AN EMPIRICALLY VALIDATED MODEL PROGRAM FOR TEACHING ALPHABETIC KEYBOARDING SKILLS VIA MICROCOMPUTER

by

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(ABSTRACT)

The purpose of this study was the systematic development and formative evaluation of a research-based model program for teaching alphabetic keyboarding skills via microcomputer. A microcomputer instructional program was developed based on instructional strategies and psychological concepts that were considered appropriate during the early stages of teaching typewriting. These strategies and concepts were identified from a review of the literature and validated by subject-matter experts.

The model program was presented in two lessons and provided instruction on keyboarding the home, the "e," the "n," and the return keys and the space bar. A minimum criterion performance level based on subject scores on one-minute timed writings was specified. A formative evaluation design was used in program tryout and revision. Sixty-six community college nontypists participated in three tryout cycles: initial developmental testing, Field Test A, and Field Test B. Two sources of background information were collected for each subject: demographic data and keyboarding aptitude data.

Diagnostic and revision data were analyzed from subjects' performance scores, time required to complete the program, researcher's technique ratings, subjects' interviews, and researcher's observations. Ninety percent of the subjects in Field Test A achieved the instructional objectives and reached the criterion level, and ninety percent of the subjects in Field Test B also reached criterion level.

The revisions made to the program during the formative evaluation process made the program more efficient as evidenced by the reduction in time required to complete the program. The decrease in the number of problems identified after each testing cycle also indicated that the program became more effective. Based on data analyzed from the study, the microcomputer is an effective medium for teaching initial keyboarding skills. The study recommends that teachers of typewriting or keyboarding consider microcomputer-based instruction as a teaching method.

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CHAPTER I

Study Overview

Introduction

The expanded use of computers and microcomputers in homes, offices, and schools has increased the need for effective keyboarding skills. Keyboarding skills are now considered essential by many persons who do not find it feasible to enroll in traditional typewriting classes. Included among this group of non-traditional keyboarding students are various professionals and lay persons who have not previously needed keyboarding skills and elementary aged youth who have not had access to traditional typewriting classes. The search for alternative methods of learning to keyboard has recently focused attention on the need for the development of software designed for teaching keyboarding via microcomputer.

The purpose of this study was the development and validation of a model instructional program designed to teach alphabetic keyboarding skills via microcomputer. The program was based on research and theories of psychomotor skill development in typewriting, principles of typewriting skill acquisition, and microcomputer-based instructional technology. A systematic instructional design and formative evaluation procedures were used during the process of developing and validating the program.

This chapter includes the discussion of: (a) the background and need for the study, (b) the statement of the research problem, (c) the definitions of terms, (d) the delimitations of the study, and (e) the statement of the research assumption.

Background and Need for the Study

During the last few decades there has been a phenomenal increase in the number of computers used in the world of work. If current predictions are true, the next few decades will see an equally dramatic increase in the use of computers in homes and in education. A recent article in Time ("Small Computer Shootout," 1981, p. 68) states that over one million small computers have already been sold, and that sales are increasing at a rate of 60 percent a year. With the development of small, low-cost computers, a computer in almost every home may soon become a reality. U. S. News and World Report (1980, p. 52) reported that home computers may be in 80 percent of homes in the United States by 1990.

Chambers and Bork (1980) surveyed 974 school districts to determine the current and projected use of computers in public schools. They reported that 74 percent of the districts surveyed were currently using computers for instruction, and they projected that 87 percent of these districts would be using them by 1985. Another article (Bourque, 1982) reported that, "Microcomputers with their price tags have made educational computing viable for even the most budget-conscious schools" (p. 47). Bourque reported that in 1980, sales of micro-computers for education reached $102 million and that an annual sales growth rate of 31 percent is expected to continue for the next four to five years.

If current trends continue, the person who knows nothing about computers may be as disadvantaged as a person who cannot read or write (Johnson, 1980, pp. 18-22; Alexander, 1981, pp. 19-21). The growth in the use of small computers in the world of work, the home, and the schools has led many educators to stress computer literacy for all graduates of secondary schools, community colleges, and universities (Johnson, 1980, pp. 18-22). In order to become proficient in using computer terminals, students need keyboarding skills. Thus, a basic keyboarding course should be an essential component of computer literacy training.

Because computers will be available in many homes, many students may need keyboarding skills long before they have the opportunity to enroll in a formal typewriting course. With the current explosive growth of computers in the office, the need for fluent keyboarding skills by all levels of office employees is more important than ever. Many employees who have not previously needed to keyboard will be required to operate computer terminals. William H. Baker reported in a recent issue of Management World (1981) that:

> In the office of the future, managers will have desktop video display terminals tied to the organizations

> information network . . . . Early estimates suggest that 15 to 20 percent of a manager's time could be saved with the implementation of a computerized executive workstation. Most of the automated equipment to date has required basic typing skills. Many clerical-level personnel already have these skills, as their jobs require it. Managers, however, have rarely been required to learn these skills and rarely employ them on the job. Thus, training managers to use the basic equipment, such as a keyboard, and gaining their acceptance of such procedures would be a major challenge in automation implementation. Keyboarding skills will continue to be a major part of computer-augmented management systems for the near future. (p. 22)

Managers can be taught to keyboard effectively by completing keyboarding courses that can be adapted to office terminals or used on personal computers. By developing proper keyboarding techniques, they can become more efficient terminal operators and improve the speed, accuracy, and efficiency of computer input. Thus, computer-based keyboarding software can be valuable in providing instruction for professionals in the office as well as home users and others who do not have access to school instructional programs.

