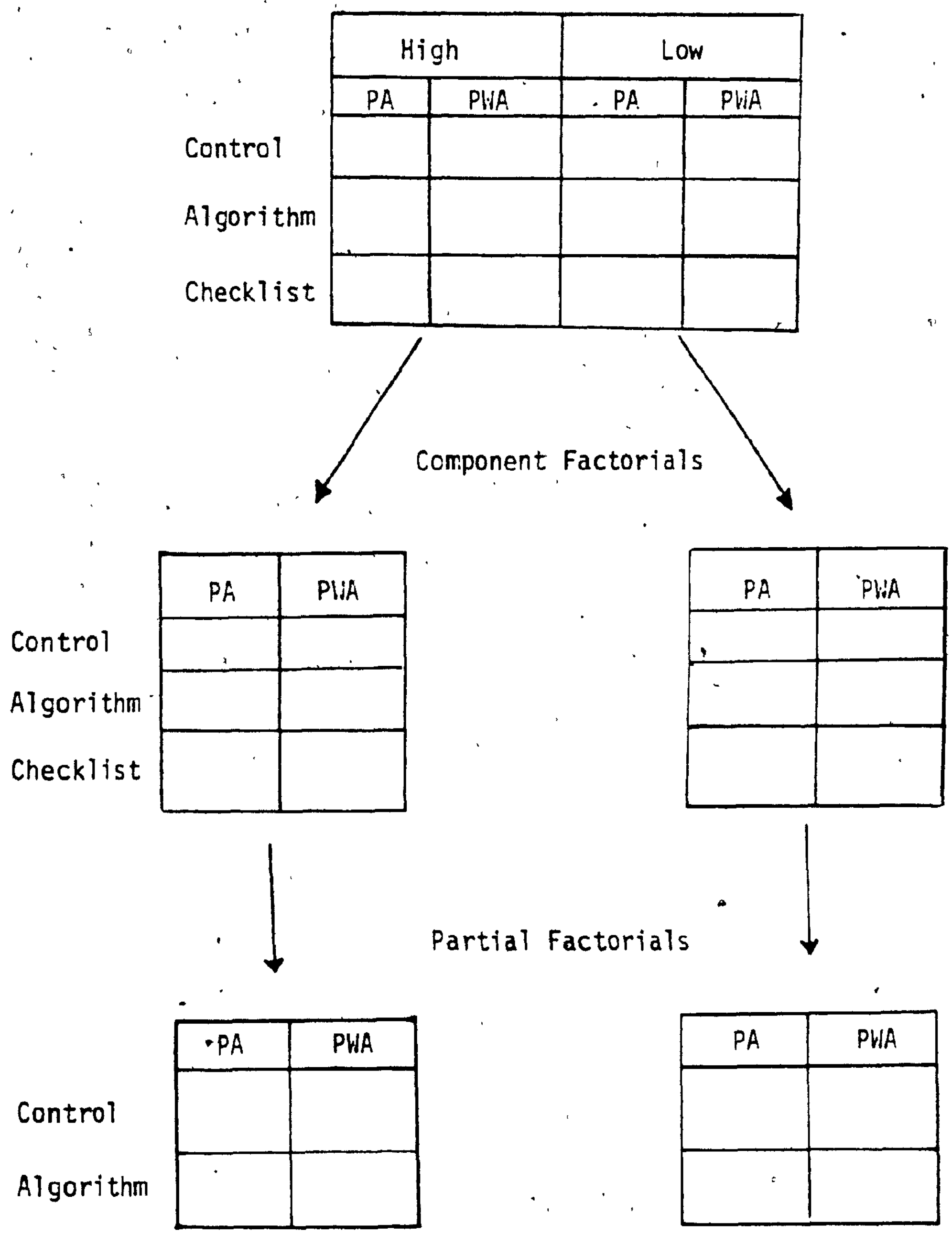


Figure 3. Over-all Three-Way Factorial Analysis.

Table 3

Component Factorials from the Three-Way Analysis

Source	SS	df	MS	F	p
T[a] x C at High	46.34	2	23.17	17.42	.001
T x C at Low	10.03	2	5.02	3.77	.03
Error	223.13	168	1.33		

Note. [a]Component factorial involves all three treatment conditions.

