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THE RELATIONSHIPS AMONG TASK COMPLEXITY, CONTENT SEQUENCE, AND INSTRUCTIONAL EFFECTIVENESS IN PROCEDURAL LEARNING

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THE UNIVERSITY OF OKLAHOMA

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THE RELATIONSHIPS AMONG TASK COMPLEXITY, CONTENT SEQUENCE, AND INSTRUCTIONAL EFFECTIVENESS IN PROCEDURAL LEARNING

A

DISSERTATION

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JOHN F. WEDMAN, JR.

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THE RELATIONSHIPS AMONG TASK COMPLEXITY, CONTENT SEQUENCE,

AND INSTRUCTIONAL EFFECTIVENESS IN

PROCEDURAL LEARNING

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CHAPTER I

INTRODUCTION TO THE STUDY

Instructional effectiveness is a function of several variables such as student characteristics and organizational strategies. The focus of this research was on the relationships between the instructional variables of task complexity and content sequence and their functional relationship to instructional effectiveness.

Background

Sequence considerations are fundamental to both research and theory on instruction. As pointed out by Tennyson (1972), "a controversial problem in instructional research and development has been the sequencing of subject material to increase both effectiveness and efficiency of learning" (p. 147). Bruner (1966) says "the sequence in which a learner encounters materials within a domain of knowledge affects the difficulty he will have in achieving mastery" (p. 49). Indeed, sequence is fundamental to any learning situation. Textbook chapters are organized in some order deemed optimal by the author, and then often resequenced by an instructor using the textbook. Lectures and presentations are structured to take the learner along some path (or paths) towards a desired goal. No matter what the content consists of, organization (of some sort), and, hence sequence (of some sort), is inevitable.

Content sequence can be thought of in relation to the orientation of the content. Three types of content orientations can be described: conceptual, theoretical, and procedural. A conceptual orientation emphasizes ideas, objects, or events which have certain common characteristics. A theoretical orientation is primarily concerned with change relationships between concepts. A procedural orientation deals with skills, techniques, and methods to achieve an end. Within each of these content orientations the sequence for developing the concept, principle, or procedure will have direct impact on the content and, therefore, the learning outcome.

The organization and sequencing of instructional content can occur on two levels: micro and macro. Micro organization strategies are ways of organizing instruction on a single content topic. Macro organization strategies are ways of organizing those aspects of instruction which relate to more than one topic (Reigeluth, 1979).

On a micro level, the question of organization has been addressed by many thinkers. Gagné has described the "events of instruction" (Gagné & Briggs, 1974) which will occur in a single instructional event. Ausubel (1960) presented the notion of the "advance organizer" as a strategy for anchoring new material to existing knowledge. M. D. Merrill (Merrill, Reigeluth & Faust, 1979) has presented "component display theory" as a strategy for organizing and presenting instruction on a single topic. Anderson (1974) has developed "kinetic structure theory" which involves the use of linking words between two consecutive verbal statements. There is, then, a wealth of useful information regarding the organization of instructional sequence on a micro level. On a macro level, the literature is less helpful.

Briggs (1977) claims that "most of the research on sequencing of instruction has dealt with sequencing at a smaller 'size of chunk,' such as frames within a programmed instructional unit requiring only a few minutes or hours of instruction rather than days or months" (p. 111). Posner and Strike (1976) developed a menu of content sequence options. Yet, they warn ". . . we have very little information, based on hard data, regarding the consequence of alternative content sequences and will need a good deal more research effort before we are able to satisfactorily suggest how content should be sequenced" (p. 665). This is not to say that sequence options are not available, but that little is known of the consequences of the options.

Central to any choice among sequence options is the question of the opportunity for the learner to integrate the subject matter content on the application level. In other words, at what point(s) in the instruction will the learner be able to apply the content as a whole, rather than apply parts of the content. Operationally, opportunity for content integration can be thought of along a continuum defined on one extreme by a sequence providing ongoing integration of the content and on the other extreme by a sequence which provides for integration only upon completion of all instruction. The forest and trees analogy which follows may be helpful here.

Instruction can begin by presenting an integrated or whole view of the subject matter content (the forest) on an application level. The learner will be able to apply a complete, but simple version of the content to a given task. Then instruction can proceed to examine the major topics (the trees), again on an application level allowing for integration of the content. After the major topics have been examined, the subparts (leaves and branches) can be examined. This general-to-detail sequence can continue until the final criterion level of detail is reached.

In contrast, the other extreme of the continuum shows content being sequenced on the final criterion level of detail. Instruction proceeds from one subtopic to the next (from leaf to leaf and branch to branch, only showing the forest after all the leaves and branches have been examined). After instruction has been completed on all subtopics, content integration is possible. The question is: "At what point(s) in the instruction will content integration on the application level be optimal for learning effectiveness?"

For a learner to be able to apply content, the learner must be able to use the content to meet the demands of a given task in a given situation. For instance, if the content is the concept of "photographic overexposure," the learner might use this concept to identify instances of photographs that were overexposed. If the content is the principle that relates depth of field and lens aperture, the student might be asked to explain why a given photograph might have a blurred background whereas another photograph has a focused background. If the content is the procedure for developing black and white film, the learner would be able to execute all the steps in the process. Note that memory alone will not meet the demands of the example tasks. An integrated application of the content is evidenced when the concepts, principles and/or procedures are applied collectively in a given situation.

The concept of content integration on the application level can be contrasted to Ausubel's concept of the advance organizer. Ausubel (1968) defined advance organizers as "appropriately relevant and inclusive materials. . . introduced in advance of learning. . . and presented at a higher level of abstraction, generality, and inclusiveness" (p. 148). The function of the advance organizer is "to provide ideational scaffolding for the stable incorporation and retention of the more detailed and differentiated material that follows" (p. 148). While both concepts (advance organizers and integrated application) are attempts to facilitate learning by providing for content integration, a critical difference between these concepts can be identified. The advance organizer is, by definition, content presented on a higher level of abstraction. Content integration on the application level, while perhaps related to content integration on a more abstract level, is conceptually distinct from the advance organizer.

The opportunity for integrated application of content is especially critical when sequencing procedural content. Procedural learning involves learning to execute a series of steps or operations in the proper order (Allen, 1967). Using Allen's definition of procedural learning, it is evident that the issue of integrated application is fundamental to learning procedural content. A learner who does not know all the steps in a procedure does not know the procedure. A learner who knows only a simple version of a procedure may not be able to respond to tasks requiring a complex version of the procedure.

For instance, an instructional sequence may have presented, in depth, the procedure for division of whole and decimal numbers, up to the point of what to do with the "remainder." The student may not have been shown how to express the remainder as a fraction and thus, cannot solve some problems involving division. In contrast, another sequence may have first presented a simple version of the entire division process. The student may know how to express division remainders, but only when working with simple division problems. Division involving decimals presents a problem too complex for the simple procedures to handle. In either instance, a relationship between procedural learning and content sequence, in particular, the timing of opportunity for content integration, appears to be at work.

Procedural content can be considered along a continuum from simple to complex. Procedures which require few steps and decisions can be thought of as relatively simple while procedures that require several steps and/or multiple decisions can be thought of as relatively complex. For instance, the procedure for setting the time on a kitchen clock is relatively simple. The procedure for setting the time, date, alarm, etc., on a modern digital watch is relatively complex. In organizing content for either simple or complex procedures, the question of sequence remains fundamental.

Statement of the Problem

The problem for this study was to examine the relationship between task complexity, content sequence (in particular, opportunity for content integration on the application level), and instructional effectiveness in procedural learning tasks.

Purpose of the Study

The purpose of this study was to increase the empirical support for theoretic prescriptions found in the literature on content sequencing. Two general questions were investigated:

1. Is the timing of the opportunity for the learner to integrate procedural content on the application level related to performance on tasks of high complexity?

2. Is the timing of the opportunity for the learner to integrate procedural content on the application level related to performance on tasks of low complexity?

Theoretical Framework and Hypotheses

The theoretical approach used in much research on sequencing is a version of the assimiliation-to-schema concept (Mayer, 1977). Mayer describes this learning concept as follows:

> In its simplest form the concept refers to the process of learning as the acquisition of new material in the learner by connecting it with (or 'assimilating' it to) some aspect of existing cognitive structure (or 'schema'), and the product of learning as the newly reorganized cognitive structure which integrates old and new knowledge and which, in turn, may serve as an assimilative schema for subsequent learning. (p. 369)

This concept leads to the theoretical prediction that "subjects given a general model or general experience in thinking about examples will have a meaningful learning set for encoding the subsequent new specifics and hence will be able to assimilate the material to a broader set of past experiences... while subjects given the same set after learning will have already encoded the new material within a much narrower set" (p. 372).

Mayer has found much of the past research on sequence using assimiliation-to-schema theory to have focused on a general-to-specifc sequence. He summarizes the research findings by saying that the general-to-specific sequence results in increased retention in verbal learning and better transfer in conceptual learning. Mayer concludes his argument by noting that events which lead to the creation of a meaningful learning set are critical to instructional effectiveness. He lists advance organizers, titles, headings, topic sentences, and meaningful organization as potential contributors to establishing a meaningful learning set. The question for this research is whether or not the ongoing opportunity for integrated application of content serves to increase learning effectiveness.

To answer this question, two bases for sequencing were used. One basis, typified by the elaboration model (Reigeluth, 1979; Reigeluth & Rodgers, 1980), calls for both initial and ongoing content integration. The other basis, typified by the progressive part method (Cunningham, 1971), calls for content integration upon completion of instruction. Neither sequencing basis is without support or criticism.

Reigeluth (1979) has discussed some the problems which arise when content is sequenced using a parts-to-whole method. He reasons that this organization results in a highly fragmented sequence which is demotivating. He indicates the "parts-to-whole sequence (is) inconsistent with much knowledge about how learning occurs most effectively" (p. 8). Reigeluth goes on to say that a general-to-detail sequence which allows for ongoing opportunity for the learner to apply a simple, but complete version of the content, will result in higher levels of learning, synthesis, retention, and affect for content which has highly related topics. However, he adds that the advantages gained by a general-to-detail sequence will lessen when the amount of subject-matter interrelatedness decreases.

In contrast to the above thinking, support can be found for content sequences which allow for an integrated application of the content only upon completion of instruction. For instance, Gagné and Briggs (1974) suggest the key to sequencing effective instruction for intellectual skills is the learning heirarchy. Learning prerequisites serve to guide this content sequence. Gagné

(1965) has also discussed the superior effectiveness of the progressive part method for sequencing several types of learning. Similiarly, Gilbert's (1971) mathetics approach is an example of a content sequence in which the learner sees the completed product throughout the instruction but does not actually apply the complete process until instruction on all new content is complete.

Hyotheses

H1: Subjects receiving instruction sequenced to provide ongoing content integration will perform better than subjects receiving instruction sequenced to provide content integration upon completion of instruction on tasks of high complexity.

H2: Subjects receiving instruction sequenced to provide ongoing content integration will perform better than subjects receiving instruction sequenced to provide content integration upon completion of instruction on tasks of low complexity.

Limitations of the Study

One limitation of this study lies in the fact that all subjects were from one urban middle school. Any generalizations beyond the representativeness of this sample must be made with caution.

A second limitation of this study is the instructional materials and evaluation instrument. Both the materials and the instrument were developed for this study. Although content validity was established for both the materials and the instrument, the results obtained from this study will provide information dealing only with these materials and instrument. Generalizations beyond these instructional materials and evaluation instrument are appropriate as far as the representativeness and validity of the materials and instrument are concerned.

A final limitation of this study is the number of teachers who delivered the instruction. Had more teachers been involved in delivering the instruction to more groups of students, greater reliability would have been achieved.

Definitions

The following definitions were used in this research:

Complex task: a task requiring many steps and/or multiple decisions.

Content integration of the application level: the ability of the learner to apply a complete version of a body of content for a given task.

General-to-detail sequence: an instructional sequence which organizes content beginning with the most general application of the content and gradually increases in level of detail and complexity towards the final criterion level.

Procedural learning: learning resulting in mastery of a set of skills, techniques, and methods to achieve an end.

Sequence: the order of each part in an instructional program.

Simple task: a task requiring few steps and limited decision making.

Single-level-of-detail sequence: an instructional sequence which organizes content on the final criterion level and provides for application of all content upon completion of instruction.

Significance of the Study

This study was designed to investigate relationships between content sequence as it contributes to content integration and procedural learning. Given that content sequence is said to be fundamental to learning from instruction, the relationship between organization and eventual integration of the content is of primary concern. Nowhere is the concern more evident than in consideration of procedural learning where the failure to integrate a single step into an overall procedure can result in an inability to correctly or completely apply a procedure or set of procedures.

If relationships among content sequence and task complexity can be demonstrated, several implications can be drawn. First, content sequence decisions, other than "'common sense' logical ordering" (Gagné & Briggs, 1974, p. 100) may begin to emerge. Second, the foundation can be increased for development and testing of theoretical models for content sequence. Third, content sequence can begin to be prescribed for given content related conditions, thus contributing to the body of knowledge becoming known as the design science of instruction (Reigeluth & Merrill, 1979). This knowledge would clearly indicate the importance of intentionally sequencing content when designing instruction rather than solely relying on existing content sequences.

CHAPTER II

REVIEW OF RELATED LITERATURE

Research and theory literature on sequence is found under both "content sequence" and "instructional sequence." This review is about content sequence, although calling it that is virtually arbitrary. As will be seen time and again in the literature, content sequence and instructional sequence are treated as functionally identical, given the case of content being developed through instruction and instruction being shaped by content.

The Concept of Content Sequence

Heimer (1969) defines instructional sequence as "the order in which the learner interacts with the units of content" (p. 494). As implied by this definition, content sequence can be conceptualized in relation to the entire notion of content, in particular, content structure.

Heimer says that "instructional sequence is most fruitfully formulated and evaluated in conjunction with content structure and that instructional sequence specifies the way in which the content structure is traversed by the learner" (p. 494). Hickey and Newton (Heimer, 1969) view the problem of sequencing as weaving a "thread up and down, back and forth, through the knowledge space" (p. 494).

Posner and Strike (1976) offer this framework for thinking about content sequence:

> Content sequences are a part of the overall content structure. Content structure refers to the content elements and the ordering relationships that exist between them. Paradigmatically, the problem of content structure can be considered a sequencing or ordering problem. Most questions about content structure can be reduced to questions concerning what content comes before what other content and the rationale for that order (i.e., the sequencing principle or, more precisely, the ordering relation). (p. 666)

This theoretical relationship of content sequence to content structure underlies much of the research and theory of content sequencing. It appears that the problem for the content sequence is to present the content structure in such a way that:

1. all content topics are included in the instruction;
2. the relationships between the topics are maintained during instruction.

The more the content sequence distorts the relationships between the content topics, the more the content structure, indeed, the content itself, is changed.

With this as a background for thinking about sequencing, a framework is needed for making instructional design decisions about sequence. Posner and Strike and Posner and Rudnitsky (1976) argue that the design question of how content <u>should</u> be sequenced can only be answered after the question of how content <u>can</u> be sequenced has been answered. These authors have developed a categorization scheme for principles of sequencing content. They propose that any content sequence is an instance of one or more of the sequencing principles.

The major types, several of the subtypes, and an example of one subtype follows:

1. World-related sequences
   a. Spatial relations
   b. Temporal relations
   c. Physical attribute relations

Example: Teach history in a chronological order (subtype 1b).

2. Concept-related sequences
   a. Class relations
   b. Propositional relations
   c. Sophistication relations
   d. Logical prerequisites

Example: Teach about aquatic animals before teaching about specific fish (subtype 2a).

3. Inquiry-related sequences
   a. Logic of inquiry
   b. Empirics of inquiry

Example: Teach how to write research proposals before teaching how to collect data (subtype 3b).

4. Learning-related sequences
   a. Empirical prerequisites
   b. Familiarity
   c. Difficulty
   d. Interest
   e. Development

Example: Teach about American sports before teaching about African sports (subtype 4b).

5. Utilization-related sequences

    a. Procedure

    b. Anticipated frequency

Example: Teach how to grip a baseball bat before teaching how to swing it (subtype 5a).

Posner and Strike suggest that while their categorization scheme cannot answer any research questions about content sequence, it can "provide the concepts needed to ask the (research) questions" (p. 686) about sequence.