Many traditional typewriting courses have not been designed to meet the needs of students who need basic keyboarding skills because much of the content is inappropriate and the time required for completion of the course is often too extensive--a full year or semester. As schools purchase more small computers and additional keyboarding software becomes available, teaching keyboarding via microcomputer will become more feasible. The teaching of keyboarding via microcomputer may also contribute to increased computer literacy by enabling students to operate the microcomputer in a nonthreatening environment, thereby eliminating computer fear and providing for transfer of learning for students who will be using computers in other courses.

The implementation of computer-based keyboarding instruction also has the potential for providing a flexible system of instruction some may consider superior to traditional group instruction. Computer-based instruction can be highly individualized, thereby providing maximum provision for student learning. Pacing (Robinson, 1979, p. 50), feedback, and immediate knowledge of results (Lindsay, 1966, p. 171) are important factors in the acquisition of keyboarding skills; and it is virtually impossible for a teacher to provide these conditions as effectively as well-designed computer software. Because the learning process in computer-based instruction is student controlled, the learning environment may be less threatening. Flexibility in scheduling is also another advantage of computer-based instruction.

The use of computers in teaching keyboarding also has many advantages for the instructor because computers can assist the teacher in managing instruction. Much of the burden of paper grading and recordkeeping can be performed by computers, thus, freeing the teacher for individual tutoring and counseling. Computers can be used diagnostically to analyze each student's work and provide alternative learning strategies. The effective use of computers in instruction can be a time-saving device for both teachers and students. Twenty to forty percent less time is required for computer-based instruction when compared to conventional instruction (Gleason, 1981, p. 16). With proper application of computer technology, students may be more highly motivated than students in traditional classes. Software that incorporates motivational factors such as fantasy, curiosity, challenge, feedback, immediate knowledge of results, positive rewards, and student control of the learning situation should make the students more intrinsically motivated and thus enhance the learning process.

As prices decrease, many schools will be acquiring microcomputers. These schools may benefit from many economic advantages in using microcomputers in instruction. The use of microcomputers in instruction can save schools valuable computer time by freeing mainframe computers from most instructional uses. Laboratories equipped with microcomputers can be used for instruction in a variety of courses including data processing, word processing, mathematics, science, and keyboarding.

Perhaps the greatest obstacle to teaching computer-based keyboarding is the lack of adequate software. Blaschke (1979) surveyed 1,200 secondary school principals and found, "The major bottleneck limiting the wide-spread and effective use of microcomputers in secondary schools is the availability of quality software" (p. 26). Lambert (1982) reported, "It is no surprise that one result of the computer literacy emphasis has been the production of thousands of mediocre educational programs" (p. 86). Dr. Ludwig Braun (1981) professor of engineering and director of the Laboratory for Personal Computers in Education at the State University of New York at Stony Brook, offered the following analysis: "There are some excellent programs but only a handful in each discipline when there should be hundreds. As the demand for new programs grows, a whole new publishing industry is developing" (p. C8). Much of the literature currently being written about educational uses of microcomputers cites the lack of software as the major problem (Alty, 1983, pp. 1-5; Michael, 1981, pp. 68-70).

The preparation of educational software is a time-consuming task involving course design, development, and evaluation. Evaluation traditionally has been viewed as an activity to follow course completion. Resta and Baker (1972, p. 67) noted that many of the research studies completed on evaluation considered only the delivery system of instruction while neglecting the instructional content itself. They indicated that too much research has dealt with questions such as the effects of one method of instruction as compared to the effects of another. They stated that these are important questions, but asking them is not appropriate until the instructional materials that are subjected to these techniques have been verified for quality.

Ofiesh and Meirhenry (1964, p. 210) stated that all instructional programs should be validated and that statements of validation criteria should be furnished with each program. Another article (McIntrye and Nelson, 1973, pp. 94-97) reported that all instructional materials should be empirically evaluated within a framework that would include a statement of educational objectives, a specification of type of learner, a description of the degree of teacher involvement, students' probability of success in reaching goals, and efficiency in terms of time and effort required. In developing instructional software, the use of systematic, formative evaluation will enhance the quality of the product when used concurrently with software design and development.

Hartley (1972) suggests that, because software development is so time consuming, a model should be tested before developing a complete program. Therefore, this study dealth with the development of a model software program for teaching alphabetic keyboarding. The development of a complete software program required financial and personnel resources beyond the scope of this study.

In reviewing literature related to producing microcomputer software, no studies were located that specifically dealt with the development and validation of keyboarding software. Therefore, this study may serve as a model for developers of future keyboarding software. This research may also serve as the basis for seeking funding for the development of comprehensive keyboarding software.

Statement of the Problem

The problem of this study was the systematic development and formative evaluation of a research-based model program for teaching alphabetic keyboarding skills via microcomputer. The research addressed the following questions:

1. What instructional strategies and psychological concepts for teaching typewriting are revealed in the literature?
2. Can these strategies and concepts be incorporated into an instructional program for teaching keyboarding via microcomputer?
3. Can the program be improved through the process of formative evaluation?
4. Upon completion of the program tryout, was the established criterion level reached?