Table 4

Partial Factorial at Levels of Ability

Source	SS	df	MS	F	p
T[a] x C at High	16.87	1	16.87	12.68	.0005
T x C at Low	8.01	1	8.01	6.02	.02
Error	223.13	168	1.33		

Note. [a]Partial factorial involves only the algorithm and checklist conditions.

indicating that neither provided superior strategy than the other. Similarly, post hoc differences were found when the control condition was compared with the average of algorithm and checklist at PA, but not at PWA. By comparison to the low ability subjects, however, the difference in favor of the aid treatments when the aid was present was slight.

Delayed Effects Design

In this analysis two tests, one immediate (PWA) and one delayed, were tested across the between group design of the study. Each test contained 25 items of a similar nature. The purpose of this analysis was to determine if the algorithm and checklist conditions retained their effectiveness over time in relation to the control condition, which at no time during the course received anything more than standard instruction in error-correction. The delayed posttest was administered about one and a half months after the administration of the immediate posttest without the aid (PWA).

Homogeneity of Regression. Again, a test of homogeneity was conducted in order to determine if the pretest could be used as a covariate in the analysis. The test of the interaction of Pretest by Treatment by Ability produced no significant results (α = .25), $f(2, 168) = 1.09$, $p < .37$. It was judged, based upon this test, that the pretest could serve as a covariate in the analysis. The pretest also was found to be highly correlated with the average of the two posttests ($r = .77$, $r^2 = .59$).

Analysis of Covariance. Three-way analysis of covariance was performed on the data. Means, adjusted means and standard deviations resulting from this analysis are shown in Table 5. The ANCOVA summary

Table 5

Means, Adjusted Means and Standard Deviations for Immediate (PWA) and Delayed Posttests

Test	Writing Level High	Low
	Control	
Immediate		
M[a]	17.40	9.03
M adj[b]	15.92	10.30
SD	2.71	3.11
Delayed		
M	16.73	8.53
M adj	15.26	9.80
SD	2.82	2.34
	Checklist	
Immediate		
M	17.63	10.50
M adj	16.80	11.73
SD	2.88	2.95
Delayed		
M	17.53	9.50
M adj	16.70	10.73
SD	2.60	2.61
	Algorithm	
Immediate		
M	18.57	9.87
M adj	17.17	11.08
SD	2.49	3.86
Delayed		
M	17.97	10.13
M adj	16.57	11.34
SD	2.09	3.26

[a]Based upon 30 subjects. [b]Regression coefficient = .57.

table appears in Table 6. The analysis of these results, then, centered upon the significant three-way interaction, $F(2, 174) = 6.46$, $p = .002$. This interaction is graphed in Figure 4. A strategy similar to that employed in the previous analysis was used in order to determine the locus of the three-way effect. First, a component factorial analysis (see Table 7) was conducted separately at each level of ability, since it appeared that differences resulted primarily between treatments and tests (immediate and delayed). The results of this breakdown of the three-way design into two-way component factorials is shown in Figure 3. These results indicate that the primary source of the three-way interaction resided in low ability subjects. Post hoc Scheffé comparisons among means were conducted separately for the immediate and delayed tests. No differences were found between checklist, algorithm and the control conditions. These results are similar to those found in the prior analysis for the measure called PWA. However, when the algorithm treatment was compared to the control group for the delayed measure, a significant difference was found. No difference was found for the comparison of checklist and control at the delayed level. These results suggest that the acquisition of the algorithm writing correction strategy increased over time, while the checklist, as a strategy diminished over time. These results occurred, as previously mentioned, only for low writing ability subjects.

Table 6

Summary of Three-Way Analysis of Covariance

Source	SS	df	MS	F	p
Treatment (T)	113.80	2	56.90	4.80	.01
Ability (A)	1463.33	1	1463.33	123.56	.00
T x A	.32	2	.16	.01	.99
Covariate	605.32	1	605.32	51.11	.00
Error	2048.91	173	11.84		
Time of Testing (Q)	16.90	1	16.90	18.38	.00
Q x T	3.22	2	1.61	1.75	.18
Q x A	.04	1	.04	.05	.83
Q x T x A	11.87	2	5.94	6.46	.002
Error	159.97	174	.92		