Early Research and Theory on Content Sequence

Educational researchers and theorists have traditionally addressed the question of content sequence. Comenius outlines nine teaching principles based on the imitation of nature. The sixth rule was "Nature (teaching), in its formative process, begins with the universal and ends with the particular" (Wiman, 1969, p. 12). Posner and Strike site several references dating back to 1902 in which questions about content sequence have been raised.

Part-Whole Sequence

Much of the early research on content sequence can be boiled down to part versus whole methods of instruction. Cunningham (1971) says "the part-whole problem is one of the oldest and most extensively researched problems in psychology and education. The question is asked whether it is more effective or efficient to practice various component parts of the task separately, and then combine them to form the whole task" (p. 366). Cunningham cites McGeoch's (1931) survey of research on the part-whole problem prior to 1930. McGeoch concluded that the literature offered no rationale for generalization about which particular method (part or whole) is best. Cunningham suggests that early reseach failed to ask the appropriate question: "When and under what conditions is it better to practice using a part or whole method" (p. 378).

Reviewing more recent (1950-1970) literature, Cunningham claims that interest in the part-whole procedure has waned considerably. However, two sets of related studies were found.

Tulving (1966) studied part and whole learning in relationship to free recall of unrelated words. Tulving's findings supported the hypothesis that when part of a list is learned, the words are subjectively organized in such a way that may retard learning the entire list. Bower and Lesgold (1969) also investigated this relationship. They supported Tulving's conclusions and say that "prior training at recalling a part of a list had a negative or detrimental influence upon S's ability to learn and recall the whole list sequentially" (p. 501). They reasoned that the subject develops a particular organization for the partial list which may not be the optimal organization for the entire list, thus retarding the subjective organization and subsequent learning of the entire list. This finding was substantiated in a similar study by Birnbaum (1969).

Cunningham summarized this research by saying "it has been demonstrated that unless the part that is learned is organized in a manner congruent with efficient whole list learning, performance will be depressed" (p. 389). He goes on to say that "the research employing preorganized lists has shown that when parts reflect one or more aspects of that whole list organization, performance is facilitated" (p. 389).

Another research effort relating to part-whole learning was conducted by Naylor and Briggs (1963). They researched the relationships between task complexity, task organization, and part and whole training methods. The findings of their research resulted in the following training principle:

> For a relatively highly organized (integrated) task, a whole-task training method should be superior to a part schedule at all levels of task complexity; however, for a relatively unorganized task (all task dimensions independent), an increase in task complexity wil result in a part-task training schedule becoming superior to whole training. (p. 217)

To conclude his analysis of the literature on part and whole learning, Cunningham suggests that part-whole researchers have asked the wrong question. Rather than part versus whole research, he suggests that attention be turned to the relationship of part to whole learning. Cunningham points to Gagné's procedures for task analysis of hierarchical subject matter as being a valuable tool in this respect.

Random-Logical Sequence

A second major trend found in the early research on sequencing centers on a comparison of the effects of "logical" and "random" sequencing. This research was designed to examine the hypothesis that "if the frames of a rather sophisticated unit of instruction were presented in a randomly sequenced manner, . . .the resultant learning would be less efficient and less effective than a carefully planned sequence" (Niedermeyer, Brown, & Sulzen, 1969, p. 61). The results of much of this research failed to validate this sequence hypothesis.

Niedermeyer et al., in their review of the literature on logical and random sequence treatments, found six studies which reported no significant differences in learner achievement when sequence was varied. During the same eight year period, they found only one study which supported the sequence hypothesis. In their study these authors "examined the effects of logical, scrambled, and reverse order sequences on the learning of a series of mathematical tasks" (p. 61). No significant differences between groups were found relative to cognitive outcomes. However, the students receiving logically sequenced instruction reported the program to be "interesting," whereas students receiving scrambled or reversed sequence instruction tended to consider the program to be "neutral." The authors concluded that "sequence may not be as crucial to cognitive outcomes as has previously been thought" (p. 66) for short instructional programs.

In a follow up study, Brown (1970) investigated the effects of logical and scrambled sequences on performance of several types of learning (lower order principles, verbal knowledge, and complex problem solving). The investigator found that for programs substantially longer than those used by Niedermeyer et al., sequence made little difference for lower order principles and verbal knowledge. However, when the tasks involved complex problem-solving behaviors "sequencing can have an important effect upon learning" (p. 45).

Miller (1969) conducted a study of the effects of sequencing and prior information in linear programmed instruction. Miller's findings include:

1) "Sequence of frames does not make a difference as long as the order of concepts is preserved" (p. 73). Here, order of concepts refers to the subordinate relationship between tasks.

2) "If both achievement and efficiency in terms of time and errors are important, the original logical sequence must be judged the best in this study" (p. 74).

3) "The availability of prior information apparently was of no help to the subject" (p. 74). Miller points out this is contrary to Mager's (1962) suggestion that students be provided with learning objectives.

4) No significant changes in attitude, as a result of sequence, were found. In conclusion, Miller says "logical sequence still appears to be the best in terms of overall effectiveness and efficiency. On the other hand, these results do question the necessity for laboring over their (sequence) construction, using rigorous methods of content sequencing" (p. 74).

A final note on the random versus logical sequence concern addresses what is meant by "logical" sequence. Myers (1978) studied the changes in content sequence for elementary algebra over a period of some eighty years. She found that the logical sequence of elementary algebra, as perceived by 1894-1923 textbook authors, was different from the logical sequence of elementary algebra, as perceived by 1954-1977 textbook authors. Care should be taken to not assume that all the "logical" sequences used in logical-random sequence research are the same.

Micro Sequencing Strategies

Preinstructional Strategies

Micro sequencing strategies are ways of sequencing instruction on a single content topic. Considerable research has been done on micro sequencing strategies, in particular, on what Hartley and Davies (1976) refer to as "preinstructional strategies." These authors reviewed the research on four preinstructional strategies: pretests, behavioral objectives, overviews, and advance organizers. Their review led to the following guarded generalizations:

1) "Under certain conditions, completing a pretest sometimes enhances subsequent posttest performance" (p. 247).

2) "It would seem that the possession of behavioral objectives (by the student) does have an effect upon learning...but this may be less clear-cut than many of the advocates of objectives usually claim" (p. 251).

3) "It would appear that, although overviews are successful as preinstructional strategies, much more needs to be known about their effects" (p. 253).

4) Citing the problem of operationalizing the concept of advance organizer for research purposes, the authors conclude that "most of the research (on advance organizers) seems confused" (p. 256).

Following this review, Hartley and Davies describe the role of preinstructional strategies. They suggest that preinstructional strategies are likely to be of greatest use in situations involving presentation (rather than discovery) of material that is meaningful to the learner.

A comprehensive look at the literature on advance organizers is offered by Mayer's (1979) review of twenty years of research on advance organizers. Mayer reviewed forty-four studies involving advance organizers and compared the results of these studies to four predictions of assimiliation theory. Mayer reaches the following conclusion: "Twenty years of research on advance organizers has clearly shown that advance organizers can affect learning, and the conditions under which organizers are most likely to affect learning can be specified" (p. 161). Many of Mayer's closing recommendations are aimed at the very problems cited by Hartley and Davies and, if followed, would serve to eliminate much of the research confusion identified by Hartley and Davies.

A second meta-analysis of the effects of advance organizers on learning and retention was conducted by Luiten, Ames, and Ackerson (1980). These authors examined 135 published and unpublished studies of the facilitative effect of advance organizers and concluded that "the average advance organizer study shows a small, but facilitative effect on learning and retention...in all content areas examined...and with individuals of all grade and ability levels" (p. 217).

Mathetics

The work of Gilbert (1971) has interesting implications for sequencing content on a micro level. Using the behavior principles of chaining and conditioned reinforcement, Gilbert claims that instruction which starts at the beginning of a behavioral sequence is inefficient. Rather, instruction should begin by teaching the student the terminal operant in the behavioral chain first and work backwards towards the first performance step. This exercise model is referred to as "mathetics" and is hailed by Gilbert as being "a true and practicable technology" (p. 215). He goes on to say that the mathetics model is fundamentally so accurate that any changes in the model will be in details only; no structural changes will be required. He says that the mathetics exercise model will apply to both simple and complex behaviors.

Mathetics, or backward chaining, was investigated by Scott (1968). Scott's experiment involved a comparison of a mathetics sequence with a progressive (forward) chaining sequence for a mathematical procedure. The results failed to support the hypothesis that subjects who were reinforced by the task and assigned to the mathetic sequence would score higher. Also, the progressive chain program was viewed as more exciting and better organized than the mathetics version of the program.

Hinkelman (1976) studied the effects of reverse and forward sequencing of instruction for a selected dentistry task. The hypothesis for the study was that the reverse sequence of instruction would facilitate learning more effectively than the forward sequence. No statistically significant differences were found between the two instructional groups. However, the reverse sequence group did have higher means on two measures of performance.

Although this research does tone down Gilbert's proclaimation of mathetics, it does not lessen the importance of the backward chaining concept. Rowntree (1974) summarizes the significance of Gilbert's contribution:

> Subsequent research (on mathetics) has, of course, demonstrated that not all chains are best taught backwards. Nevertheless, the concept (of mathetics) dramatically reminds us that the obvious way is not always the only way to sequence teaching. (p. 78)

Events of Instruction

The question of sequence on a micro level has been addressed by Gagné in his discussion of the four phases of a learning sequence (1970). These phases are:

1) the apprehending phase—the process of attending, perceiving, and coding the stimulus situation;

2) the acquisition phase—the transition from not being able to do some particular performance to being able to do it;

3) the storage phase—retention of the change (brought about in the acquisition phase) in long-term and/or short term memory;

4) the retrieval phase—the event occuring when the individual must display what has been learned.

Gagné uses these learning phases as the basis on which to build the "events of instruction." The function of the events of instruction is to "ensure that the timing and sequencing of events internal to the learner is proper for the occurrence of learning" (p. 304). The events of instruction are:

1) Gaining and controlling attention.
2) Informing the learner of expected outcomes.
3) Stimulating recall of relevant prerequisite capabilities.
4) Presenting the stimuli inherent to the learning task.

5) Offering guidance for learning.
6) Providing feedback.
7) Appraising performance.
8) Making provisions for transferability.
9) Insuring retention.

While the order is approximate, Gagné claims that events listed prior to number five cannot be temporally switched with events occuring after number five.

The literature on the events of instruction, whole cloth, is limited. Yet when each event is taken singularly, each event has been the focus of much research in instructional psychology. In fact, Gagné and Rohwer (1969) used the events of instruction as the organizational scheme for their 1969 review of the literature in instructional psychology.

The application of the events of instruction is described by Gagné and Briggs (1974) within the overall process of instructional design. They point out that the purpose of the events of instruction is to "activate and support the internal processes of learning" (p. 135). The events may be built into the instructional materials, supplied by the teacher, by the learner, or by the group (Briggs, 1977). Briggs says that the events of instruction "require the (instructional) designer's attention in order that instruction achieve its purpose" (p. 193).

Kinetic Structure

Anderson (1974) has developed the concept of kinetic structure which is concerned with the "serial order and linkage of verbal statements in curriculum communications" (p. 219). The hypothesis is that "when there are linking words between two consecutive verbal statements in extended discourse, acquisition of one statement of a pair will facilitate acquisition of the second statement" (p. 220). Anderson has developed a process for measuring the amount of kinetic structure in a given verbal communication. By restructuring the verbal elements (a clause containing a subject and a predicate) of a communication to increase the kinetic structure, the communication will be more effective. Some research on this microstrategy for sequencing is available and has been summarized by Anderson.

Anderson has found much of the research on kinetic structure to be descriptive. He reports "there appears to be a difference in the amount of structure in lessons obtained from teachers in different disciplines" (p. 228). In experimental studies, the degree of kinetic structure is the independent variable and knowledge acquisition the dependent variable. Anderson reports that several studies show that the amount of knowledge acquisition is related to the amount of kinetic structure in the content.

Macro Sequencing Strategies

Macro sequencing strategies are ways of sequencing and organizing those aspects of instruction which relate to more than one content topic. The research literature on macro sequencing is somewhat limited. Briggs' (1977) comment is worth repeating: "Most of the research on sequencing of instruction has dealt with sequencing at a smaller 'size of chunk,' such as frames within a programmed unit" (p. 111). Somewhat ironically, one macro sequencing strategy that has been well researched is the product of Briggs' frequent writing partner, Robert Gagné.

Learning Hierarchies

In 1962 Gagné presented a model of hierarchical learning based on the notion that a complex task can be analyzed into a network of learning prerequisites. The resulting network is called a learning hierarchy. A learning hierarchy is:

> an arrangement of intellectual skill objectives into a pattern which shows the prerequisite relationships among them. Beginning with a particular objective...the learning hierarchy shows which intellectual skills are prerequisite; having identified this second set of skills, the prerequisites of each of these is in turn indicated, and this process continues until one has displayed in a bottom row the most elementary intellectual skills with which one needs to be concerned. (Gagné & Briggs, 1974, p. 109)

Learning prerequisites can be identified by asking "What would the individual have to be able to do in order that he can attain successful performance on this task, provided he is given only instructions?" (Gagné, 1962, p. 358).

In relation to the question of sequence, Gagné says "the learning hierarchy is supposed to provide a basis for finding a suitable learning route for every student" (Gagné, 1970, p. 241). Instruction begins on the lowest prerequisite skills not mastered by the student and proceeds up the hierarchy towards the terminal learning objectives. Gagné and Briggs indicate that the learning hierarchy technique is appropriate when designing a sequence of instruction within a topic. However, they go on to say that a topic often has several components. Consequently, the learning hierarchy can be considered a macro sequencing strategy.

Research involving learning hierarchies is quite common. Gagné (1962) showed the utility of instruction sequenced using a learning hierarchy. First, a hierarchy was constructed for the task of deriving formulas for the sum of a number series. Next, initial testing of subjects was conducted to determine which prerequisite skills had been mastered by each subject. For all subjects (N=7), the following observations were made:

1) if mastery of a higher-level task was shown, all related lower-order tasks were found to be mastered;

2) if a lower level task was not mastered, all related higher-level tasks were also shown to be not mastered;

3) if a higher level task was not mastered, some related lower-level tasks may have been mastered.

In other words, the learning hierarchy functioned in the hypothesized manner.

At this point in the research, instruction was provided to subjects on those prerequisite tasks which were not mastered, beginning with the lowest successfully achieved learning task, and proceeding towards successful completion of the final task. After instruction six out of seven subjects demonstrated mastery of the final task. While this effort by Gagné served more to demonstrate the workings of a learning hierarchy than to empirically establish the effectiveness of such a sequence strategy, the impact on this work on future research is significant.

Eustace (1969) employed a "hierarchically structured learning program somewhat similiar to Gagné's " (p. 449). The program was intended to help students learn the concept of "noun." Eustace experimentally manipulated the sequence of the learning material presentation and predicted that more learning would occur when materials are presented in an ordered sequence. Analysis of the data resulted in confirmation of the hypothesis, lending support to the utility of the learning hierarchy method of sequencing content.

Okey and Gagné (1970) studied the prediction that "a way to improve performance on a final task is to provide additional instruction leading to attainment of subordinate skills failed by a substantial number of students" (p. 321-322). To test this prediction, a group of students studied an initial version of a learning program and were tested on both the final task and the subordinate skills to that task. Using this information, the program was revised and studied by a second group who took the same test. The results showed that "adding instruction leading to improved performance on subordinate skills in a science program was successful in significantly improving performance on the criterion task" (p. 324).

McCain (1971) compared the effects of hierarchical and nonhierarchical sequences on learning for high and low ability groups. Statistical comparisons led the experimenter to conclude that logical (hierarchical) sequencing was superior to scrambled or reversed sequencing.

Headley (1971) compared the effectiveness of three learning programs. One program was sequenced in a linear fashion, one in a hierarchical fashion, and one in a random sequence. The results of the study were mixed but the hierarchical sequence did result in significantly higher post-test scores than either of the other sequences. Measures of retention were nonsignificantly higher for the hierarchical sequence than the other sequences. The linear sequence yielded more correct responses to the frames within the program.

Another strand of research involving learning hierarchies has centered on the validation of the hierarchy. White (1974a) criticized the existing model for validation of learning hierarchies and pointed out eight flaws (including inadequate sample size, lack of precision in defining terms, and inappropriate testing procedures) in previous research efforts for checking validity. White presented a new model which he claims overcomes the experimental design problems he criticized. White (1974b) proposed a method of testing the validity of hierarchical connections which he claims has distinct advantages over previous validity tests.