Definitions of Terms

Definition of selected terms used in the study are given below:

Computer-based instruction. The general term used to describe the use of computers in the instructional process.

Criterion performance tests. The tests administered to subjects at the end of the lesson to measure the effects of the instruction.

Formative evaluation. Systematic evaluation used during the process of instructional development. The focus of formative evaluation is on the collection of appropriate empirical evidence during the development and tryout of the instructional program in such a way that revisions can be based on this evidence.

Home keys. The home keys used in this study refer to the asdfjkl; keys.

Model alphabetic keyboarding program. A portion of a total program for teaching alphabetic keyboarding. The model program consisted of two lessons that taught the asdfjkl;en keys, the return key, and the space bar.

Delimitations of the Study

The study was delimited in the following ways:

1. The major focus of the evaluation was formative evaluation.
2. The subjects were community college students who had had no prior typewriting instruction.
3. The instructional program included selected alphabetic keyboard content.
4. The program was developed for the Apple II microcomputer.
5. The program utilized copy displayed on a screen.
6. The program focused on teaching typewriting skills on a microcomputer, and the skills may not be transferable to other keyboard applications.
7. The program taught the home, the "e," the "n," and the return keys, the space bar, and proper keyboarding techniques.

8. No moving graphics, animation, or color were used in program development.

Assumption

It was assumed that the research related to teaching typewriting was appropriate for this study and could be adapted to teaching computer-based keyboarding.

CHAPTER II

Review of Literature

This chapter contains the review of literature related to this study. The four major areas are: (a) instructional program development and formative evaluation, (b) principles of psychomotor skill development in typewriting, (c) principles of typewriting alphabetic keyboarding skill acquisition, and (d) microcomputer-based instructional technology.

Instructional Program Development and Formative Evaluation

Systematic models for instructional program development and evaluation have been discussed by several authorities. A discussion of some models that seemed appropriate for this study follows.

Popham and Baker Instructional Cycle

One of the most popular models for instructional development was developed by Popham and Baker (1971). This seven-stage model was used successfully by developers of other instructional products (Bennett, 1980; Thompson, 1973; Ward, 1972). The seven phases of this instructional product development cycle included: (a) product formulation, (b) instructional specifications, (c) prototype test item tryout, (d) product development, (e) product tryout, (f) product revision, and (g) operations analysis. These phases of development are discussed below.

During the first phase, the "formulation phase," the need for the product is determined and the target population is specified. Other factors that should be considered during this phase are the cost, social utility, and availability of competing products of high quality.

Phase two, the "instructional specification phase," deals with the development of instructional objectives. During this phase, all instructional objectives for the product should be specified. These objectives should be stated in precise terms of desired learner outcomes, should contain conditions under which the behavior should occur, and should identify the standards of acceptable levels of performance. Prerequisite entry behaviors of the learners should also be specified during this phase.

Phase three is called the "prototype test item tryout phase." Criterion tests that measure the terminal, en-route, and entry behaviors should be prepared before the development of the instructional product. These tests should be administered to learners in the target population in order to confirm empirically the correctness of decisions made up to this point. It may be necessary to revise some of the instructional specifications after the prototype test item tryout.

During phase four, the "product development phase," the instructional materials are prepared. Learners are expected to be able to reach the terminal objectives after completing the product. During the developmental phase, the initial version of the materials will be tried out frequently on one or two learners and revisions made. Popham and Baker (1971) identified the following rules related to the product development phase:

> 1. Supply the learner with appropriate practice during an instructional sequence.
>
> 2. The product should provide the learner with the opportunity to obtain knowledge of results.
>
> 3. The instructional product should contain provisions for promoting the learner's interest in the product.
>
> 4. Avoid the development of an inflexible strategy in approaching product development tasks.
>
> 5. If teachers are involved in the instructional process, make their participation as replicable as possible.
>
> 6. In general, adopt a "lean" programming strategy.
>
> 7. If the product is to be used in the classroom, develop it so that teacher attitudes toward the product will be positive.
>
> 8. Selection of the instructional medium should be made in light of the desired instructional objectives, intended target population, cost, and other relevant considerations.
>
> 9. The time devoted to the development of the product should be commensurate with the importance of the product. (pp. 145-148)

Phase five has been labeled "product tryout." During this phase, it is suggested that the materials be used extensively with groups of learners. It is desirable for this tryout to be in a realistic setting. For example, if the product is designed for classroom use, then the tryout should be in a classroom. During the product tryout or field test phase, extremely small or large numbers of learners should be avoided. Effort should be made to ensure that the procedures followed in using the product can be replicated. Also, procedures for summarizing data should be developed well in advance of the field test so that the results will be of value in product revision.

During phase six, "product revision," additional revisions to the product may be made based on empirical data from the field test. If extensive revisions are needed at this time, it may be necessary to further field test and revise the product. Four rules for product revision are given:

1. Base product revisions on legitimate inferences from field test data.

2. The primary inferences regarding product revisions should be made from criterion data.

3. Learner response data during the program should be considered a valuable source of cues for product improvement.

4. No loss of face for the initial developer of the product should be associated with revisions of an instructional product. (pp. 154-156)

The last phase of the product development cycle is called the "operations analysis phase." After the product has been completed, a systematic analysis of the procedures involved should be performed. This analysis should be retained for future reference.