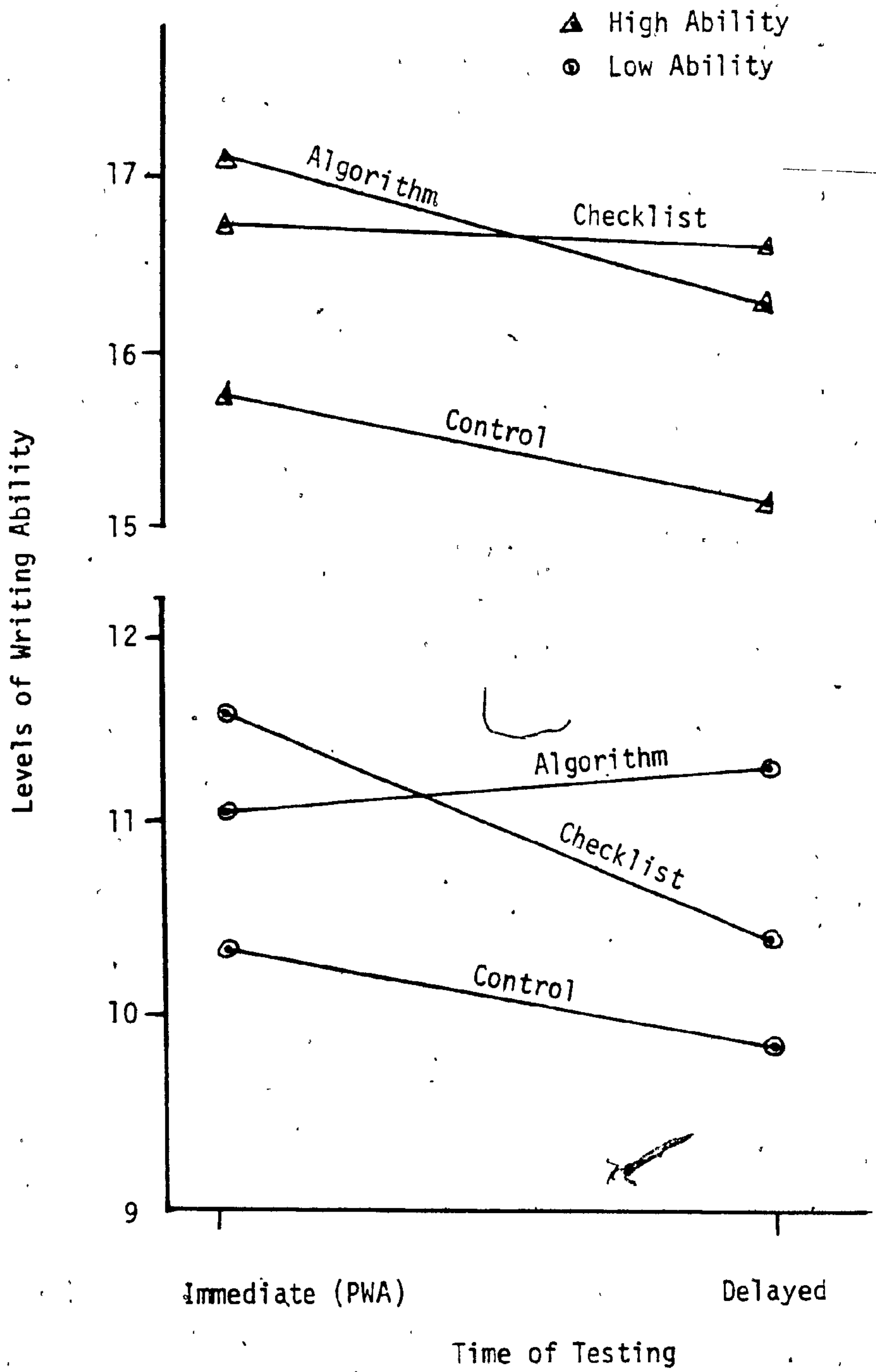


Figure 4. Interaction of Writing Ability, Immediate and Delayed Testing.