Beeson (1977) conducted a research project to investigate the application of learning hierarchies to an area of science curriculum. Care was taken to avoid the weaknesses described by White. Using Whites model, a hierarchy was constructed for a task of determining quantities of electric circuits. Testing was conducted and materials were developed and implemented. In the discussion of the research Beeson says "there is now a quite impressive amount of evidence that these (intellectual) skills should be ordered into a hierarchical sequence for most efficient learning" (p. 126). However, the author goes on to say that "the evidence suggests that learning of the skills in a hierarchy is mechanical rather than meaningful" (p. 127). While Beeson does not elaborate further on this point, doubt is cast on the transferability of skills learned in a hierarchical manner.

Criticisms of Gagné's learning hierarchy are limited. Rowntree (1974) refers to Gagné's work as "perhaps the most fruitful approach to sequencing" (p. 79). Yet critics can be found. Posner and Strike (1976) suggest that "Gagné's approach tends to obscure the diversity of underlying bases for prerequisite relationships. This masking of orderly relations may also obscure the relationship of content structure to cognitive operations" (p. 682). They suggest that Gagné should make the distinction between logical prerequisite (based on the logic of content structure) and empirical prerequisite (based on empirically established relations regardless of their logical necessity). Phillips and Kelly (1975) echo this concern by saying "the pursuer of Gagnéan hierarchies needs the skills and knowledge of a physicist or mathematician rather than those of a psychologists" (p. 362).

Reigeluth (1979) leveled several criticisms aimed at the hierarchical organization of instruction. The criticisms begin by describing a hierarchical organization as "an instructional sequence that begins with highly fragmented, small pieces of subject matter content." Reigeluth claims such an organizational scheme is considered by some educators to be "demotivating" and "inconsistent with much knowledge about how learning occurs most effectively." He goes on to say that "'learning hierarchies' represent a very incomplete basis upon which to make decisions about sequencing the instruction" and "learning prerequisites are not a sufficient basis for organizing a whole course" (p. 8). Reigeluth offers the elaboration model for organizing instruction as a way to go beyond the learning hierarchy.

Elaboration Model

The elaboration model for organizing instruction is a relatively new development in the area of instructional design. Reigeluth (1979) describes the workings of the model:

> The elaboration model of instruction starts by presenting knowledge at a very general or simplified level in the form of a special kind of overview (the epitome). Then it proceeds to add detail or complexity in 'layers' across the entire bredth of the content of the course or curriculum, one layer at a time, until the desired level of detail or complexity is reached. (p. 9)

After each elaboration, the content to that point is summarized, reviewed, and the context reestablished. A six-step design procedure was developed to assist in designing instruction via the elaboration model.

Since the introduction of the elaboration model, several articles dealing with the model have appeared in the literature (Reigeluth & Rodgers, 1980; Reigeluth & Sari, 1980; Reigeluth, Merrill, Wilson, & Spiller, in press). Reigeluth, Merrill, Wilson, & Spiller (1978) have filed an ERIC report describing the project which developed the elaboration model. However, as Reigeluth

(1979) points out "the model and procedures . . . have undergone very limited field-testing and virtually no research" (p. 14). The next few years should show a good deal of elaboration related research.

The elaboration model might best be classified as a general-to-detailed or simple-to-complex sequence strategy. Under this broad heading, the literature is more helpful than under the more narrow descriptor of elaboration model. Mager and Beach (1967) assert that "students...agree they would like instruction to proceed from 'simple to the complex'" (p. 59-60). Mager goes on to say that "students generally find it more meaningful to move from the big picture toward the details" (p. 61).

In a study of content sequence for tasks related to dentistry, Abou-Rass (1972) compared the effects of a simple-to-complex sequence with a complex-to-simple sequence. The results showed that the simple-to-complex sequence required less learning time but the complex-to-simple sequence reduced the probability of committing errors. Measures of attitude towards the simple and complex tasks indicate that students who begin training on the complex task developed a more favorable attitude toward both tasks where as students who begin training on the simple task developed poor attitudes toward the complex task. In other words, neither of Mager's assertions were supported.

Dinsmore (1978) evaluated three methods of sequencing instruction: simple-to-complex, complex-to-sequence, and scrambled. While analysis failed to find overall significant differences in performance scores for the three treatment conditions, the simple-to-complex sequence did result in the greatest gains followed, in order, by the complex-to-simple sequence and the scrambled sequence.

Short and Houghey (1967) carried out a study to evaluate two different sequencing strategies. One strategy (multiple concept) involved presenting relatively simple versions of several related concepts at the beginning of instruction and then gradually increasing the level of complexity of the presentation materials across all concepts. The second strategy (single concept) involved presenting one concept at a time and preceeding from simple to complex versions of the concept. When the desired level of detail and complexity for one concept was reached, another concept was introduced and the process continued. The authors found the multiple concept strategy to be superior for instruction on science concepts but found no significant differences when the strategies were applied to language arts concepts.

The comments of Cunningham (1971) about the part-whole problem of sequencing are relavent to the notion of a general-to-specific content sequence. Cunningham suggests that parts "must be considered as more than simple divisions of the whole. Parts can be regarded as 'little wholes' determined on the basis of the organization of the whole or on the basis of a unity possessed by the part itself . . .. Moreover, it has been demonstrated repeatedly that when material which possesses some organization is presented in such a way that the organization is apparent to the subject, learning will be facilitated" (p. 392). This can be interpreted as supportative of a general-to-specific sequence where the general version is a "little whole."

General-to-specific content sequences are not new. Bruner's spiral sequence (1960) provided a structure for content areas where the student cannot study a single topic in depth without knowing something about the other related content topics. Reynolds and Glaser (1964) studied the effects of linear and spiral programming upon measures of learning. The linear program presented ten discrete science topics without review. The spiraling program presented the initial frames of instruction on all topics before preceeding to more complex levels. At each level of complexity, review frames were inserted. Those subjects using the spiraling program studied approximately 40% more frames due to the insertion of the review frames. Considering both post test scores and time for completion, the authors concluded that the spiraling method was "a less effective programming method than the more standard linear programming" (p. 169).

Other Sequence Issues

Learner control. A widely held but unstated assumption about sequencing is that the teacher, instructional designer, or writer is in control of the content sequence; the learner plays a passive role in the sequencing process. This assumption has not gone unchallenged in the literature.

Mager (1969) conducted a preliminary investigation to determine whether a learner-generated sequence would be similar to an instructor-generated sequence. He also looked at commonalities among learner-generated sequences. The study was carried out by assigning individual learners interested in electronics to instructors. The instructors were only to respond to questions from the subjects. The subjects were in complete control of the direction, duration and number of the instructional sessions. The results of this study led Mager to conclude that:

> The content sequence most meaningful to the learner is different from the sequence guessed by the instructor to be most meaningful to the learner . . .. This study also suggested that the learner's motivation increases as a function of the amount of control, or apparent control, he is allowed to exercise over the learning experience. (p. 412)

Mager closes by calling for research to establish the effectiveness of learner generated sequences.

The literature shows evidence that Mager's call has not gone unheard. Houser (1974) examined the relative effects of three instructional sequences (student generated, instructor generated, and random) on students ability to solve metric measurement coversion problems. Statistical analysis indicated no significant differences in the proportion of students who demonstrated mastery on a posttest when compared by type of sequencing procedure used.

Lahey (1979) conducted a study to help decide whether or not learner control over instructional sequence is as effective as programmed control in computer based instruction. Lahey concludes that "there appears to be no pedagogical disadvantage to using the learner control lesson presentation mode...but there may be economic and technological advantages" (p. 13).

These and other studies have led M. D. Merrill (1979) to the following proclaimation about learner control over instruction:

> Finally, may I suggest again that the challenge is not learner control versus system control but rather how to help students optimize the use of the learner control already available to them. The ultimate learning environment after all is life itself in which learner control is not only desirable but mandatory if we are to realize even a little of our potential as human beings. (p. 16)

Sequence X Cognitive Style. Researchers have investigated the possible relationship between content sequence and some dimensions of cognitive style. Douglass and Kahle (1977) looked at this relationship by comparing the effects of inductive and deductive sequences on field independent and field dependent learners. Analysis found neiter of the main effects nor their interaction to be significant. In a similar study one year later, Douglass and Kahle (1978) found that the same cognitive style dimensions did significantly interact with the same sequence options when only those subjects found in the tails of the field dependence—independence continuum were considered. The authors recommend that instruction be individualized to provide deductively sequenced materials for field dependent students and inductively sequenced materials for field independent students.

Murray's (1978) study examined the relationship between part-whole methodology for teaching physical skills and differences in cognitive style. The cognitive style dimension examined was along the sequential-holistic processing continuum. The study's results showed sequential processors learn more quickly using a part methodology while holistic processors were shown to learn more quickly when using a whole method.

McDade (1978) examined the relationship between two content sequences and cognitive style. One sequence involved presenting general concepts before facts (CF sequence) while the other sequence involved presenting facts followed by general concepts (FC sequence). Subsumption theory predicts that the CF sequence would be superior to the FC sequence for all students. Educational set theory predicts that there will be an interaction between sequence and educational set, a cognitive style dimension relating conceptually set students and factually set students. McDade reports that the results were closer to the prediction based on educational set theory and concluded that "student learning may be promoted by using individual differences in student cognitive styles when designing instructional strategies" (p. 141).

Sequencing Concerns in Procedural Learning

Content Sequences for Procedural Learning. Much of the literature on content sequence venns with aspects of procedural learning. Yet, not all content sequence strategies lend themselves to procedural learning. For instance, it would be inefficient to use a chronological sequence for teaching someone to process color slide film. The old procedures (taught first or last, chronologically) involved many steps which are not required by current practices. While the learner may develop an appreciation for the convenience of the more modern procedure, there is no reason to believe that learning efficiency or effectiveness would be increased by a strategy employing a temporal sequence. Four sequencing strategies which were described earlier in this review were selected for inclusion in the following analysis. They are the mathetics approach, the elaboration model, the learning hierarchy, and the part method. Following a brief review of the strategies, three questions will be asked of each strategy: 1) At what point(s) in the content sequence is the learner given the opportunity to practice the procedure? 2) How are relevant concepts and principles incorporated into the learning sequence? 3) What process is employed to identify the content within the procedure?

Mathetics and Procedural Content. Mathetics (Gilbert, 1971), or backwards chaining, is an exercise model for organizing instruction. The process is best explained by an example. Suppose a procedure consists of five operants or steps labeled, in order, A, B, C, D, E. The first content demonstrated to the learner is step E. Then step D is demonstrated and Step E is performed by the learner. Next step C is demonstrated and steps D and E are performed by the learner. This process continues until the initial step (step A) is executed by the learner. Reinforcement is given each time the learner performs the terminal step in the procedure, greatly reducing the tendency to expect reinforcement prior to completing the procedure.

Elaboration and Procedural Learning. The elaboration model (Reigeluth, 1979) employes both a whole-to-part sequence and a simple-to-complex sequence for procedural content. Instruction begins by presenting a fundamental and simple version of the entire procedure. Next a somewhat more complex version is presented. This progression towards increasing complexity is continued until the terminal level of complexity is reached. Each level of complexity is referred to as a level of elaboration. Following each level of elaboration the instruction summarizes the new content and places it within the context of earlier content.

Learning Hierarchy and Procedural Learning. A learning hierarchy (Gagné, 1970) is the result of an analysis of a given learning task into simplier capabilities that need to be learned as prerequisites. Thus, content is organized in a part-to-whole sequence. Instruction begins with the "lowest" type of intellectual skill and proceeds until the skill level required to perform the given task is reached. Gagné describes the basic functional unit of a learning hierarchy as a pair of intellectual skills, one subordinate to the other. The learning prediction is that mastery of a subordinate skill will facilitate learning of a higher level skill to which it is related. The learning hierarchy does not identify a single sequence of instruction. Rather, the learning hierarchy is likened to a map of what is to be learned, showing alternate routes the instruction may follow, so long as all prerequisite capabilities are learned.

Part Methods and Procedural Learning. The part method for sequencing content is built on the hypothesis that is more efficient to learn parts of a task and then put the task together via chaining than it is to learn the entire task at once. Cunningham (1971) identified four variations of the part method: pure part method, progressive part method, repetitive part method, and reversed repetitive part method. In the pure part method each part of a procedure is separately learned to a criterion and then combined to a whole procedure. In the progressive part method the student first learns part one of a procedure, then part two, and then practices them. Next, part three is learned and practiced with parts one and two. This process continues until the entire procedure (or set of procedures) is learned. In the repetitive part method the student learns part one alone, and then parts one and two together, and so on until the entire procedure is learned. The reversed repetitive part method is a general version of the mathetics method described earlier. In the analysis that follows, the progressive part method will be used as representative of the three forward chaining methods described by Cunningham. The mathetics method will be used as representative of the reversed chaining method.

Limits to the Analysis. This section of the review will focus on the intersection of content sequence strategies and procedural learning. This will be done in light of selected concerns of content sequence considered relavent to procedural learning. The areas of consideration are: the opportunity for practice, the process of determining content within the procedure, and the role of other types of content (concepts and principles) within procedural content.

Analysis of Opportunity for Practice. The importance of opportunity to practice a procedural task is widely acknowledged. The adage "practice makes perfect," often times edited to "perfect practice makes perfect," is accepted as a truism by most educators when considering procedural learning. While the question of "how much practice?" is not answered by the sequencing strategy being employed, two other questions relating to opportunity for practice are answered. These questions are "When in the instructional sequence will practice be given?" and "What content will be practiced during the practice session?"

In the mathetics model a series of exercises are developed, each exercise adding an additional step to the procedure. Consequently, the opportunity to practice the terminal step (which is taught first) is much greater than the opportunity to practice the initial task (which is taught last). The amount of content to be practiced increases as instruction progresses through the model. Thus, more content is practiced in later exercises than in earlier exercises. It should be noted that Cunningham concludes that "it is necessary that the parts (of a procedure) be practiced in the same order as they appear in the whole task" (p. 394). Except for the final exercise, the mathetics model violates this guideline.

The elaboration model itself does not call for practice. As a macro strategy, the elaboration model prescribes how to select, sequence, synthesize, and summarize instruction. With regards to the delivery of instruction Reigeluth and Rodgers (1980) suggest that procedural operations be taught by using generalities, examples, and practice. The practice items should be as different from each other in as many ways as the learner is likely to encounter in the real world. Practice would be provided as part of the instruction on each level of elaboration. For operations which are fundamental to the procdure, practice would occur on every level of elaboration. For operations which are less essential to the procedure, practice would occur on later levels of elaboration. The content to be practiced is determined by what level of elaboration the instruction is concerned with.

The progressive part method provides for distributed practice of the steps in the procedure. As each step is introduced, practice is called for on this step and all steps that have already been taught. Practice is done in the final order of performance. Thus, the first step receives more practice than does the last step. Since instruction is on the final criterion level, the content to be practiced is determined by the step just learned. Practice will be on this and all previous steps in the procedure. This can be contrasted to practice in the elaboration model which provides practice on versions of the entire procedure rather than parts of the entire procedure.

In a sequence based on a learning hierarchy, practice is available on all prerequisite intellectual skills leading to mastery of the final task. However, like the elaboration model, the learning hierarchy does not prescribe the delivery of instruction. Gagné (1970) offers the "events of instruction" as guidelines for delivering instruction. The ninth, and final, event involves insuring retention by providing practice for simpler types of learning (i.e., changing and verbal associations). Gagné questions the role of practice in higher types of learning (i.e., concept and rule learning). Thus the content to be practiced is determined by the type of learning required to master the content. Since the route through the hierarchy is not prescribed, there is no specific time in the sequence for practice.

Analysis of the Role of Concepts and Principles. The ability to perform a procedure is severely limited if the steps or operations have been learned by rote and without meaning. This is especially true when a complex procedure, learned without meaning, is to be performed in an unfamiliar setting. The concepts and principles which support the procedural content must also be learned for transferance to be likely. The role of concepts and principles in procedural learning is evident in the literature on mathetics, learning hierarchies, and elaboration. This is not the case with the progressive part method.