Hartley's Strategies for Program Design

In a discussion of evaluation of programmed instruction, Hartley (1972, pp. 133-173) stressed the need for the development and validation of the objectives and criterion measures of proficiencies, the empirical testing of the program, and systematic procedures for revision. He stated that criterion tests must be related to the objectives of the program, must be appropriate for the teaching methods employed, and must be valid and reliable. He also advocated pretesting the criterion tests with learners.

He discussed evaluation of programs as "internal evaluation" and/or "external evaluation." According to Hartley, (1972 pp. 133-173) internal evaluation of programs is that which takes place during development stages and includes the strategies used to improve effectiveness. This "internal" evaluation is completed during developmental testing and field testing of the program. He referred to developmental testing as the informal tryout of the program with individual learners during the developmental process for the purpose of determining if the program is suitable for those for whom it is written. Serious defects in the program should become apparent as the program is tried.

His steps for developmental testing included the preparation of the test, the preparation of the material, and the preparation of the learner. The learner should be typical of students for whom the program is intended and should usually be selected from the middle ability range of the specified students. He suggested that students be informed that they are helping to develop a program and not being tested. As the program is presented to the students, the programmer observes the learner's response. The programmer makes careful notes, and at the end of the program discusses the process with the learner. He may seek the learner's opinion on whether the program is interesting or boring, too easy or too difficult, and whether there were any parts that were unclear or caused trouble.

After each developmental testing cycle, the programmer must decide whether to make revisions at this time or retest the program with other students to see if similar comments are received. Repeated tryouts and revisions should be made until the program is ready for field testing. He suggested that if individual tryouts are repeated fewer than ten times, the program is ready for field testing.

When the programmer is satisfied with the results of developmental testing, the program is assumed to be ready for field testing. The field test is more formal than developmental testing, and Hartley suggested that it be conducted on at least fifteen students. The purpose of the field test is to determine whether the program meets the instructional objectives. If the program failed to meet the objectives, then the data obtained from the field test should be used for revision purposes. In order to determine the effectiveness of a program, data may be obtained from measures of learner prerequisite abilities, test scores (before, after, and retention), errors made, time taken, and student attitudes.

Other Developmental Strategies

Gleason (1981 p. 11), writing in a recent issue of *Educational Technology*, listed the following steps in preparing a good computer assisted instructional program: (a) careful specification of objectives, (b) selection of programming strategies, (c) detailed analysis of content, structure, and sequence, (d) development of pretests and post-tests, (e) preparation of preliminary drafts, (f) revisions to preliminary drafts, (g) trials with students, (h) validation, and (i) documentation.

Markle (1967), in an article on empirical testing of instructional programs, suggested that empirical testing of programs be divided into three distinct phases: (a) the developmental testing phase, (b) the validation testing or field testing phase, and (c) the comparative testing phase. During the developmental stages, Markle supported the clinical observation of interaction with a few students for the purposes of discovering communication or design problems, motivational problems, and learning variable problems. During the validation testing phase, we seek to learn "Who learns what under what conditions in how much time?" (p. 112). Procedures of developmental testing and field testing in order to validate programs were also supported by Rowntree (1974, p. 147).

A more recent article supporting the systematic development of instructional designs (Hannum and Briggs, 1982, pp. 9-14) reported that instructional systems that are systematically planned are superior to traditional instruction.

Formative Evaluation

Various authors have used different terminology to describe the evaluation procedures used during the process of instructional development, revision, and validation. This kind of research is often called process research. Hartley (1972, p. 138) referred to "internal evaluation;" Rowntree (1974, p. 147) preferred the terms "developmental testing;" and Hively (1970) used the terms "experimental analysis of instruction." Scriven (1967) preferred to call the evaluation used to improve the course while it is still "fluid," formative evaluation. He described formative evaluation "as field testing the work while it is being developed and, in so doing, getting feedback on the basis of which he again produces revisions" (p. 43). Scriven is supported in the use of the terms formative evaluation by Popham (1973, p. 13) and Hannum and Briggs (1982, p. 11). The use of formative evaluation procedures are recommended for evaluating career education products (Passmore & Asche, 1978). Throughout this study, the terms formative evaluation will be used to identify the procedures used to evaluate an instructional program during the developmental, revision, and validation stages.

Program Validation

"To validate a program means to prove its validity empirically, by field testing it with a sample of students who are representative of the students who will be using the program. It also means doing the revisions indicated and repeating the process of validation until the program meets an acceptable criterion of performance" (Burke, 1982, p. 102). There is some debate about what an acceptable level of performance is. Lumsdaine (1965a, p. 287) cautions against using absolute standards. A 90/90 criterion level has become fairly common, however (Lumsdaine, 1965a, p. 287; Hartley, 1972, p. 142; Burke, 1982, p. 102). This means that 90 percent of the students must accomplish 90 percent of the objectives. Burke also suggests that this criterion be matched to the students, the material, and the conditions under which the program will be used. Bennett (1980) found a validation criterion level of 90/90 to be satisfactory; however, Thompson (1973), because of the nature of the research, chose a level of 80/80.