Table 7

Component Factorial at each Level of Ability

Source	SS	df	MS	F	p
T x C at Low	14.22	4	3.56	3.87	.001
T x C at High	2.88	4	.72	.78	> .05
Error	159.97	174	.92		

Chapter 5

Discussion and Conclusion

The main goal of this study was to make a genuine attempt at prescribing and applying learning strategies that would satisfy a real educational need. Based on an extensive body of research into learning strategies, the algorithm and checklist were believed to be two viable learning strategies that could facilitate in the development of the skill of sentence-error-correction in writing. The results of this experiment confirm what other researchers have reported: a learner can be adapted to instruction by guiding his information processing operations with the use of strategies that when used would develop or activate his mental skills (Rigney, 1978; Weinstein, 1980; Bovy, 1981). Thus, teaching the algorithm and the checklist strategies in order to develop mental skills will aid in building a repertoire of strategies which will eventually be needed by the learner to develop metacognitive skills. Overall results of the experiment add evidence to the fact that learning strategies (i.e., the algorithm and the checklist) do, in fact, have an impact on the learners exposed to the strategy training conditions.

It was hypothesized that students with high and low writing ability lacking in error-correction skills would benefit from the strategy training conditions. It was further assumed that subjects with low writing ability would benefit more from the strategy training than high ability subjects. The rationale was that high ability subjects are usually capable of deciding for themselves which strategy to use

(Bovy, 1981; Snow, 1980). The overall results did, in fact, support this hypothesis.

Writing ability was not, as mentioned earlier in the study, a randomly selected variable; it was chosen because it was thought to interact with the specific learning strategy when present as an aid and when removed. For low writing ability subjects, the checklist group outperformed the algorithm group when the strategy aid was present during testing; however, it did not when it was removed. This suggests that for low ability writing subjects the checklist performs well as a job aid. When the two groups (the algorithm and the checklist) were compared, when the strategy aids were not present during testing, the two groups performed equally effectively. This study along with studies done by Thorndyke and Stasz, 1980; Bovy, 1981; Winn, 1982 indicate that low ability subjects produce superior performances in applying learned knowledge to novel problems when they were instructed in learning strategies. However, when the two treatment groups (i.e., the algorithm and the checklist) were compared with the control group during testing without the strategy aids, no difference resulted.

The fact that the checklist is very effective when used and that neither the algorithm not the checklist when removed outperformed the control group suggests the following possibilities. The checklist may be appropriate as a job aid, or as a learning strategy, information in it may not have reached the status of "mental skills". That is, as argued by Bovy (1981), the learner does not yet have control of the cognitive processes needed to accomplish the learning task, and in the case of this experiment, the learner is relying on the aid externally. The algorithm, on the other hand, models problem-solving processes by providing step-by-step prescriptives for carrying out a defined sequence of operations in order to solve a problem, in this case, to correct sentence errors. In order for the learner to shift from external reliance to internal control, both time and practice using the new strategies must be provided.

For high writing ability subjects, results from this experiment were less dramatic. No significant differences were found between the algorithm and the checklist training conditions when the strategy aids were present or were not present during testing. Because high ability learners usually have developed adequate internal processing methods, in addition to having a repertoire of strategies from which to choose, it is argued by Bovy (1981) that they exhibit a decrease in performance when directed to use a specific processing strategy. Although results from this experiment do not entirely support her position, it can be argued that the results were affected by high ability subjects choosing their own strategies, regardless of how effective they were. In fact, according to Winn (1983), modelling or assigning strategies could even interfere with the way they learn. However, the over-all results from this experiment have indicated that high ability subjects have, in fact, benefitted, although slightly, from the strategy treatments rather than decreasing in performance as suggested by Bovy. This supports Snow's (1980) argument that although high ability subjects do use strategies in learning situations, they do not necessarily use the best strategy for the task. In other words, it should not be taken for granted by the educator or the designer that high ability learners are capable of deciding for themselves at all times which strategy to use and when to use it.

The results, in addition to supporting the first hypothesis, have added support to the second hypothesis that differential performance would result depending on whether or not the strategy aid (i.e., the algorithm or checklist) was present during testing. The checklist and the algorithm groups did out-perform the control groups when the aids were present and when they were not present. However, results indicated that the greatest difference was observed when the aids were removed. This may be explained by the fact that the algorithm and the checklist are, perhaps, still at the job aid status and have not, as previously mentioned, reached the status of "mental skills". Since the learner is relying on the aids externally, the control necessary to apply the learning strategies is still applied from outside the learner. Again, it becomes evident that time and practice are necessary to develop meta-cognitive skills that are found within the learner. That is, once the learners have internal control, they, then, are capable of deciding for themselves on the best strategy for the task (Winn, 1983).