The progressive part method, in its simplest form, makes no mention of the role of concepts and principles in the instructional sequence. This weakness is pointed out by Cunningham in the discussion of how "parts" are formed. Cunningham suggests that "the extent to which parts can be kept distinct, one from another, will, in large part, determine the extent and direction of transfer and interference... Parts can be regarded as 'little wholes' determined on the basis of the organization of the whole or on the basis of a unity possessed by the part itself" (p. 392). Cunningham may be hinting at the role of principles when he speaks of the part reflecting the organization of the whole procedure. Likewise, he may be alluding to the role of concepts when he suggests that the parts should be kept distinct from each other. Fortunately, the literature is more helpful on another parts method, mathetics.

Gilbert recognizes the role of theory (concepts and principles) in instruction. Gilbert suggests that a student should learn the theory of a given procedure before he learns to perform the procedure. Gilbert's thinking is that an understanding of the principles involved will give meaning to the steps in the procedure, especially when the procedure is complex or when specifics of the procedure are changed. Gilbert describes an "induction" sequence (p. 247) for teaching the concepts and principles involved in a procedure.

The role of concepts and principles in the elaboration model is discussed by Reigeluth and Rodgers. They point out that procedural content should include concepts and principles to give meaning to otherwise rote operations. This will also provide for greater depth of understanding and increased ability to apply the procedure in unforeseen circumstances. As instruction proceeds to more complex versions of the procedure, more supporting concepts and principles are included, giving the learner additional understanding of the procedure.

The role of concepts and principles in procedural learning sequenced via a learning hierarchy is dependent upon the type of learning required in the procedure. Learning a verbal chain does not require learning concepts since concept learning is not prerequisite to learning verbal chains. Since the only intellectual skill that has a superordinate relationship to concept learning and rule learning (or principle learning) is problem solving, it follows that only those procedures which involve problem solving will have concepts and principles as supportative content. However, this problem might be due to the fact that Gagne is talking about types of learning and not types of content.

Analysis of Content Identification. Educators are in relative agreement that content decisions are made by first identifying the terminal objective(s) to be mastered. Beyond this point, agreement is less easily found. The content generated by a learning hierarchy may not be the same as the content generated via the elaboration model even though the terminal objective may be the same. The process for identification of content prescribed by the four sequencing strategies will be analyzed for procedural learning.

The progressive part model, as described by Cunningham, would generate content topics which reflect the overall organization of the procedure. As reviewed earlier, research has shown that for memorization tasks, learning will be facilitated if the organization of a partial list is the same as the organization of the entire list. The content topics used for instruction on a procedural task organized via the progressive part model would be more than simply step one, followed by step two, and so on. Cunningham suggests the parts be identified through the use of a Gagné type task analysis for content with a hierarchical structure. He also says that other methods of task analysis would have to be developed for tasks which do not possess a hierarchical structure.

The content found in instruction on procedural learning organized via the elaboration model is the product of an information processing analysis (P. Merrill, 1980). Merrill describes the process as follows: observe an individual performing the task; for covert cognitive steps, have the performer think aloud; list the specific operations, decisions, information required, and the results of each operation; prepare a flow chart of the task; check the accuracy of the flow chart. The results of this analysis is the total content on the final criterion level. For other levels of elaboration, the content consists of less complex versions of the procedure with the necessary supporting concepts and principles.

Gagné suggests that the content for a learning hierarchy is best determined by placing emphasis on the attainment of the learner. The learning hierarchy describes the prerequisite intellectual skills the individual needs to attain in order to perform a given operation. For a given objective, the content for instruction is determined by the identification of these prerequisites. Once the hierarchy is identified, instruction begins with the simplest intellectual skills (chaining, verbal associations) and continues until the level of complexity required by the task is reached.

The content for procedural learning using a mathetics approach is determined using a tactics analysis procedure. The final step in the procedure is examined to determine if more efficient alternatives to the step can be found. This same examination continues backwards through the first step in the procedure. The more efficient alternatives are substituted into the orginal procedure to see if they are still more efficient in conjunction with other steps in the procedure. The objective of this process is to produce the most efficient procedure to accomplish a given task. Gilbert also describes a process for identification of the concepts and principles required to insure meaningful learning of a given procedure. This process involves "boiling down" the procedure until the procedure can be described in general terms (called the domain theory). This content is then included in the instructional sequence prior to instruction on the procedure.

Summary. The literature offers a diversity of perspectives on content sequence. Much of the early research was relatively simplistic, focusing on the relative effectiveness of practicing parts of a body of content versus practicing the entire body of content. Part versus whole research has prompted some theorists to hypothesize a relationship between the overall organization of the content and the organization of the parts of the content. This hypothesis is currently reflected in the notion that content sequence is a function of content structure.

Early research also challenged the hypothesis that intentionally sequenced content will result in increased learning. This research compared the effects of "logical" and "random" content sequences. While the research findings are mixed, a "logical" sequence appears to be more effective than a "random" sequence. This line of research failed to establish a basis for creating optimal "logical" sequences.

The more recent literature has been dominated by research on micro sequencing strategies--strategies for sequencing instruction on a single topic.

Preinstructional strategies have been found to be generally effective in a large number of studies. In particular, the advance organizer has been extensively studied and found to be relatively consistent in its positive effects on learning.

Events occuring within instructional sessions have been sequenced by the "events of instruction" model. Beginning with gaining attention and ending with insuring retention, these nine instructional events have been shown to result in more effective instruction.

Another micro sequencing strategy of recent interest is the mathetics approach, or backwards chaining. Contrary to the "common sense" notion that the instructional sequence should be the same as the application sequence, the mathetics approach begins instruction with the final step in the process to be learned and chains backwards towards the first step in the process.

On a more micro level, the concept of kinetic structure has been operationalized to assess the sentence-to-sentence organization in verbal instruction. Kinetic structure has been found to be related to instructional effectiveness; communications with a high degree of kinetic structure result in increased learning.

The literature is less helpful when considering content sequence strategies for multiple content topics. The most commonly employed process involves analyzing a given learning task into the prerequisite intellectual skills related to the task. This hierarchical arrangement of learning prerequisites results in a type of learning roadmap showing routes (or sequences) the instruction might follow. While the use of sequences derived from learning hierarchies have been shown to result in increased learning, the model has been criticized as being both inadequate and misleading.

An alternative to the learning hierarchy can be found in the literature under the title of the elaboration model. This instructional organization results in a multilevel content sequence following a general-to-detail pattern. While similiar to a few earlier sequence strategies, little research has been conducted on this recent addition in instructional design.

Some research has placed sequence under the control of the learner. Learner control over content sequence has been found to be as effective as system control, prompting one theorist to suggest that learner control is essential for realization of the human potential.

The research indicates that not all content sequences are appropriate for all types of content. When selecting and using a sequence for procedural content, consideration should be given to the opportunity for practice, the process of identifying the learning content within the procedure, and the role of supporting concepts and principles within the instructional sequence. This consideration will assist in identification of strengths and weaknesses in a given sequence model.

Conclusion. This chapter has reviewed selected literature on content sequence and has examined the venn between content sequence and procedural learning. While sequencing options are abundant, sequencing prescriptions are scarce. Sequence should not be considered an instructional variable, but rather a class of instructional variables, each variable resulting in a different question to be studied when information needed for sequence decisions is not available. This review has failed to find an answer to the problem for this research: "At what point(s) in the instructional sequence should the learner be able to apply an integrated version of the content?"

CHAPTER III

METHODOLOGY

This study is an investigation of relationships among content sequence, task complexity, and procedural learning. This chapter outlines the methodology used to conduct the investigation.

Subjects for the Study

The subjects for the study were from a population of middle school students in Oklahoma City. Two middle school social studies teachers willing to participate in the study were identified. Then two classes for each teacher were selected to form the experimental groups. The only requirement for a class to be selected was that a class selected by one teacher did not meet at the same time as a class selected by the other teacher. The classes ranged in size from 29 to 32.

The two classes for each teacher were randomly assigned to one of two treatment conditions. One treatment condition was instruction on content sequenced to provide ongoing content integration on the application level (OCI sequence). The other treatment condition was instruction on content sequenced to provide content integration upon termination of instruction (TCI sequence). The size of the OCI sequence group was 51; the size of the TCI sequence group was 52.

Materials for the Study

Instructional Materials. The materials used in this study were developed by the researcher to provide instruction for the following objectives related to personal checking account procedures:

1. Given a set of blank checks and payment information for each check, the student will complete each check according to specified procedures.
2. Given a check register with initial balance information, the student will record all checks written on the checking account according to specified procedures.
3. Given a set of deposit slips and items for deposit, the student will complete the deposit slips according to specified procedures.
4. Given a check register with initial balance information, the student will use specified procedures to record all deposits made to the checking account and keep a running balance.
5. Given a check register, a set of canceled checks, deposit slips, and a bank statement, the student will use specified procedures to reconcile the checking account.
6. Given situations common in handling checking accounts, the student will identify the approrpiate procedures and the correct order for carrying out the procedures.

The validity of the objectives was estblished by a business education expert and were considered to be consistent with objectives frequently used when teaching checking account procedures.

Presentation materials consisted of a set of overhead transparencies developed by the researcher. These transparencies provided information, examples, and practice on the procedures used in checking accounts. Also, they provided information, examples, and practice for learning concepts and principles related to the procedures. One additional set of five transparencies was developed for the OCI Sequence. The frames of the transparencies contained written instructions to help the teacher present the content on the transparency. For a detailed description of the transparencies, see Appendix A.

Handout materials were mock versions of forms commonly encountered in checking account procedures. The handouts consisted of checks, deposit slips, check registers, bills, bank statements, and reconcilement forms. These were completed by the student for practice following instruction. One additional set of five handouts was distributed to students in the OCI Sequence. For a description and examples of the handouts, see Appendix B.

Testing Instruments. Two test instruments were developed, based on the learning objectives listed above. The first instrument was designed to assess the students' ability to apply two different procedures classified as simple. One procedure, check writing, involved three tasks: interpreting a bill, writing a check for the bill, and recording the check. The second procedure, deposit making, involved three tasks: interpreting a check, making out a deposit slip for the check, and recording the deposit. As indicated, each of the six tasks were assessed twice, making a total possible score of 12 on this instrument.

The second instrument was designed to assess the students' ability to apply a complex procedure, account reconcilement, to a given situation. Eight observable steps were identified within the procedure and were used as criteria against which student performance was assessed. A total score of 8 was possible on this instrument.

The content validity for the testing instruments was established by a business education expert. The instruments were considered to provide a valid assessment of the learning objectives listed above. The test instruments can be found in Appendix C.

Procedures

The procedures used in this research were designed to investigate two general questions:

1. Is the timing of the opportunity for the learner to apply an integrated version of procedural content related to performance on tasks of high complexity?

2. Is the timing of the opportunity for the learner to apply an integrated version of procedural content related to performance on tasks of low complexity?

The procedures consisted of seven phases: content selection, identification of subskills, content sequencing, material development, teacher training, instructional delivery, and evaluation.

Content Selection Phase. To address the above questions, it was first necessary to identify a body of procedural content which met the following criteria:

1. The content must be of interest to the subjects.
2. The content must lend itself to observable (overt) applications.
3. The content must consist of both high and low complexity tasks.
4. The content must consist of multiple, related topics.
5. Instruction on the content must be possible within the constraints of time (five one-hour sessions), and setting (self contained classrooms).

6. The content must be appropriate for middle school students.

7. The content must be novel to the subjects.

Procedures for handling checking accounts met all criteria and was selected for use in this study. Three specific procedures were identified for instruction:

1. making and recording payments by check
2. making and recording deposits
3. reconciling accounts.

The specific learning objectives can be found in the materials section of this chapter.

Identification of Subskills Phase. A task analysis was performed to determine the subskills that were required to learn and/or perform each procedure. An information processing approach to task analysis, described by P. Merrill (1976, 1980), was followed. This procedure included the following steps:

1. An expert (a Certified Public Accountant) was observed performing each task.
2. For covert cognitive steps, the expert was asked to "think aloud" and describe the covert operations being performed.
3. A list was made of the specific operations performed, decision points encountered, information or objects operated upon, and the results of each operation.
4. A flow chart was prepared showing the sequence for performing the procedure, including decision points and any iterative loops.
5. The accuracy of the flow chart was checked by performing each operation in the flow chart with a variety of inputs.

This process was repeated for each procedural task. The results of the task analysis can be found in Appendix D.

A byproduct of the task analysis was the identification of supporting concepts and principles for each procedure. As explained in the second chapter of this research, if a procedure is learned without an understanding of the concepts and principles involved in the procedure, the learning will likely be rote. A list of the supporting concepts and principles identified for the selected procedures can be found in Appendix E.

Content Sequencing Phase. Two content sequences constituted the treatment conditions. The sequence variable manipulated was the opportunity for the learner to apply an integrated version of the content. One content sequence provided for ongoing content integration (OCI Sequence); the other sequence provided for content integration upon completion of all instruction (TCI Sequence). Both sequences were developed using information obtained from the task analysis.

To provide for ongoing content integration on the application level, a general-to-detailed content sequence was used. In general, the content sequence was organized according to the elaboration model (Reigeluth & Rodgers, 1980). As described in the review of literature chapter, the elaboration model begins instruction with a simple, general version of the procedure. Instruction proceeds by adding complexity and detail to the content. Each increase in complexity and detail results in a new "level of elaboration." This elaboration process continues until the final criterion level is reached.

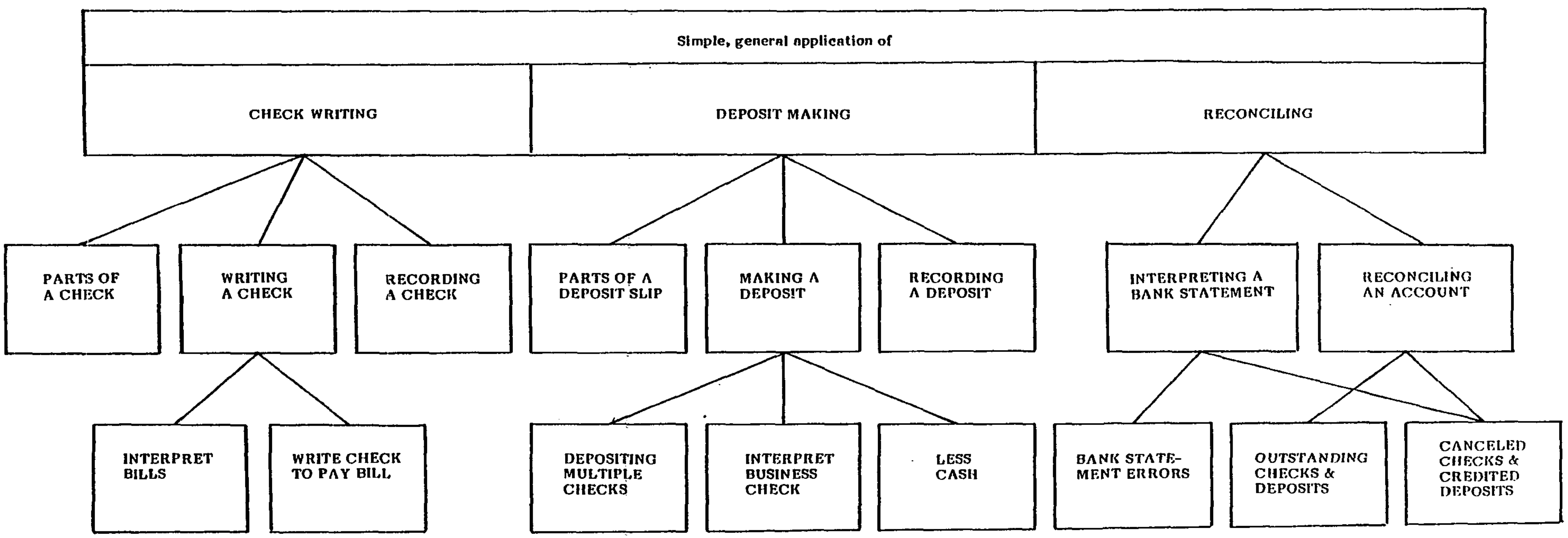
The OCI sequence for checking account procedures was determined by first examining the task analysis for each procedure. Using Reigeluth and Rodger's criteria, an epitome was selected. The epitome, a simple version of the procedures, was selected by looking for "simplifying assumptions which serve to 'lay bare' the fundamental procedure" (Reigeluth & Rodgers, 1980, p. 18). The epitome was presented on the application level by involving the students in a simulation of the fundamental procedures in checking account handling.