Summary of Instructional Program Development and Formative Evaluation Procedures

In summarizing the literature on instructional development and formative evaluation, the following generalities may be applied:

1. Programs that are developed should be based on a specific statement of instructional objectives that indicates the terminal performance desired of the learners and the criteria for measuring their attainment of the objective.
2. The learners' entry behavior should be identified and this information should be used in the design of the instruction.
3. The content and instructional sequence should be based on task analysis of behaviors as well as the psychological principles for learning the task and should be systematically designed.

4. Instructional programs should be validated through developmental testing, revision, and field testing with groups of learners typical of the target population.
5. A program is assumed to be empirically validated when learners in the field test reach a predetermined criterion level on the criterion performance test.
6. Although caution is given for the adoption of absolute validation standards, a level of 90/90 seems to be the most used level.

Psychomotor Skill Acquisition in Typewriting

Typewriting is categorized in many ways. It is often referred to as a motor skill because it involves muscular activity to operate the typewriter. Robinson (1979, p. 37) has referred to typewriting as a psychomotor skill because in learning typewriting one uses mental processes as well as coordinated muscular movements. Some authors prefer the terms perceptual-motor skill because during the process of typing, "stimuli to sensory receptors; eyes, ears, fingertips, muscles, tendons, and joints, are screened, transformed, and organized by a neural process known as selective perception into modified mental images of the original stimuli" (p. 37). Regardless of the term used to identify the acquisition of typewriting skill, most authors agree that typewriting is a "complex skill made up of finely discriminated movement patterns that depend upon interrelated sensory, perceptual, mental, and motor inputs and outputs which must occur close together in time" (p. 37).

Psychologists are also in agreement that psychomotor skills are learned through the perception of a stimulus (West, 1969; Singer, 1980; Drowatzky, 1981). Upon perception of the stimulus, the various processes interact in order for the appropriate response to be elicited. "Typewriting always consists of making responses to situations or stimuli" (Jones, 1974, p. 13).

In order to identify principles of psychomotor skill development that are pertinent to the acquisition of alphabetic keyboarding skill, related literature in psychomotor skill development was reviewed. This review included the following concepts.

Stimulus Response Theory

"The basic process in learning is association" (Stolorow, 1959a, p. 18). A basic principle of association is that changes in behavior are the result of learner responses to stimuli (West, 1969, p. 33). Several association theories will be discussed in order to provide a background for an understanding of the process of learning a motor skill.

Thorndike's learning theories. Edward L. Thorndike, a leader in the development of stimulus response (S-R) psychology of learning, based his theory on three basic laws (Singer, 1980, p. 85). His original law of exercise stated that during repetition the S-R connections are strengthened and the probability of the desired response is increased. His original theory was later broadened to include the principle that for more effective learning to occur the desired connections should be rewarded by some means such as praise or knowledge of right or wrong.

Thorndike's law of effect stated that when the response is followed by a pleasant reward or reinforcement, the response is strengthened. His law of readiness takes the learner's personal state into consideration. He stated that learning is more effective when learners are emotionally, intellectually, and physically "ready" to perform a task and when that act is satisfying to them. Thorndike also was one of the first psychologists to emphasize that transfer of learning occurs best when learning is specific, and he emphasized specific training for desired behaviors.

Lindsay (1966) has summarized the following concepts, based on Thorndike's theories, that are relevant to motor skill development:

1. Repetition of situations leads to a negligible increase in strength unless the connections are rewarded.

2. In order for a response to be rewarded, it must occur. The learner varies his response until an appropriate one occurs which is rewarded by its success.

3. The effects of punishment are indirect and difficult to predict, depending largely upon what the punishment causes the individual to do and the effect of this punishment-response. Identifying an incorrect response would be of considerably less value than providing sufficient cues to increase the possibility of a correct response which could be confirmed.

4. Although the consequences following a connection are influential without either belongingness or relevance, the possibility of a response recurrence is

strengthened if the response or its consequences belong, or are appropriate to, the stimulus situation.

5. The attitude and preparatory adjustment of the organism, based upon past experience and momentary tendencies, determines what the person will do and what will satisfy or annoy him. Attention and intention appear to be critical factors in motor skill development.

6. The learner reacts to novel situations through his inborn tendencies to respond; responses are based upon past experiences.

7. The learner is able to react selectively to essential elements in the situation.

8. Transfer depends upon identical elements (either content or procedures) in situation and upon past experiences with these elements.

9. Reinforcement in the classroom depends upon (a) identification of bonds to be formed or weakened, (b) identification of satisfying and annoying effects, and (c) ease with which these satisfying and annoying effects may be applied. (p. 89)

Hull's associative learning theory. Hull contributed to associative learning through the theory that the response received is influenced by the number of reinforced trials; the learner's drive, incentives, current state of mind; and the intensity of the stimulus. He suggested that mere repetitious practice of non-reinforced trials may lead to weakening of performance; however, a period of rest may lead to increased performance. He, therefore, recommended spaced practice as an aid to learning motor skills (Singer, 1980, p. 86).