In order for the learner to be able to adapt to the instruction provided, Winn (1983) states that the learner must have a sufficiently large repertoire of mental skills that can be used as learning strategies. It was, hoped, that training the subjects to use the algorithm or the checklist would, in fact, be aiding or developing such a repertoire. The data collected from the delayed posttest administered five weeks after the conclusion of this experiment indicated that on the second unaided test (delayed) only the low ability algorithm condition group outperformed the control group. This suggests that the algorithm functions more as a mental aid, stimulating intellectual processes for the low ability subjects than did the checklist. The algorithm is a process that allows learners, once they understand the procedures involved to organize the learning task in order to solve problems, and in this case, the problem of detecting and correcting errors in sentences. Training a learner how to reason by using an algorithm is, in essence, training him in mental skills. It has been suggested by researchers such as Winn, 1982; Bovy, 1981; Scandura, 1977; Federico, 1980 that the learning strategy should model the cognitive processes that are used in the learning task. Landa (1974, 1976) noted in his studies that algorithm training can help learners to examine their own problem-solving processes and to use the information to improve their cognitive skills. An algorithm is, in essence, an analysis of a cognitive process into discrete operations. The checklist, on the other hand, is a list of rules rather than a problem solving process. However, analysis of the results for the variable condition (i.e., the algorithm, the checklist and the control group) revealed that only the checklist condition reliably outperformed the algorithm condition. This may be explained by the fact that the checklist physically and psychologically is easy to interpret, is familiar to most users, and is simple in format. The checklist lends itself to easy application, and as a result may minimize the load on the short term memory. The revision process in writing, as Stallard (1974) has noted, contains a number of processes that can be overwhelming to the novice editor. Using the checklist is probably less taxing than the algorithm when used as an aid or when assimilated as a strategy.

The subjects, in the experiment, using the algorithm were faced with two tasks: learning to use the algorithm which in most cases was an unfamiliar procedure and learning, at the same time, error-correction skills. Because of its complexity, the algorithm may, in fact, impede immediate performance as an aid since it is too bulky and time consuming to be used per se. All groups received the same number of practices with the same amount of time; perhaps, for the algorithm to be internalized, more time and practice is necessary.

The fact that the algorithm and checklist trained groups responded more favourably than the control groups supports the precept that a learner can be taught by means of learning strategies to develop error-correction skills in writing. In addition, data collected from the delayed posttest administered five weeks after the conclusion of this experiment to all subjects added further support to the hypothesis. Results indicated that both treatment groups outperformed the control groups.

Recommendations and Conclusion

It has been argued over the years whether learning strategies make any difference in determining the acquisition of learning. Learning involves insight and means understanding of logical relationships or perceptions of the connections between ends and means. On the basis of these results, therefore, it is reasonable to suggest that teaching learning strategies can positively affect learning. Specific recommendations can be made for teachers teaching error-correction skills to learners in order to achieve effective written communications. It is suggested that this study be replicated, but with some modifications. These modifications would include using educational level (i.e., number of years of formal education) rather than writing ability. In addition, it is suggested that a less complicated algorithm be designed in future studies. In order for this to be done, fewer grammar points should be taught and included in the algorithm and perhaps more time spent on the presentation of the procedure. It is the thinking process used in order to attack and then solve a problem that needs to be practised. The experimental algorithm was too bulky and at times hindered the subjects. Further research could be conducted to teach a variety of effective strategies to subjects and to instruct them in their use (Rigney, 1978). By building a repertoire of strategies within the learner, the novice writer's dependency on external aids can be shifted to internal reliance, that is, reliance on long-term memory, self-generated instructions and self-monitoring.

We as instructional designers and educational technologists must continually direct our attention to providing alternative strategies for learners in order to process information more effectively and efficiently. Which strategies learners of various aptitude levels and grade levels possess or are capable of possessing remain unanswered. More research needs to be conducted within this paradigm. Dansereau (1978) noted in his research that "individual aptitude or strategies" or both may be the cause of performance differences.

In conclusion, this study along with those included in this paper has shed more light on some key issues that educational technologists, instructional designers and educators have been concerned with; namely, the need to adapt the learner to the materials, and most importantly, the need to be aware of the cognitive strategies that a learner brings to and uses during the learning process. This study only represents a cursory look into the teaching of learning strategies. More strategies should be taught and tested to add empirical validity in linking learning theory to teaching. Error-correction is only one aspect of writing; other aspects of the writing process should also be investigated.