To sequence the remaining operations in the procedure, the simplifying assumptions were gradually relaxed, allowing for more complex operations. Following each expanded version of the content (called "levels of elaboration"), the instruction reviewed and synthesized the content to that point. This part of the sequence is called the "expanded epitome." Each expanded epitome provided opportunities for content integration on the application level. Figure 1 provides an illustration of the sequence developed via the elaboration model. For a detailed description of this content sequence, see Appendix F.

To provide for integrated application of content upon completion of instruction, a progressive part sequence was used. As described in the review of literature chapter, this model begins with instruction and practice on the first part of the overall procedure. Then instruction is provided on the second part of the overall procedure and the first part is practiced with the second. Next, instruction is provided on the third part and this is practiced with the first and second parts. This continues until instruction has been given on all parts of the content.

The TCI sequence for checking account procedures was determined by examining the task analysis for the procedures. The performance sequence

Figure 1. Ongoing content integration model



indicated by the task analysis was used as the instructional sequence for each procedure. The overall instructional sequence was:

1. check writing
2. check recording
3. deposit making
4. deposit recording
5. interpreting bank statements
6. reconciling accounts.

This overall sequence was a utilization sequence based on anticipated frequency of use. Selection of a utilization sequence was somewhat arbitrary. Unlike an elaboration based sequence which prescribes the overall sequence between topics, a progressive parts based sequence makes no provision for sequencing between content topics.

Within each topic, the TCI Sequence was based on the final criterion level. In other words, for each procedure, instruction was organized in the manner shown by the task analysis. Practice was provided on each new topic plus all previous topics when appropriate. This "snowball" approach provided the opportunity for integrated application of all content at the end of all instruction. Prior to that time, the learner practiced only those parts of the content which had been covered at that time. Figure 2 shows a model of the TCI Sequence developed via the progressive part model. For a detailed description of this content sequence, see Appendix G.

Material Development Phase. The learning objectives, the task analysis, and both content sequences described above were used as a basis for development of the instructional materials. As described earlier, the materials

Figure 2. Terminal content integration model.

INSTRUCTION:	CHECK WRITING								
PRACTICE	CHECK WRITING								
INSTRUCTION		INTERPRET BILLS							
PRACTICE	CHECK WRITING	INTERPRET BILLS							
INSTRUCTION			RECORD CHECKS						
PRACTICE	CHECK WRITING	INTEPRET BILLS	RECORD CHECKS						
INSTRUCTION				MAKING DEPOSITS					
PRACTICE				MAKING DEPOSITS					
INSTRUCTION					INTERPRET CHECKS				
PRACTICE				MAKING DEPOSITS	INTERPRET CHECKS				
INSTRUCTION						RECORD DEPOSITS			
PRACTICE				MAKING DEPOSITS	INTERPRET CHECKS	RECORD DEPOSITS			
INSTRUCTION							INTERPRET BANK STATE.		
PRACTICE							INTERPRET BANK STATE.		
INSTRUCTION								B.S. ERRORS	
PRACTICE							INTERPRET BANK STATE.	B.S. ERRORS	
INSTRUCTION									RECONCILING ACCOUNTS
PRACTICE							INTERPRET BANK STATE.	B.S. ERRORS	RECONCILING ACCOUNTS
PRACTICE	CHECK WRITING	INTERPRET BILLS	RECORD CHECKS	MAKING DEPOSITS	INTERPRET CHECKS	RECORD DEPOSITS	INTERPRET BANK STATE.	B.S. ERRORS	RECONCILING ACCOUNTS

consisted of overhead transparencies and worksheets. The transparencies and handouts varied between treatments only in order of presentation although the OCI sequence used five additional transparencies and handouts. These additional materials were used during the initial part of instruction calling for very simple content. All materials are described in Appendices A & B.

Once the materials were developed, they were organized according to an elaboration-based sequence, numbered in presentation order, resequenced according to a progressive parts based sequence, and renumbered in the new presentation order. The numbering helped insure the proper sequence was followed during the instructional phase.

Teacher Training Phase. Prior to delivery of instruction, the teachers were trained by the researcher in the use of the materials and the delivery of the instruction. Following a committment to participate in the research, the training consisted of:

1. a phone conversation describing the research;
2. discussion of a one page summary describing the research;
3. discussion of a three page summary of the two instructional sequences;
4. a 1½ hour meeting to review the instructional materials and make final plans for the instructional sessions.
5. a daily 30-45 minute meeting with each teacher to preview the instruction for that day.

Instruction Phase. The two sets of instruction resulting from the two content sequences were delivered by the two trained classroom teachers. Each teacher delivered both sets of instruction once. Each teacher's two classes were randomly assigned to one of the two treatment conditions. The instruction consisted of five one-hour sessions delivered to the teachers' regular classes. Instruction began on a Monday and concluded on Friday of the same week. Following the prescribed content sequence, the teacher presented the content for the day. To help insure that the teachers did not diverge from the prescribed sequence, three steps were taken:

1. The transparencies were numbered in the appropriate sequence and managed by the researcher.
2. Instructions on how to present the content for the transparency were written on the frame.
3. The handouts were given to the teacher by the researcher when appropriate.

In other words, the primary tasks of the teacher were to deliver the instruction and motivate the students. The management and organization of instruction were performed primarily by the researcher.

Evaluation Phase. The testing instruments described earlier were administered to all subjects in attendance on the Monday following completion of instruction. Eleven subjects were absent that day and were evaluated later in the week. All testing was complete within one week following the completion of instruction. The tests given on Monday were administered by the teachers with the researcher present. The test instructions were read aloud. The make up tests were administered by the teachers and later collected by the researcher. The students were told that their scores on this test would be included in their semester grade.

No pre-test was given the subjects. Hartley (1973) suggests pre-tests can have an orienting, motivational, and teaching function as well as an effect on post-test performance. Since a major concern of this study is the issue of eventual integration of the content by the student, it was felt that a post-test only design was most appropriate.

Teacher Preference Evaluation. Teacher preference for one instructional sequence over another was informally assessed before, during, and after the five days of instruction. The assessment consisted of private discussions with each teacher. While the discussions were basically without structure, at some point the teachers were asked if they saw any particular strengths or weakness with either sequence or if they had developed a preference for one sequence over another. In general, the teachers were hesitant to endorse either sequence and were anxious to see the results of the study.

One teacher expressed a general feeling of being "rushed" in both instructional sequences and expressed a desire to have a few (1 or 2) more training sessions. This teacher went on to say that he was always concerned when some students didn't seem to be "getting it." This might be interpreted as a tendency for this teacher to pace his instruction for the slower learner. The other teacher did not express any feeling of being rushed. Both teachers agreed that both instructional sequences were well organized and had many strengths.

Design

A post-test only design was used to study the research hypotheses. Data consisted of student scores on performance measures for tasks of low complexity and scores on a single measure for a task of high complexity. By having two teachers deliver both content sequences, it was possible to partially block for teacher preference effect. If one content sequence results in significantly different scores from the other content sequence for both teachers, then the possibility that the difference can be attributed to teacher preference is less when two (or more) teachers are involved. These two variables, teacher and sequence, were built into a two (teacher 1, teacher 2) by two (ongoing content integration, terminal content integration) factoral design. Two separate two way analysis of variance (ANOVA) were used to test the hypotheses. Figures 3 & 4 show the research paradigms. Significance was set at the .05 level.

Using the procedure described by Winer (1962, p. 104), the power of the statistical test (ANOVA) was calculated. For a sample size of 50, an alpha level of .05, an estimated variance of 4 to 6, and a "practically importance difference" of 0.5, calculations indicated the power of the test to be approximately .7.

A second consideration was the relationship between the high and low complexity tasks. If the hypothesized effects of the ongoing content integration sequence are to be realized, the content should consist of interrelated topics. if performance on the simple task is found to be related to performance on the complex task, then this finding would indicate the tasks are not independent. A Pearson-r was calculated to determine the correlation between scores on tasks of high and low complexity. A relatively high correlation would indicate that the tasks were not independent of each other.

Figure 3 Design for low complexity task

Teacher Factor		Sequence Factor: Ongoing content integration	Sequence Factor: Terminal content integration
	Teacher 1	N = 25	N = 28
	Teacher 2	N = 26	N = 24

Figure 4 Design for high complexity task

Teacher Factor		Sequence Factor: Ongoing content integration	Sequence Factor: Terminal content integration
	Teacher 1	N = 25	N = 28
	Teacher 2	N = 26	N = 24

CHAPTER IV

RESULTS

Means were calculated for performance measures on both simple and complex procedures. The overall mean (N=103) for performance on a simple task was 10.22 with a standard deviation of 2.19 and range of 2 to 12 (maximum possible range of 0 to 12). The overall mean (N=103) for performance on a complex procedural task was 4.32 with a standard deviation of 2.88 and range of 0 to 8 (maximum possible range of 0 to 8). Histograms of the overall scores can be found in figures 5and 6.

Figure 5. Histogram: Performance Scores on Simple Task

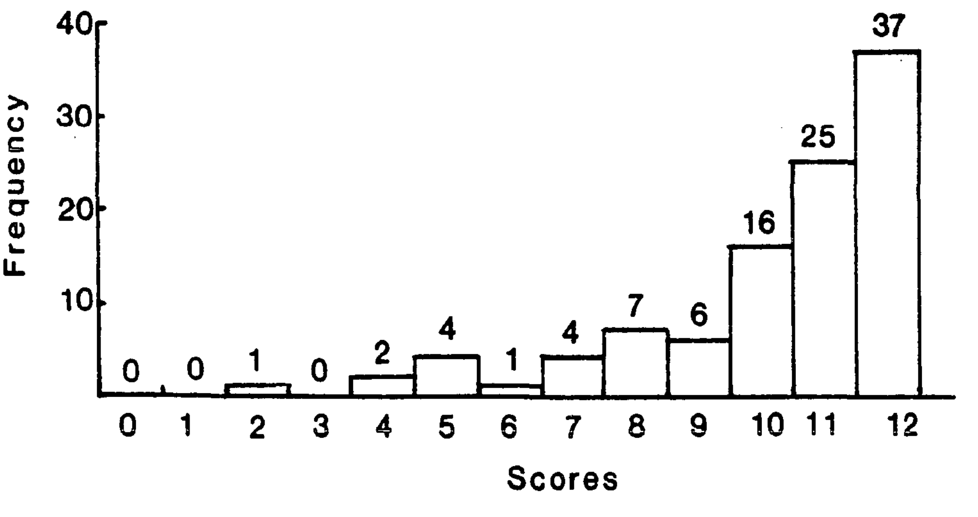
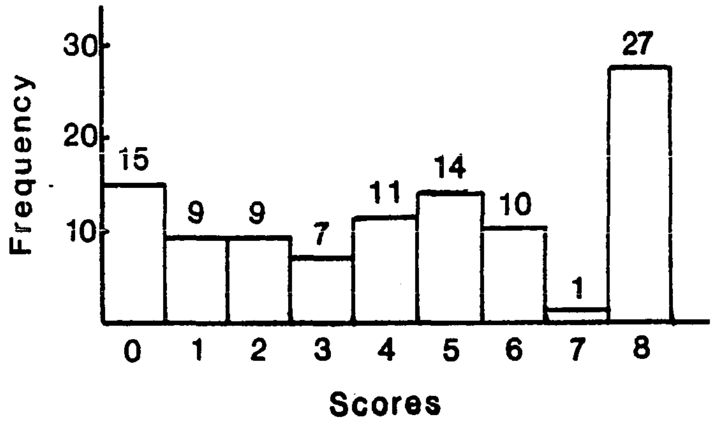


Figure 6. Histograms: Performance Scores on Complex Task



Means were also calculated for the four treatment groups. These means and standard deviations can be found in tables 1 and 2.

TABLE 1

Overall Means and Standard Deviations for Sequence and Teacher.

Factor	Task	N	Mean	S.D.
Teacher 1	simple	53	10.70	1.52
Teacher 1	complex	53	4.92	2.77
Teacher 2	simple	50	9.72	2.62
Teacher 2	complex	50	3.68	2.83
OCI Sequence	simple	51	10.29	2.12
OCI Sequence	complex	51	4.04	2.88
TCI Sequence	simple	52	10.15	2.45
TCI Sequence	complex	52	4.60	2.83

TABLE 2

Means and Standard Deviations for Treatment Groups.

Sequence	Teacher	Task	N	Mean	S.D.
OCI Sequence	1	simple	25	10.72	1.70
OCI Sequence	2	simple	26	9.88	2.45
TCI Sequence	1	simple	28	10.68	1.42
TCI Sequence	2	simple	24	9.54	2.87
OCI Sequence	1	complex	25	4.08	2.93
OCI Sequence	2	complex	26	4.00	2.95
TCI Sequence	1	complex	28	5.68	2.50
TCI Sequence	2	complex	24	3.33	2.78

A Pearson's r was calculated to determine the correlation between individual's scores on the simple and complex performance measures. A mild correlation (r=0.45) was found. For a sample of this size (N=103), this correlation is significant at the .0001 level.

A two by two factoral analysis of variance (ANOVA) was used to analyze performance measures for both high and low complexity tasks. This statistic allowed the researcher to test the sequence related hypotheses of the study and also look for a possible teacher preference effect. The results of this analysis are presented below.

Test of Hypotheses

For simple tasks, the ANOVA showed no significant difference in performance measures that could be attributed to content sequence. A main effect for teacher was found at the .05 alpha level. No significant interaction between the two factors was found. Cell means for simple procedural tasks can be found in

Table 3. Figure 7 shows a graphic representation of the cell means. Table 4 shows the ANOVA summary for performance on simple tasks.

TABLE 3

Means for Simple Procedural Task (check writing & deposit making).

	Ongoing Content Integration	Terminal Content Integration	
Teacher 1	$\bar{X}$ = 10.72	$\bar{X}$ = 10.68	10.70
Teacher 2	$\bar{X}$ = 9.88	$\bar{X}$ = 9.54	9.72
	10.29	10.15	

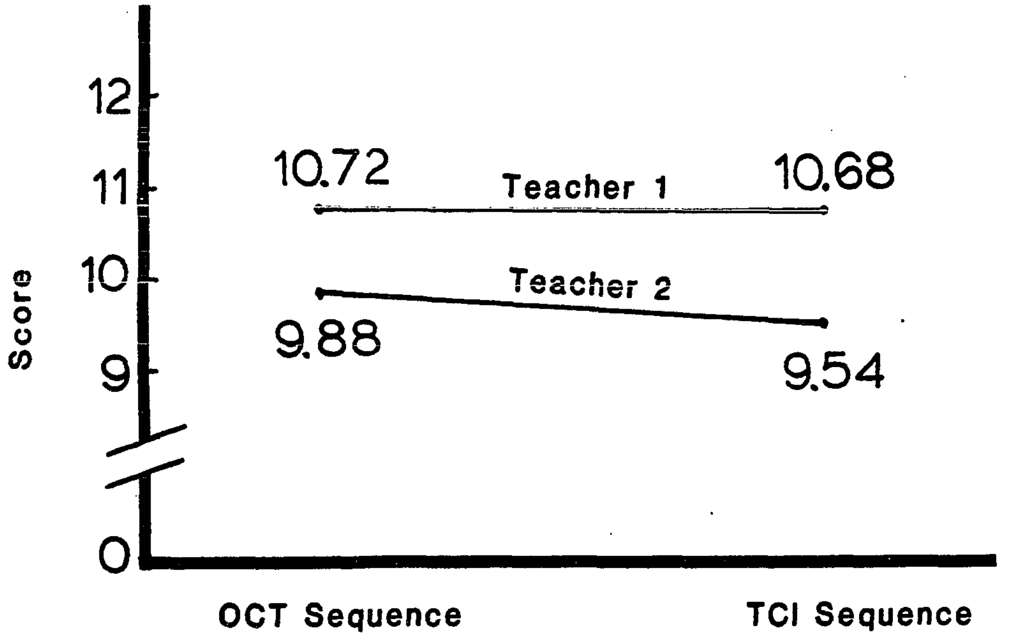
TABLE 4

Analysis of Variance for Simple Procedural Tasks (check writing & deposit making).