Skinner's operant conditioning. Skinner's theory of operant conditioning has many implications for learning psychomotor skills. Skinner was mainly concerned with changes of behavior based on responses to stimuli as contrasted to Pavlov's respondent conditioning where a subject has to respond in a certain way to a given stimulus. Under operant conditioning, desired responses are brought about by following the desired response with immediate reinforcement. The sequence of events occurring under operant conditioning becomes stimulus-response-reinforcement or S-R-R. Central to the concept of operant conditioning is the idea of reinforcement, and factors associated with reinforcement; such as, the schedule and timing of the reinforcements (Singer, 1980, p. 88; West, 1969, p. 66).

Gagne's motor chaining model. Gagne's motor chaining model is based on the concept that each stimulus-response or link serves as the cue or stimulus for the next one. In order for an act to be mastered, each individual link in the chain must be mastered. Gagne suggested that verbal cues such as pronouncing letters or nonspoken, internal cues assist the learner in chaining of events. These cues are essential in the early learning of a skill; however, once proficiency at a task is developed, the dependence on cues decreases. According to Gagne, certain conditions must be present for chaining to be developed effectively:

1. Each link should be fully learned. Because each link is related to the preceding one, any breakdown in one would probably hamper the entire activity.

2. Each link should be demonstrated in the proper order. This can be encouraged with proper cueing techniques.

3. Individual links should occur appropriately in time. The principle of continuity is relevant here, for responses should be made on receipt of the right stimuli. Delays in the performance of certain links

might ruin the goal of the activity, for timing and association lead to successful executions.

4. Sufficient repetitious practice should occur if the chain is to be well learned.

5. Reinforcement, in the form of successful completion of the act or satisfaction at the end of the act, is necessary; otherwise chaining behavior is extinguished. (Singer, 1980, p. 87)

Motor skill learning variables. Lindsay (1966) reviewed nine major systems of learning for learning variables applicable to the development of motor skills in typewriting and found agreement on the following concepts:

1. In order for learning to take place, a response must occur, with learning dependent upon the consequences of the response.

2. Repetition is not the cause of learning, but repetition provides opportunity for learning variables to operate. Practice is essential to the development of complex motor skill.

3. Too much repetition is deleterious. Short intervals of practice separated by short intervals of non-practice are superior to massed practice.

4. Punishment (distinguished from negative reinforcement) is not recommended as a learning procedure. For all types of learning, the effects of punishment are indirect and difficult to predict. (p. 135)

Lindsay found general agreement among stimulus-response psychologists in the following areas:

1. Discrimination of prepotent or significant cues reduces the error in trial and error learning.

2. The processes of discrimination (perception of differences that already exist in stimuli, i. e., detection of cues) and differentiation (process of making or becoming different through response

variations) operate together in the development of motor skill.

3. Temporal contiguity (closeness in time) is a necessary factor in skill development. Some theorists hold that contiguity of stimulus and response is sufficient for learning to occur; others include contiguity between response and reinforcement. A large body of empirical data indicates that knowledge of results through immediate reinforcement is central to motor skill development.

4. The process of "chaining" a descriptive term referring to the fluency of coherent combinations of movements exhibited at expert phases of skill development, involves internal cue stimuli and reinforcement stimuli, through the kinesthetic sense, that help direct serial actions. Chaining is characterized by decrease in conscious attention to the mechanics of the skill until an error disturbs the response pattern. (pp. 136-137)

Reinforcement

According to Singer (1980), "reinforcement refers to any event that increases the probability of the occurrence or maintains the strength of a particular act or behavior" (p. 450). Operant conditioning theory is based on the effect of reinforcement in the acquisition of desired behaviors. Encouragement, praise, grades awarded after good or correct performances are examples of reinforcers traditionally used in the development of psychomotor skills. These reinforcers are often referred to as rewards. Sources for reinforcement include the information provided by the teacher, the learner's judgment as to the quality of performance; or in the case of computer-based instruction, the computer program.

Types of reinforcement. Schmidt (1975) describes a type of reinforcement as knowledge of results. Schmidt defines "knowledge of results as the information provided by the experimenter (or teacher or other external source) concerning the subject's success. Knowledge of results can have nearly any degree of exactness; and usually refers to how a subject did in terms of the score he is trying to achieve and comes artificially from an external source" (p. 86).

Schmidt calls other sources of information about performance feedback. Feedback includes information from visual, auditory, or kinesthetic cues to the learner. Thus the learner can see, hear, or feel certain things about his performance; these sources of information are also valuable to the learner in assessing his performance.

Singer (1980, p. 455) used the term augmented or supplementary feedback to describe knowledge of results received when the amount of information available as a result of the learner's actions is insufficient and must be augmented or supplemented through external sources. Singer believed that augmented feedback or knowledge of results can motivate, regulate, direct, and/or reinforce behaviors. Feedback is classified in three categories depending on the intent for which it is used.

1. Information feedback: used for comparison purposes to correct errors.

2. Rewarding (reinforcing) feedback; little information present, helps shape behavior in certain directions.

3. Motivating feedback; influences attitude to continue practicing the task. (p. 460)

The importance of reinforcement, knowledge of results, and feedback in the acquisition of motor skills is reflected in this statement by Lindsay (1966). "Reinforcement has been empirically shown to be the most important variable in motor skill development. There is little improvement through practice without reinforcement, progressive improvement with it, and deterioration after its withdrawal" (171). Bilodeau (1969) also stresses that, "studies of feedback or knowledge of results . . . show it to be the strongest, most important variable controlling performance and learning . . . (p. 255).