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Appendices

Appendix A

PRETEST

1. An organ is a group of tissue capable tc perform some special function, as for example, the heart, the liver, or the lungs.
2. Even though she has open a window, the smell of smoke is still to strong.
3. Please send me informations with regard of insurance policies available from your company.
4. Dairying is concerned with the production of milk, but with the manufacturing of milk products such as butter and milk.
5. If you will buy one box at regular price, you will receive another one.
6. When he was a little boy, Jim would walk along the beach, watch the boats, swimming and fishing in the river.
7. The bell signaling the end ringed loud, interrupting the professor.
8. The information officer at the bank told to us that there was several kinds of accounts.
9. Ellen does not finish studying in time to go the party with her friends last night.
10. The Department of Fine Arts and Architecture has been criticized for not having much required courses schedulled for this term.
11. In order to get married. One must present a medical report along with you identification.
12. Henry refused to attend the dinner because he did not like to dress formerly.

13. While he was in the army, he learned both the Russian as well as the German.

Appendix B

POSTTEST

Find and correct the errors in the following passage.

Ask any record company Executives to list important pop recording artists of the decade, and no doubt he will mentions Jose Feliciano. Now a recognized star. Both in the United States and abroad, Jose Feliciano endured many difficulties on his way to fame. After moving from Puerto Rico to America, he had to fight to become famous, in addition, he had to overcome the problems of being blind.

Jose's father which had been a farmer leaved the Caribbean to try his luck at Manhattan. Because he wanted to become a musical star; Jose learned to play the guitar. He spend much of his time indoors listening Elvis Presley and Ray Charles on the radio. His music began to show it's effect.

His first job was in the Detroit Michigan. Then he was returning to the east to perform in Greenwich Village. He was continuously encourage by his wife to keep working. Finally, with her encouragement and his perseverance, in 1968 his song "Light My Fire" started his career.

With his new hit, Jose who intent was to spread his music looked forward to playing all over country from the Atlantic to the Pacific, from Canada to Mexico. Today, having won the music industry Grammy Award, Jose continue to work hard. As usual, his next concert it will be before a sell-out crowd.

(Appendix B continues)

Appendix B

POSTTEST

Find and correct the errors in the following sentences.