Source	df	SS	MS	F
Teacher	1	24.961	24.961	5.33*
Sequence	1	0.948	0.948	0.20
Teacher x Sequence	1	0.583	0.583	0.12
Within (error)	99	463.759	4.684	
TOTAL	102	489.864		

* $p < .05$

Figure 7. Cell Means for Performance on Simple Task



For complex tasks, the ANOVA showed no significant difference in performance measures that could be attributed to content sequence. A main effect for teacher was found at the .05 alpha level. A significant interaction between the sequence factor and teacher factor was found at the .05 alpha level. Table 5 shows the cell means for the four treatment groups. Figure 8 shows a graphic representation of the cell means. Table 6 shows the analysis of variance summary for performance on simple tasks.

TABLE 5

Means for Complex Procedural Task (reconciliation).

	Ongoing Content Integration	Terminal Content Integration	
Teacher 1	$\bar{X}$ = 4.08	$\bar{X}$ = 5.68	4.92
Teacher 2	$\bar{X}$ = 4.00	$\bar{X}$ = 3.33	3.68
	4.04	4.60	

Figure 8. Cell Means for Performance in Complex Task.

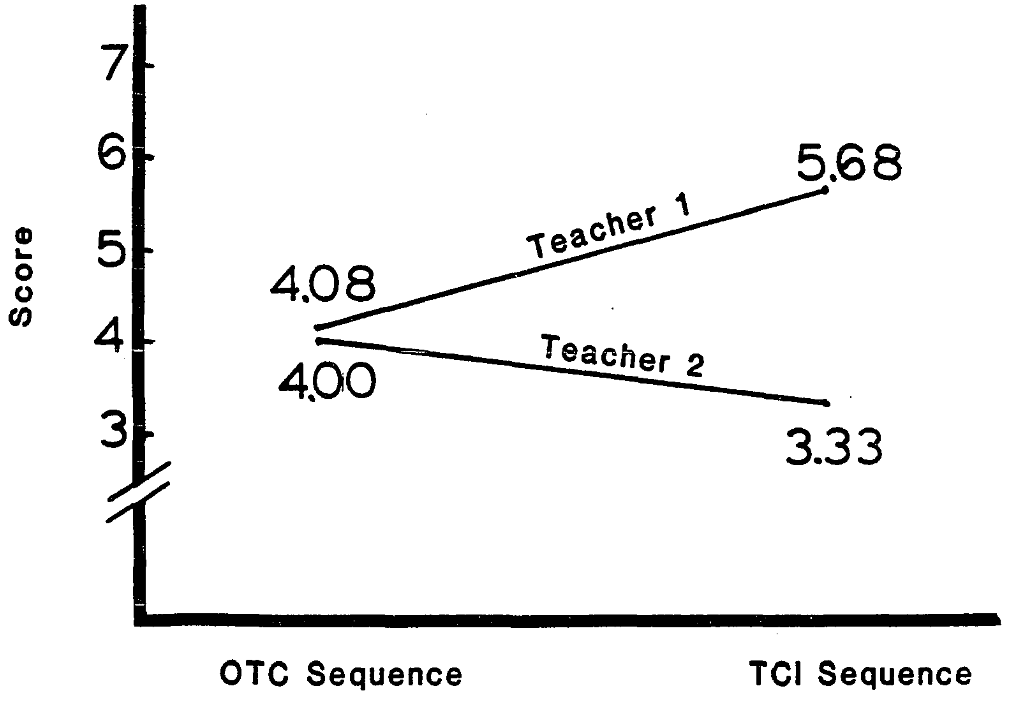


TABLE 6

Analysis of Variance for Complex Procedural Task (reconciliation).

Source	df	SS	MS	F
Teacher	1	37.741	37.741	4.68*
Sequence	1	5.572	5.572	0.72
Teacher x Sequence	1	32.926	32.926	4.24*
Within (error)	99	769.208	7.770	
TOTAL	102	848.427		

* $p < .05$

To further examine the interaction between content sequence and teacher found for complex tasks, simple main effects were calculated using a t-test. No significant difference in simple main effects was found in performance measures for either teacher. No significant difference in simple main effects was found in performance measures for either content sequence. The results for these t-tests can be found in Tables 7 & 8.

TABLE 7

Simple Main Effects for Complex Procedural Task by Teacher.

	Ongoing Content Integration	Terminal Content Integration	df	t
Teacher 1	$\bar{X}$ = 4.08	$\bar{X}$ = 5.68	51	non sig.
Teacher 2	$\bar{X}$ = 4.00	$\bar{X}$ = 3.33	48	non sig.

TABLE 8

Simple Main Effects for Complex Procedural Task by Sequence.

	Teacher 1	Teacher 2	df	t
Ongoing Content Integration	$\bar{X}$ = 4.08	$\bar{X}$ = 4.00	49	non sig.
Terminal Content Integration	$\bar{X}$ = 5.68	$\bar{X}$ = 3.33	50	non sig.

CHAPTER V

SUMMARY, DISCUSSION, RECOMMENDATIONS AND CONCLUSION

Summary

A fundamental concern in instructional design is the selection of a content sequence which will result in optimal learning. The focus of this research was on the relationships among content sequence, task complexity, and learning effectiveness. In particular, this research examined the relationship between the timing of opportunity for integrated application of content and procedural learning for tasks of high and low complexity. It was hypothesized that instruction would be most effective for both high and low complexity tasks when the content was sequenced to provide ongoing content integration.

To test the hypotheses of this study, a sample of 103 middle school students were given instruction in one of two sequences. One content sequence provided opportunities for the student to apply integrated versions of the content throughout the instruction (OCI Sequence). The other sequence provided a single opportunity for the students to apply an integrated version of the content upon termination of instruction (TCI Sequence). Instruction was delivered by two regular classroom teachers. Both teachers used both content sequences, helping to block for a teacher preference effect.

After completion of five one-hour training sessions, subjects were administered two performance tests. One test was designed to assess student performance on low complexity tasks; the other to assess performance on high complexity tasks. Scores on the two test instruments were found to be mildly correlated, indicating that the low and high complexity tasks were not independent of each other. Rather, empirical evidence (via correlational analysis and content analysis) suggests that the content used in this study consisted of interrelated topics.

Data for both high and low complexity tasks were analyzed using a two (teacher 1, teacher 2) by two (ongoing content integration, terminal content integration) analysis of variance (ANOVA). For low complexity tasks, the ANOVA found no significant difference in performance scores that could be attributed to content sequence. The hypothesized superiority of the ongoing content integration sequence for instruction on low complexity tasks was not supported. The analysis did reveal a significant main effect for the teacher factor. No interaction was found between content sequence and teacher. Apparently, for tasks of low complexity, the content sequence variable examined had little effect on performance. Rather, some teacher variable(s) (unexamined in this study) seems to be related to performance on low complexity tasks.

For high complexity tasks, the ANOVA found no main effect that could be attributed to content sequence. The hypothesized superiority of the ongoing content integration sequence for instruction on high complexity tasks was not supported. The analysis did find a significant main effect for the teacher factor. This was confounded by a significant interaction found between content sequence and teacher. Analysis of the simple main effects found no significant difference for either content sequence or teacher.

In general, this study failed to find significant differences between the investigated content sequence variable for either high or low complexity tasks. Significant differences in performance were found to be related to the teacher delivering the instruction rather than the content sequence.

Discussion and Recommendations

This study indicates that the timing of the opportunity for applied integration of procedural content has little effect on student performance, suggesting that the two content sequences were equally meaningful to the learner. This finding is contrary to the hypothesized relationships and counter to theoretic support found in the literature. A discussion of this, along with recommendations for further study, follow.

Discussion of Findings. Assimiliation-to-schema theory predicts that "subjects given a general model or general experience in thinking about examples will have a meaningful learning set for encoding the subsequent new specifics and hence will be able to assimilate the material to a broader set of past experiences . . . while subjects given the same set after learning will have already encoded the new material within a much narrower set" (Mayer, 1977, p. 372). For simple procedural tasks, the ANOVA did not support this prediction. While the scores for the OCI Sequence group were slightly higher, the difference was not found to be significant.

Such findings for simple procedural tasks are not necessarily inconsistent with the theoretic predictions. It is conceivable that while middle school students generally cannot perform simple checking account procedures without instruction, most are somewhat familiar with the process involved. Most middle school students know that checks are written to pay for something and money is put in a bank. Thus, a "meaningful learning set" may have already been established for the simple procedures.

It is also conceivable that a task could be so elementary that the "general experience for thinking about examples" was not substantially different from later "new specifics." If this is the case, the initial and ongoing experiences provided by the OCI Sequence was little more than additional practice of the simple procedures.

For the complex procedural task, the results are not as readily explained. The ANOVA did not support the theoretical prediction from assimiliation-to-schema theory for the complex task of checking account reconciling. The task was quite novel, both as a concept and as a procedure, reducing the possibility that a "meaningful learning set" was already established. Also, the general version of the procedure was a good deal simpler than the criterion level task, suggesting that subjects in the OCI Sequence had greater opportunity to establish a meaningful learning set than subjects in the TCI Sequence. Yet, the results were not as predicted.

The disordinal relationship between content sequence and teacher found for the complex task further confuses the situation. For teacher 2, student performance was consistent with theoretic predictions while for teacher 1, student performance was contrary to theoretic predictions. One possible explanation is that one teacher preferred the TCI Sequence and the other teacher preferred the OCI Sequence. Discussions with the teachers did not indicate such a preference. Another possible explanation is that compatability, rather than preference, was at work. One sequence may have been more suitable to one teacher's teaching style while the other sequence may have been more suitable to the other's. While such speculations are outside the realm of sequence theory, the interaction between sequence and teacher for complex procedural tasks should be explored. The incongruity between the theoretical predictions and the empirical findings of this study, along with insights gained during the study, has led to the following recommendations.

Recommendations. The timing of the opportunity for integrated application of content may not be critical for the amount of content used in this study. More content, in either depth or scope, would produce more relationships within the content, making content integration more complex. Further study is indicated in which the question of the amount of content is explored. Such studies might involve an increase in the depth and/or scope of the content using the same hypotheses and design as used in this study.

The teacher effect found for both high and low complexity tasks may have obscured the effect of sequence on performance. Future study might overcome this problem by either using a larger number of teachers or by using a mediated instructional delivery system. If mediated instruction were used, provisions would have to be made for unplanned remediation which might be required by some students.

The opportunity for integrated application of content was presented in both content sequences. This presence, rather than the time or frequency of opportunity for integrated application, may be of significance. Future research might involve the use of several content sequences, only some of which provide for the integrated application of content.

Both content sequences were highly organized, allowing for little input into the sequence on the part of the teacher. Yet, teacher effects were found in both high and low complexity tasks. Future research might reveal that some teachers prefer already sequenced materials while other teachers prefer to sequence materials themselves. It is not inconceivable that content is sequenced to increase the teaching ease as well as increase learning efficiency. Understanding the interactions between teacher characteristics and content sequence control may provide valuable insights into the design of instruction.

The instruction used in this study was not designed for mastery learning. Future research might find that learning efficiency (time to mastery) is related to content sequence. Research should be conducted which allows the learner to control the rate of instructional delivery within a given content sequence. In such studies, learning efficiency (time) rather than learning effectiveness (performance) would become the dependent variable.

While past research on aptitude-treatment interactions has generally failed to identify learner characteristics on which instructional prescriptions can be based, this avenue should be further explored in the context of instructional sequence. Both stable characteristics (i.e., cognitive style) and unstable characteristics (i.e., prior knowledge, attention span and interest) may be related to content sequence. For example, sequential processors may perform better when instruction is organized in a part-to-whole sequence while holistic processors may prefer a general-to-detail sequence.

The test instruments used in this study were reproductions of the actual forms used in checking account procedures. While this increased the content validity of the instruments, the forms may have provided too many prompts for completing the procedures. For instance, several prompts are found on blank checks (date prompt, payee prompt, amount prompt) which guide the user through the process of writing a check. Similiar prompts are present on other checking account forms. The subjects may have been following instructions (attending to prompts) rather than applying learned procedures. Future study might use other procedural content which does not involve so highly prompted procedures. Geometric constructions and computer programming would meet these requirements and would include both simple and complex interrelated tasks.

In this study the teacher factor was found to have greater relationship to learning effectiveness than the sequence factor. In a study by Stein (in progress), variations in content sequence have produced no significant differences in learning efficiency. Yet, student attitude toward reading has been found to be related to learning efficiency. These studies were about sequence; both failed to find significant sequence effects; and both revealed other factors which strongly entered into learning effectiveness or efficiency. Perhaps sequence studies can afford the instructional researcher the opportunity to better assess other instructional variables. Rather than attempting to control all variables except those manipulated, this research would control one variable, sequence, and thus increase the apparent effect of the other instructional variables. Instead of a collection of "one-shot" studies, this research would be a series of studies systematically becoming narrower in scope and focusing in on those instructional variables which are most strongly related to instructional effectiveness and efficiency.

Posner and Strike's menu of sequencing principles provides a framework for identification of sequence options. This study employed a utilization related sequence to provide the overall organization for the terminal content integration sequence. However, not all types of sequence should be considered appropriate for all types of content.

For example, in this study a world-related sequence (i.e., temporal, spatial, physical attribute) would have been inappropriate. A temporal sequence would have taught old versions of checking account procedures before teaching current versions. It is unlikely that this sequence would result in more effective learning of checking account procedures than a sequence which began with simple procedures and progressed to more difficult procedures. It can be seen that the sequence options available in the current study were limited to either concept-related, utilization-related, or learning-related sequences. Future research using the Posner and Strike menu should not fall into the trap of randomly examining content sequences without first considering the appropriateness of the sequence to the content.

The results of this study have direct implication for those content sequence models which call for the ongoing integration of content on the application level. While replication and extension of this study is needed, consideration must be given to the possibility that this sequence variable has little relationship to learning effectiveness in procedural learning. Future research should be designed to look at the effect of this variable within those models which call for the ongoing integration of content on the application level.

For example, content could be sequenced according to the elaboration model and delivered to two groups. One group would receive instruction which include the ongoing opportunity for integrated application of content (called the "epitome" in the elaboration model). The other group would receive the same instruction but without the ongoing opportunity for integrated application of content (elaboration model without the epitome). It is possible that the question is not "Which sequence?" but rather "What is to be included in the selected sequence?"

Conclusion

This research identified a variable in content sequence options, integration at the application level, and studied its relationship to learning simple and complex tasks. Such relationships can serve as the basis for generation of research questions, the sequencing of instructional content, and contribute to the development of a theory of sequencing.

Posner and Strike (1976) and Posner and Rudnitsky (1976) have provided a general framework for identification of these sequence variables, yet no concerted effort has been seen which systematically attempts to isolate the effects of critical variables within content sequences. The myriad of sequence options and the paucity of sequence prescriptions testifies to the need for systematic research on sequence variables.

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APPENDIX A

DESCRIPTION OF TRANSPARENCIES

Forty-four transparencies were used in the sequence of instruction calling for terminal content integration. Forty-nine transparencies were used in the sequence of instruction calling for ongoing content integration. The transparencies fell into three broad categories: concept development, principle development, and procedural demonstration.

Concept development transparencies consisted of a concept, a generality about the concept, and instances and non-instances of the concept. For example, the content and general layout for a transparency on the concept of "check" was:

CHECK

A CHECK is a <u>written</u> order telling a <u>bank</u> to <u>pay out money.</u>

example?

yes or no	You call the bank and tell it to pay someone.
yes or no	You write a note to the bank and tell it to pay someone.
yes or no	You write a note to the bank wishing everyone a Merry Christmas.
yes or no	You write a note to the bank asking for a loan.

Principle development transparencies consisted of the principle and several opportunities to apply the principle. The word "rule" was used instead of "principle" on the transparencies to simplify the vocabulary. For example, the content and general layout for a transparency on the principle of reducing a balance when recording a check was:

Rule:

When a CHECK is written, SUBTRACT the AMOUNT of the check from the BALANCE.

Example:

__________ 19 ___

Pay to ______________________ $ _____

____________________________ Dollars

____

Date	Number	Transaction	Amount Dep.	Amount Pay.	Balance

Several overlays were used in this transparency for new input and practice.

Procedural demonstration was commonly done using the appropriate form(s). Overlays were used for repeat demonstrations. When the procedure involved finding critical information on forms, such as the amount due on a bill, transparencies of actual bills were used.

The following list contains a brief description of each transparency. The first number to the right of the description shows the presentation order for the ongoing content integration sequence; the second number shows the presentation order for the terminal content integration sequence.