To support their statements concerning the importance of knowledge of results (KR), Bilodeau, Bilodeau, and Schumsky gave learners 20 trials to make a movement of a given length while blindfolded. One group received KR after every practice trial, and one group received no KR at all. They found there was no improvement in performance without KR while the group with KR showed considerable improvement over the 20 trials. After 20 trials the no-KR group were given KR and showed nearly the same improvements that the KR group did indicating that there was no transfer from the no-KR conditions (Schmidt, 1975, p. 87). An earlier study by Thorndike produced similar results (West, 1969, p. 34). Adams, Goetz, and Marshall also concluded from their study that: "(a) the acquisition of skill was directly related to the amount of feedback present, (b) augmented feedback led to more effective performance than minimal feedback, and (c) response-produced feedback had a great impact on both learning and performance and should be central in theories of learning dealing with motor behaviors" (Singer, 1980, p. 458).

Schedules of reinforcement. How often should knowledge of results be administered for the most efficiency? Bilodeau and Bilodeau in studying four groups provided KR after every trial, or after every third, fourth, or tenth trial and found that performance improved only on those trials immediately following the presentation of KR indicating that it is the absolute number of KR's provided that determines learning (Schmidt, 1975, p. 88).

The more descriptive the KR given to learners, the better the performance. Trowbridge and Cason provided one group of learners with irrelevant KR, one group with no-KR, one group with qualitative KR such as right or wrong, and a final group with quantitative KR. The results show no improvement with no-KR or with nonsense KR, some improvement with qualitative KR, and considerable improvement by the group given quantitative KR (Schmidt, 1975, p. 87). These findings are also supported by a study conducted by Smoll (Singer, 1980, p. 458).

There is some difference of opinion of how soon after a response KR must be given. Studies have shown that a delay between the response and KR has no effect on the acquisition of motor skills provided there is no intervening response between the response and its KR (Schmidt, 1975, p. 92). West supported the theory of making reinforcement closely contiguous to responding or furnishing immediate knowledge of results. Keller, Estes & Murphy found that in teaching Morse code it was much more efficient to provide students with immediate knowledge of results (West, 1969, p. 38).

Schmidt and White found that when KR was withdrawn very early in practice, performance deteriorated considerably; however, after a greater number of trials when KR was withdrawn performance was maintained (Schmidt, 1975, p. 94). This supports the opinion that during early learning of a skill KR is extremely important; however, after a skill is developed KR can be gradually reduced or withdrawn without a significant reduction in performance. During advanced stages of development, the learner's own error detection mechanism is operating (Singer, 1980, p. 458). It has been found that "continuous reinforcement results in relatively rapid acquisition of a new behavior, . . . and reinforcement on an intermittent schedule results in relatively slow acquisition of new behavior, if the behavior is acquired at all. However, once behavior is acquired, it will be relatively slow to extinguish" (Parker, 1979, p. 61). Therefore, it is recommended that during the early stages of learning a new skill such as keyboarding the more immediate and continuous the KR the more successful the performance. However, if continuous reinforcement is difficult to implement, experiments have shown that variable-ratio reinforcement scheduling, with its inherent uncertainty, is quite effective in shaping, maintaining, and elevating behaviors, as long as reinforcements come after a reasonable number of responses (Singer, 1980, p. 451).

Research has also shown that in general learners should experience as much success as possible in the early stages of learning before experiencing failure. Bayton and Conley found that early failure has an inhibiting effect on an experience; however, as successes increase through time, subsequent failures may increase motivation (Singer, 1980, p. 452). Psychologist and educators agree that praise is preferred to punishment as a reinforcer. Hurlock found that of children in four groups the praised group did best, the reproved group was second best, the ignored group third, and the no comment group finished last (Singer, 1980, p. 453). Extrinsic reinforcers have also been found to be effective in influencing work output and training efficiency of students (Singer, 1980, p. 454).

Principles of reinforcement. Lindsay, (1966) has summarized principles of reinforcement as they relate to typewriting.

1. The effectiveness of a reinforcer is closely related to the temporal interval between the response and the reinforcing event. Delayed reinforcement permits conditioning of incorrect techniques.

2. Reinforcement schedules should vary with phase of development.

3. Continuous reinforcement is most effective in establishing new behavior. In phase one, permitting the beginner to watch his keyboard responses provides action feedback, which is the most readily available source of immediate and continuous reinforcement. If visual feedback is to contribute to motor discrimination, the learner must be prepared to notice the muscular sensations that accompany the action and must be aware that visual feedback is a temporary

crutch. Visualization also meets the criterion for specificity by enabling the learner to modify his response as he correlates it with instructional cues.

4. Response reinforcement must be immediately shifted to an intermittent schedule following keyboard familiarization.

5. In developing cue discrimination, response reinforcement is contingent on the properties of accompanying stimuli.

6. Differential reinforcement is crucial to response differentiation in which a response is not merely right or wrong but may reflect various degrees of accuracy, fluency, and speed. Differential reinforcers enable the learner to determine the value of each response modification.

7. The informational value of differential reinforcement is inversely proportional to the adequacy of cue stimuli prior to responding. Differential reinforcers become more important as cues are reduced in later phases of skill development.