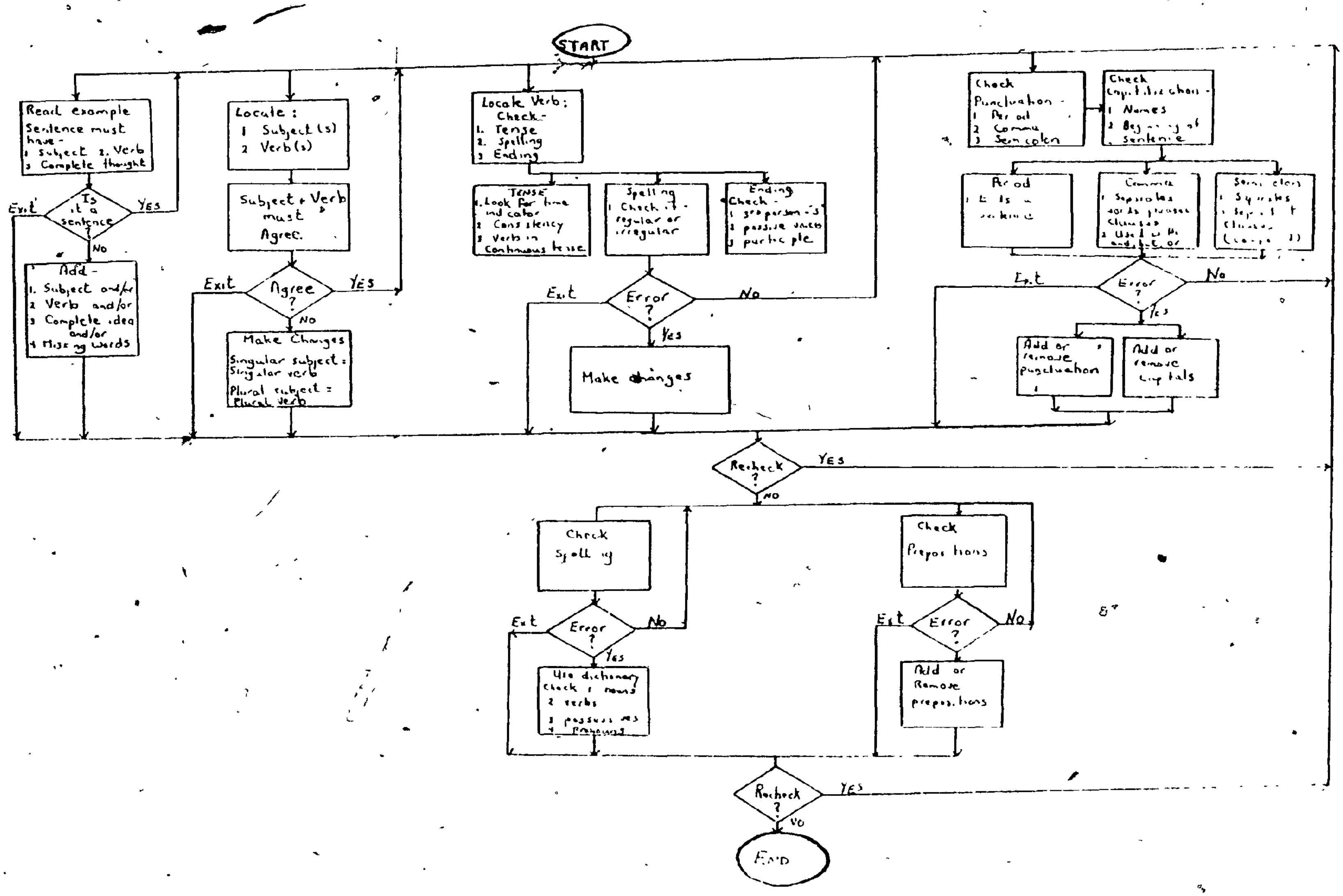
1. When he finally arrived to the Office, Doctor Smith had left.
2. During rush hour. Everyone gets very irritable.
3. The scientist was disturb by the conclusion they had reached at end of the experiment.
4. It will costs a considerable amount of money to repair some of the new equipment, however, the supervisor feel the money must be spent.
5. Although I was arriving in plenty of time; I found little food left.
6. Jack is a boy who I suppose will go to college in Montreal Quebec.
7. He have a good vacation in ontario last summer.
8. The lady was hitted by a car, and she was going to work.
9. Louise who is a conscientious student always does her work well.
10. The students they explained me the problem.
11. Theres no effect from the medicine.
12. The Canadians must be more concerned with the country business.
13. Their is a sale in the mens' department.

Appendix C

ERROR-CORRECTION CHECKLIST

	YES	NO
1. Capitalization		
2. Article		
3. Preposition		
4. Sentence Construction - run-on sentence fragment		
5. Punctuation (comma, semicolon, period)		
6. Faulty Verb Tense		
7. Double Subject		
8. Spelling		
9. Correct Use of the Apostrophe		
10. Subject-Verb Agreement		

Appendix D


START
Read example
Sentence must have -
1 Subject 2. Verb
3 Complete thought
Is it a sentence
Yes
No
Exit
Add -
1. Subject and/or
2 Verb and/or
3 Complete idea and/or
4 Missing words
Locate :
1 Subject (s)
2 Verb (s)
Subject + Verb must Agree.
Agree ?
Yes
No
Exit
Make Changes
Singular subject = Singular verb
Plural subject = Plural verb
Locate Verb; Check -
1. Tense
2. Spelling
3 Ending
TENSE
1. Look for time indicator
2 Consistency
3 Verbs in Continuous tense
Spelling
1 Check if - regular or irregular
Ending Check -
1 3rd person - s
2 passive voice
3 participle
Error ?
Exit
No
Yes
Make changes
Check Punctuation -
1 Period
2 Comma
3 Semicolon
Check Capitalization -
1 Names
2 Beginning of Sentence
Period
Comma
Semicolon
Error ?
Exit
No
Yes
Add or remove Punctuation
Add or remove Capitals
Recheck ?
Yes
No
Check Spelling
Error ?
Exit
No
Yes
Use dictionary
Check 1 nouns
2 verbs
3 possessives
4 Pronouns
Check Prepositions
Error ?
Exit
No
Add or Remove prepositions
Recheck ?
Yes
No
End