Description	Ongoing	Terminal
*Simple bill	1	-
*Simple check	2	-
*Simple check register	3	-
*Simple deposit slip	4	-
*Simple bank statement	5	-
Blank check—example	6	1
Check—concept development	7	2
Payee—concept development	8	3
Completed check—example	9	4
Identify correctly completed checks	10	5
Complete a blank check	11	6
Check writing information—practice	12	7
Blank check register—example	13	18
Check register—concept development	14	19
Transaction—concept development	15	20
Balance—concept development	16	21
Recording checks—principle	17	22
Blank deposit slip—example	18	23
Deposit—concept development	19	24
Completed deposit slip—example	20	25
Identify correctly completed dep. slip	21	26
Deposit making information—practice	22	27
Recording deposits—principle	23	32

*Not used in terminal content integration sequence

Description	Ongoing	Terminal
Bank statement—concept development	24	33
Bank statement—example	25	34
Service charge—concept development	26	35
Reconciled accounts—concept development	27	39
How to reconcile—simple example	28	40
Reconcilement information—example	29	41
Interpreting bills—example	30	8
Interpreting bills—practice	31	9
Interpreting bills—practice	32	10
Interpreting bills—practice	33	11
Interpreting bills-practice	34	12
Interpreting bills—practice	35	13
Interpreting bills—practice	36	14
Interpreting bills—practice	37	15
Write check to pay bill—example	38	16
Write check to pay bill—practice	39	17
Interpreting check for deposit—example	40	28
Interpreting check for deposit—practice	41	29
Interpreting check for deposit—practice	42	30
Depositing several checks—example	43	31
Finding bank statement errors—example	44	36
Finding bank statement errors-practice	45	37
Finding bank statement errors-practice	46	38
Outstanding checks & deposits—concept	47	42
Canceled checks & credited deposits—concept	48	43
How to reconcile—complex example	49	44

APPENDIX B

DESCRIPTION OF HANDOUTS

The handouts used during the instruction consisted of mock forms, both blank and with information, which are normally encountered in checking account procedures. The forms included: blank checks, completed checks, blank deposit slips, completed deposit slips, check registers, bank statements, bills, and reconcilement forms. The handouts were distributed at appropriate points in the instructional sequence being employed. Appendices F and G indicate when the various handouts were used. Examples of the forms follow.

CARSON PETROLEUM CORP.
General Account
2190 LIBERTY TOWER 100 BROADWAY
OKLAHOMA CITY OKLAHOMA 73102

Citizens National Bank
Oklahoma City Oklahoma 73101

NO. 02643

DATE APRIL 24, 1981

AMOUNT $57.35

PAY FIFTY SEVEN & 35/100 DOLLARS

TO THE ORDER OF HARDING STUDENT

CARSON PETROLEUM CORP.
Arthur Signature
AUTHORIZED SIGNATURE

DEPOSITED WITH
AMERICAN Exchange BANK and Trust Co
1201 WEST MAIN P O BOX 88 NORMAN OKLAHOMA
CHECKS AND OTHER ITEMS ARE RECEIVED FOR DEPOSIT SUBJECT TO THE TERMS AND CONDITIONS OF THIS BANK'S COLLECTION AGREEMENT

DATE ____________ 19____

Your account no ____________

Name ____________

Address ____________

City, State ____________

Deposits Received After 3:00 P.M. Weekdays are credited to your Account on the following business day.

DEPOSIT TICKET

	DOLLARS	CENTS
CURRENCY		
COIN		
– LESS CASH –		
TOTAL		

BANK COPY

SOUTHWESTERN BELL

MAR 21 81 **FOR YOUR RECORDS** /943-02R/ 405 360 6376

SERVICE & EQUIPMENT-MAR21 THRU APR20		7.05	
ITEMIZED CALLS - SEE DETAIL		10.65	
TAXES-U.S. STATE AND LOCAL		.55	
CURRENT CHARGES	DUE BY APR 09		18.25
UNPAID FROM LAST BILL			1.00

TO CALL OUR BUSINESS OFFICE
DIAL 239-0360 0508 0515 TOTAL 19.25

NUMBER

______ 19___ 86-59/1031

PAY TO THE ORDER OF ______ $______

______ DOLLARS

AMERICAN

MEMO ______ ______

:103100593:

CHECK REGISTER

DATE	NUMBER	TRANSACTION DESCRIPTION	√	AMOUNT OF DEPOSIT	AMOUNT OF PAYMENT	BALANCE

RECONCILEMENT

MONTH __________ 19 ___

CHECKS OUTSTANDING

CHECKS	AMOUNT	
	$	
TOTAL	$	

STATEMENT BALANCE $ __________

SUBTRACT CHECKS OUTSTANDING $ __________

SUB-TOTAL $ __________

ADD DEPOSITS OUTSTANDING $ __________

BALANCE $ __________

AMERICAN Exchange BANK and Trust Co

STATEMENT DATE
CHECKING ACCT. NO.

BALANCE LAST STATEMENT	TOTAL AMOUNT OF CHECKS PAID	NO. OF CHECKS PAID	NO. OF DEPOSITS	TOTAL AMOUNT OF DEPOSITS MADE	SERVICE CHARGES	BALANCE THIS STATEMENT

DATE	CHECK NO. TERM. NO.	TRANSACTION DESCRIPTION	TRANSACTION AMOUNT

APPENDIX C

TEST INSTRUMENTS

Write a check for this bill and record it in the check register.

OG&E

ELECTRIC SERVICE BILL

KEEP THIS PART OF BILL

8538 0748 7

ACCOUNT NUMBER

RATE	SERVICE FROM	SERVICE TO	CONSTANT	DEMAND	READING	KWH	AMOUNT
RES	03 04 81	04 02 81	1		44723	192	

CURRENT BILL 14.50

AMOUNT INCLUDES

SALES TAX	.24
FRANCHISE PAYMENT	
FUEL ADJ AMOUNT	1.18
FUEL ADJ FACTOR	.006125

1205 OAKHURST AV
NORMAN OK
73071

APT 3

TOTAL AMOUNT DUE 14.50

CURRENT BILLING DUE DATE 05 12 81

AFTER DUE DATE PAY THIS AMOUNT 15.00

1205 OAKHURST AV APT 3

• AMOUNT IN EXCESS OF %

NUMBER

__________ 19___ 86-59/1031

PAY TO THE ORDER OF __________ $_____

__________ DOLLARS

AMERICAN

MEMO __________

⑆103100593⑆

DATE	NUMBER	TRANSACTION DESCRIPTION	√	AMOUNT OF DEPOSIT	AMOUNT OF PAYMENT	BALANCE
						156 60

Make out a deposit slip for this check and record it in the check register.

CARSON PETROLEUM CORP.
General Account
2190 LIBERTY TOWER 100 BROADWAY,
OKLAHOMA CITY, OKLAHOMA 73102

Citizens National Bank
Oklahoma City, Oklahoma 73101

NO. 0264

PAY TWENTY-THREE AND 25/100 DOLLARS

DATE MAY 2, 1981

AMOUNT $23.25

TO THE ORDER OF HARDING STUDENT

CARSON PETROLEUM CORP.

Sue Edwards

AUTHORIZED SIGNATURE

DEPOSITED WITH

AMERICAN Exchange BANK and Trust Co.

1201 WEST MAIN P.O. BOX 88 NORMAN, OKLAHOMA

CHECKS AND OTHER ITEMS ARE RECEIVED FOR DEPOSIT SUBJECT TO THE TERMS AND CONDITIONS OF THIS BANK'S COLLECTION AGREEMENT

DATE __________ 19___

Your account no. __________

Name __________

Address __________

City, State __________

DEPOSIT TICKET

	DOLLARS	CENTS
CURRENCY		
COIN		
– LESS CASH –		
TOTAL		

BANK COPY

DATE	NUMBER	TRANSACTION DESCRIPTION	√	AMOUNT OF DEPOSIT	AMOUNT OF PAYMENT	BALANCE
						41 50

Write a check for this bill and record it in the check register.

OG&E ELECTRIC SERVICE BILL — KEEP THIS PART OF BILL

ACCOUNT NUMBER: 8533 0748 7

RATE	SERVICE FROM	SERVICE TO	CONSTANT	DEMAND	READING	KWH	AMOUNT
RES	03 04 81	04 02 81	1		44723	192	

CURRENT BILL 19.45

AMOUNT INCLUDES: SALES TAX .24; FRANCHISE PAYMENT; FUEL ADJ AMOUNT 1.18; FUEL ADJ FACTOR .006125

1205 OAKHURST AV
NORMAN OK
73071
APT 3

TOTAL AMOUNT DUE 19.45

CURRENT BILLING DUE DATE 05 02 81

AFTER DUE DATE PAY THIS AMOUNT 20.09

ADDRESS WHERE SERVICE USED: 1205 OAKHURST AV APT 3

* AMOUNT IN EXCESS OF %

NUMBER

_______________ 19____ 86-59/1031

PAY TO THE ORDER OF ____________________ $ ______

______________________________ DOLLARS

AMERICAN

MEMO ______________ ______________

⑆103100593⑆

DATE	NUMBER	TRANSACTION DESCRIPTION	√	AMOUNT OF DEPOSIT	AMOUNT OF PAYMENT	BALANCE
						89.57

Make out a deposit slip for this check and record it in the check register.

CARSON PETROLEUM CORP.
General Account
2190 LIBERTY TOWER 100 BROADWAY
OKLAHOMA CITY, OKLAHOMA 73102

Citizens National Bank
Oklahoma City, Oklahoma 73101

NO. 0264

DATE May 1, 1981

AMOUNT $87.53

PAY Eighty-seven and 53/100 Dollars

TO THE ORDER OF Harding Student

CARSON PETROLEUM CORP.
AUTHORIZED SIGNATURE

DEPOSITED WITH
AMERICAN Exchange BANK and Trust Co.
1201 WEST MAIN P.O. BOX 88 NORMAN, OKLAHOMA
CHECKS AND OTHER ITEMS ARE RECEIVED FOR DEPOSIT SUBJECT TO THE TERMS AND CONDITIONS OF THIS BANK'S COLLECTION AGREEMENT

DATE ______________ 19____

Your account no. ______________

Name ______________

Address ______________

City, State ______________

DEPOSIT TICKET

	DOLLARS	CENTS
CURRENCY		
COIN		
– LESS CASH –		
TOTAL		

BANK COPY

DATE	NUMBER	TRANSACTION DESCRIPTION	√	AMOUNT OF DEPOSIT	AMOUNT OF PAYMENT	BALANCE
						21.32

Reconcile this account

MEMBER F.D.I.C.

AMERICAN Exchange BANK and Trust Co.
Norman, Oklahoma

STATEMENT DATE
5-2-81
CHECKING ACCT. NO.
123456

STUDENT
HARDING MIDDLE SCHOOL

BALANCE LAST STATEMENT	TOTAL AMOUNT OF CHECKS PAID	NO. OF CHECKS PAID	NO. OF DEPOSITS	TOTAL AMOUNT OF DEPOSITS MADE	SERVICE CHARGES	BALANCE THIS STATEMENT
100.00	35.00	3	2	80.00	.30	144.70

DATE	CHECK NO. TERM. NO.	TRANSACTION DESCRIPTION	TRANSACTION AMOUNT
4-28		CHECK	10.00
4-28		CHECK	4.50
4-29		DEPOSIT	35.00
4-3-		CHECK	20.50
5-1		DEPOSIT	45.00

CHECK RECONCILEMENT

MONTH ______ 19 ______

CHECKS OUTSTANDING

CHECKS ID	AMOUNT
	$
• TOTAL	$

BANK BALANCE THIS STATEMENT $ ______

• LESS CHECKS OUTSTANDING $ ______

SUB-TOTAL $ ______

ADD DEPOSITS NOT CREDITED $ ______

BALANCE $ ______

DEPOSITED WITH

AMERICAN Exchange BANK and Trust Co.

1201 WEST MAIN P.O. BOX 88 NORMAN, OKLAHOMA

CHECKS AND OTHER ITEMS ARE RECEIVED FOR DEPOSIT SUBJECT TO THE TERMS AND CONDITIONS OF THIS BANK'S COLLECTION AGREEMENT.

DATE Apr 28 19 81

Your account no. 123456

Name Student

Address ______

City, State ______

Deposits Received After 3:00 P.M. Weekdays are credited to your Account on the following business day.

DEPOSIT TICKET

	DOLLARS	CENTS
CURRENCY		
COIN		
	10	00
	25	00
– LESS CASH –	—	
TOTAL	35	00

BANK COPY

DEPOSITED WITH

AMERICAN Exchange BANK and Trust Co.

1201 WEST MAIN P.O. BOX 88 NORMAN, OKLAHOMA

CHECKS AND OTHER ITEMS ARE RECEIVED FOR DEPOSIT SUBJECT TO THE TERMS AND CONDITIONS OF THIS BANK'S COLLECTION AGREEMENT.

DATE Apr 30 19 81

Your account no. 123456

Name Student

Address ______

City, State ______

Deposits Received After 3:00 P.M. Weekdays are credited to your Account on the following business day.

DEPOSIT TICKET

	DOLLARS	CENTS
CURRENCY		
COIN		
	60	00
– LESS CASH –	15	00
TOTAL	45	00

BANK COPY

NUMBER 101

Apr 27 1981

86-59/1031

PAY TO THE ORDER OF Harding Middle School $ 10 00/100

Ten & 00/100 DOLLARS

AMERICAN

MEMO

Student

:103100593:

NUMBER 102

Apr 27 1981

86-59/1031

PAY TO THE ORDER OF T G & Y $ 4 50/100

Four & 50/100 DOLLARS

AMERICAN

MEMO

Student

:103100593:

NUMBER 103

Apr 29 1981

86-59/1031

PAY TO THE ORDER OF Miller's Sporting Goods $ 20 50/100

Twenty & 50/100 DOLLARS

AMERICAN

MEMO

Student

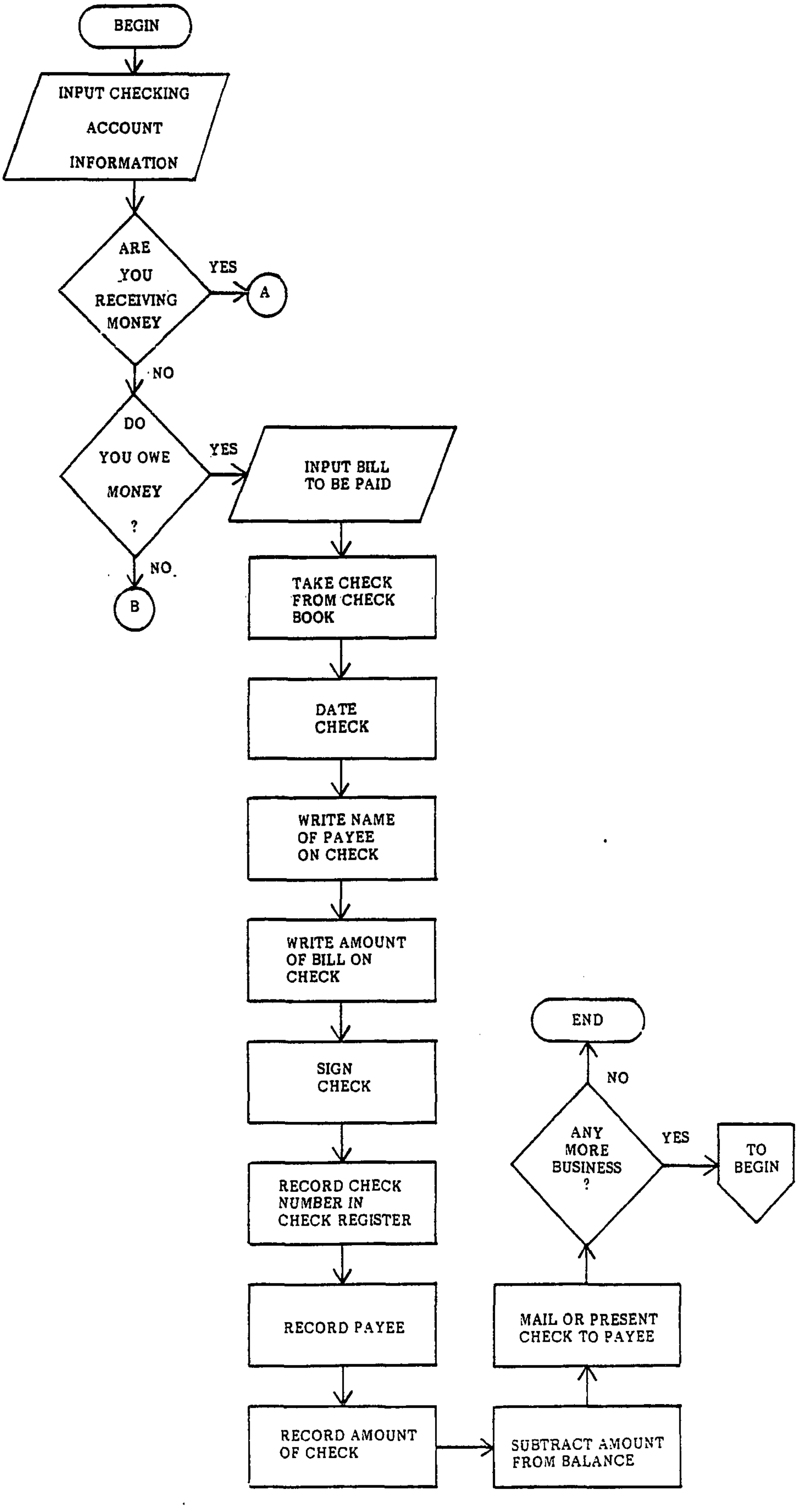
:103100593:

CHECK REGISTER

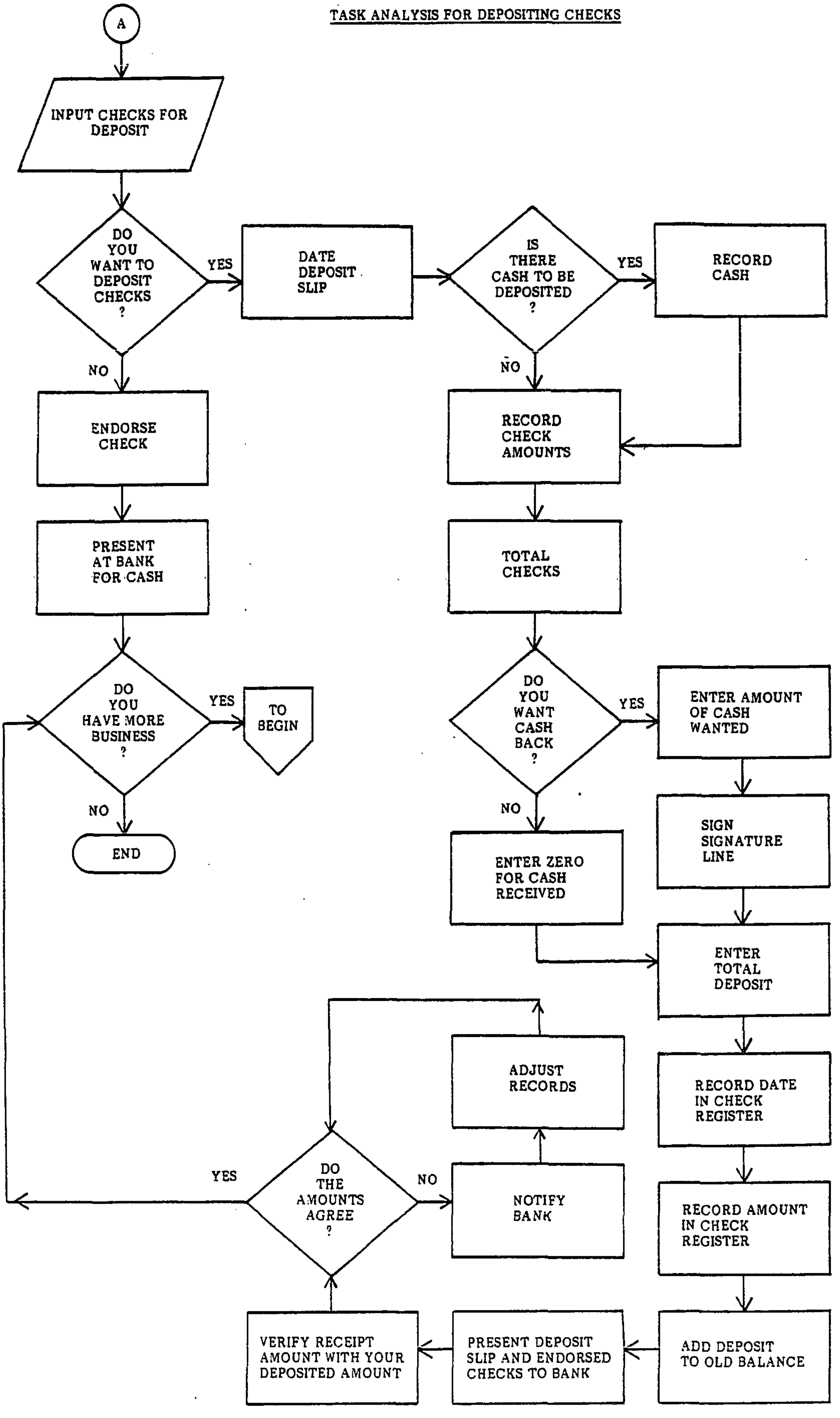
DATE	NUMBER	TRANSACTION DESCRIPTION	√	AMOUNT OF DEPOSIT		AMOUNT OF PAYMENT		BALANCE	
								100	00
4-27	101	Harding Middle School				10	00	90	00
4-27	102	T G & Y				4	50	85	50
4-28		Deposit		35	00			120	50
4-29	103	Miller Sporting Good				20	50	100	00
4-30		Deposit		45	00			145	00
4-30	104	Wheeler Dealer				20	00	125	00

APPENDIX D

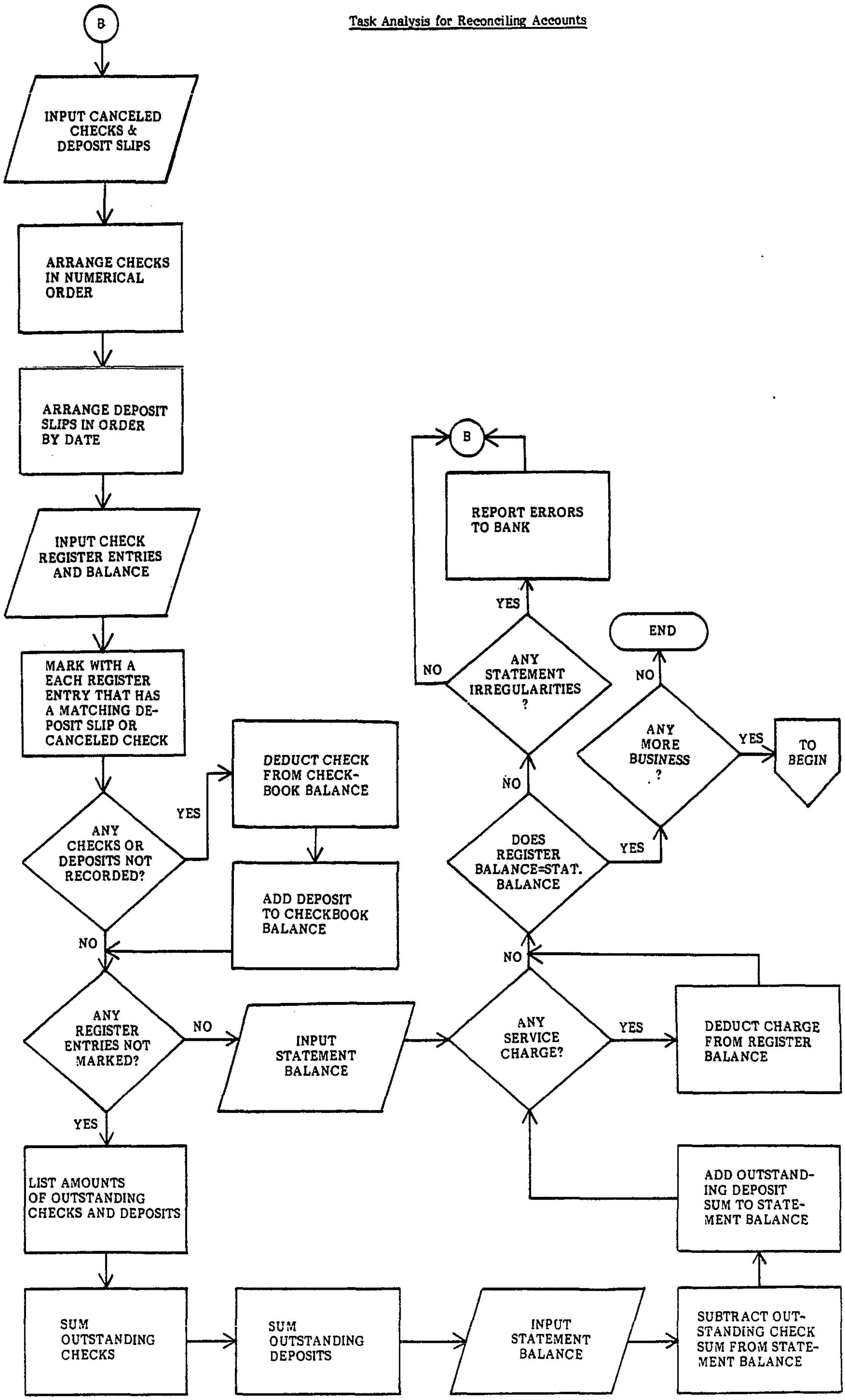
TASK ANALYSIS FLOW CHART


BEGIN
INPUT CHECKING ACCOUNT INFORMATION
ARE YOU RECEIVING MONEY
YES
A
NO
DO YOU OWE MONEY ?
YES
NO
B
INPUT BILL TO BE PAID
TAKE CHECK FROM CHECK BOOK
DATE CHECK
WRITE NAME OF PAYEE ON CHECK
WRITE AMOUNT OF BILL ON CHECK
SIGN CHECK
RECORD CHECK NUMBER IN CHECK REGISTER
RECORD PAYEE
RECORD AMOUNT OF CHECK
SUBTRACT AMOUNT FROM BALANCE
MAIL OR PRESENT CHECK TO PAYEE
ANY MORE BUSINESS ?
YES
TO BEGIN
NO
END

TASK ANALYSIS FOR DEPOSITING CHECKS



Task Analysis for Reconciling Accounts



APPENDIX E

SUPPORTING CONCEPTS AND PRINCIPLES

<u>Supporting Concepts</u>

Balance: amount of money in an account.

Bank statement: a printed copy of the bank's record of an accounts use.

Canceled check: a check the bank has paid.

Check: a written order telling the bank to pay a certain amount to someone.

Check register: a form for recording checks and deposits.

Credited deposits: a deposit the bank has added to an account.

Deposit: money put in a bank in an account.

Outstanding check: a check that has been written but not yet paid by the bank.

Payee: the person or company receiving the check.

Reconcile: to make a bank statement balance agree with a check register balance.

Service charge: a charge made by a bank for checking account services.

Transaction: a piece of business.

<u>Supporting Principles:</u>

If a deposit is made, the account balance is increased.

If a check is written, the account balance is decreased.

If an account has been reconciled, the check register balance agrees with the bank statement balance.

APPENDIX F

INSTRUCTIONAL ORGANIZATION

PROVIDING ONGOING CONTENT INTEGRATION

Epitome: A simulation involving pairs of students. Student #1 writes a "simplified check" (requires only the name of the payee, the amount, and the signature) to student #2. Student #2 completes a "simplified deposit slip" (requires only the amount of the deposit and the depositors name) and deposits the check with the "banker" (the instructor). Both students will record the transaction in a "simplified check register" (requires only the amount of the transaction be added or subtracted from the shown balance). The "banker" distributes a "simplified bank statement" to the students showing all transactions and the current balance. A "service charge" will have been deducted from all accounts, requiring the students to "reconcile their accounts."

Concepts for level one elaboration: checks, deposits, bank statements, reconcile, balance, check register, payee, service charge, transaction. Instruction for level on elaboration (All level one instruction will use forms which require complete information.):

Check writing:	Parts of a check. Demonstration of proper way to write a check. Check writing practice involving writing checks to hypothetical vendors.
Record checks:	Demonstration of proper way to record checks in a check register. Students will record checks written in the above exercise.
Making deposit:	Parts of a deposit slip. Demonstration of proper way to complete a deposit slip. Students will practice completing deposit slips using information provided by the instructor.

Record deposit: Demonstration of proper way to record deposits. Students will record deposits written in above exercise.

Bank statements: Demonstration of proper way to verify a bank statement. Students will practice verifying bank statements.

Reconcile account: Demonstration of the proper way to reconcile a bank account. Students will practice the proper way to reconcile a bank accout.

Expanded epitome: A simulation involving pairs of students. Student #1 writes a check to student #2. Student #2 completes a deposit slip and deposits the check. Both students will record the transactions. Next, the students reverse roles and repeat the exercise. The banker will then distribute bank statements to the students showing all transactions and the current balance. A service charge will have been deducted from all accounts requiring the students to reconcile the accounts.

Concepts for level two elaboration: canceled checks, credited deposits, and outstanding checks.

Instruction for level two elaboration (All level two instruction will use forms which require complete information. Payment and deposit information will be determined by interpreting bills and checks distributed to each student):

Interpreting bills: Demonstration of various types of bills and techniques for finding the critical information.

Writing checks for bills:	Students will write checks for the bills in the above exercise. Checks will be recorded.
Interpreting types of checks:	Demonstration on various types of checks and techniques for finding the critical information.
Completing deposit slips for multiple checks:	Students will receive checks of various formats. A single deposit slip will be used to deposit all checks.
Recording deposits:	Students will record deposits made in the above exercise.
Interpreting bank statements:	Demonstration on various bank statement errors and techniques for finding the errors.
Reconciling accounts:	Students will be given a set of canceled checks, canceled deposit slips, a check register, a bank statement, and a reconciliation sheet. The students will reconcile the account.

Expanded epitome: A simulation involving individual students. Each student will be given a number of bills to be paid and checks to be deposited. The appropriate procedures will be followed by the students to handle the transactions. Then a bank statement will be distributed and the accounts will be reconciled.

APPENDIX G

INSTRUCTIONAL ORGANIZATION

PROVIDING TERMINAL CONTENT INTEGRATION

Introduction

The instructor will present an oral overview of the procedures for handling checking accounts.

Instruction for check writing: Demonstration of proper procedure for writing checks. Practice on check writing. Demonstration on interpreting billing statements. Practice on writing checks for bills. Simulation involving pairs of students. Students receive "bills" from each other. Each student writes a check to the other student for a specified amount. The checks are exchanged.
Concepts developed: checks, bills, transaction, and payee.

Instruction for recording checks: Demonstration of proper procedure for recording checks. Practice on recording checks. Simulation involving pairs of students. Each student writes several checks to each other and record the checks.
Concepts developed: record keeping, check register, and balance.

Instruction for completing deposit slips: Demonstration of proper procedure for completing deposit slips. Demonstration on interpreting checks. Practice making deposit slips for checks. Simulation involving pairs of students. Each student writes two checks to the other student and records the checks. Checks are exchanged and deposit slips completed.
Concepts developed: deposits.

Instruction for recording deposits: Demonstration of proper procedure for recording deposits. Practice recording deposits. Students record deposits from above exercise. Simulation involving individual students. Each student will be given a number of bills to be paid and checks to be deposited. The appropriate procedures will be followed by the students to handle the transactions.
Concepts developed: balance.

Instruction for bank statements: Demonstration of proper procedure for interpreting a bank statement and procedure for verifying the accuracy of the account statement. Practice verifying bank statements.

Concepts developed: bank statement, balance.

Instruction for reconciling an account: Demonstration of procedure for reconciling an account. Practice reconciling an account. Simulation involving individual students. Each student will be given a number of bills to be paid and checks to be deposited. The appropriate procedures will be followed by the students to handle the transactions. Then a bank statement will be distributed and the account will be reconciled.

Concepts developed: reconcile, canceled check, credited deposits, outstanding checks, service charge.

Summary: A simulation involving individual students. Each student will be given a number of bills to be paid and checks to be deposited. The appropriate procedures will be followed by the students to handle the transactions. Then a bank statement will be distributed and the accounts will be reconciled.