8. After the initial phase, teacher observation and evaluation are basic to effective differential reinforcement. Negative feedback corrects technique errors of which the learner may be unaware. (p. 173)

Summary of Psychomotor Skill Acquisition

A summary of the concepts of psychomotor learning that are applicable to the development of typewriting skills follows:

1. Feedback or knowledge of results is necessary for the development of psychomotor skills.

2. Augmented or supplementary feedback is valuable to the learner in assessing performance during early stages.

3. Kinesthetic feedback develops slowly; therefore, extrinsic reinforcement is necessary during the early stages of motor skill development.
4. Quantitative goals should be individualized.
5. Early errors and awkward techniques should be ignored.
6. The closeness in time of the stimulus, response, and reinforcement the more effective the learning process.
7. The effectiveness of reinforcement is related to the temporal contiguity between the response and the reinforcer.
8. There should be no intervening responses between the response and the reinforcer.
9. Response schedules should vary with stages of learning.

Typewriting Alphabetic Keyboarding Skill Acquisition

No studies were identified that related to the development of keyboarding skills via microcomputer; therefore, related literature in the development of typewriting alphabetic keyboarding skill was reviewed. The review included these subjects: (a) materials for keyboard presentation, (b) order of presentation of alphabetic keys, (c) sight vs. touch typing, (d) speed vs. accuracy approach, (e) vocalization, (f) pacing, (g) student individualization and goal setting, and (h) demonstration or modeling.

This review covered four major typewriting methods books (West, 1969; Robinson, 1979; McLean, 1978; Russon & Wanous, 1973), articles from business education journals, and applicable research studies. Other non-current typewriting methods books were also surveyed for background information.

Materials for Keyboard Presentation

Some typewriting teaching materials use nonsense syllables in presenting the keyboard. Unfortunately, some of these materials tended to extend these nonsense syllables drills beyond their usefulness. A nonsense syllable may be defined as a sequence of strokes that does not appear in the language; such as jujm. Nonsense syllables may be used to briefly introduce new keys, but it is desirable to switch to ordinary prose as soon as feasible for practice material. The use of ordinary prose also allows for the development of chaining of letters which contributes to quicker development of typing skill. It is important to remember that learning the keyboard does not consist of learning 26 letters but does consist of learning these letters in sequence with the letter that occurs before and after it. There are 575 different two-letter sequences in English (West, 1978, p. 6). In order to provide for immediate transfer of learning, practice materials should be used that provide practice on these letter sequences. Therefore, the use of normal words and sentences is recommended as soon as possible after instruction begins (West, 1969, pp. 148-152; Robinson, 1979, p. 52; McLean, 1978, p. 18; Russon & Wanous 1973, p. 180).

Of thirteen experimental comparisons of the two types of keyboarding learning materials, ten reported significantly superior performance on the part of students trained from the beginning on word or sentence material (West, 1969, p. 150).

West (1969) summarizes the reasons for the inferiority of nonsense syllable material as follows:

> 1. Insofar as nonsense drills mainly contain sequences that do not exist in the language (eg., sx, fv, jm) they keep stroking on the lowest letter-by-letter level and preclude a beginning of the formation of response chains for sequences that do exist in the language.
>
> 2. When very large amounts of nonsense-drill practice are imposed, non-existent sequences may become chained and later have to be unlearned. For example, there might be tendencies to move toward "v" after "f", when some other letter must in fact follow.
>
> 3. Nonsense sequences can be stroked with the attention elsewhere and for that reason alone can be expected to be less beneficial than materials requiring active and close attention. More generally, nonsense-drill practice is dullness personified, whereas meaningful materials are more interesting and therefore provide better motivation.
>
> 4. Both the responses and the associations in nonsense drill are fewer in number than those contained in the more varied sequences contained in meaningful materials. Stimulus variability is greater in meaningful copy. (p. 151)

Therefore, practice materials used during keyboard learning should use a vocabulary that is extensive rather than intensive after the initial presentation of new keys. The use of extensive practice materials will provide for more transfer to other materials, more attentiveness to the work, more learning, and less fatigue and boredom (West, 1969, p. 192).

Order of Presentation of Keys

There is no research evidence to prove that one method of presenting the keyboard is superior to another; however, most authorities agree that the keyboard should be presented in a manner that will allow for early typing of words and sentences (West, 1969, Robinson, 1979; McLean, 1978).

Robinson (1979) discusses four sequences for presenting the keyboard; the horizontal sequence, the vertical sequence, the "whole" sequence, and the "skip around" sequence.

Horizontal sequence. In the horizontal sequence, students are taught a row at a time. The homerow is presented, followed by the top row, and then the bottom row. He cites the following disadvantages of this method:

1. It causes learning interference because the same fingers on opposite hands must make reaches in the same direction in very early learning.
2. It encourages hand movement instead of finger reaches to the third and first rows of keys.
3. It loads the more difficult reaches into a limited number of practice activities or lessons.
4. It delays sentence typing unduly. (p. 39)

Vertical sequence. The vertical sequence in which the homerow is presented first and then the remaining keys are introduced finger by finger starting with the index fingers and then moving outward has the following reported disadvantages:

1. It crowds difficult reaches into a limited number of lessons.

2. It develops a tendency to err on letters typed by the same fingers on opposite hands.

3. It forces fine discriminations between vertically and horizontally adjacent keys and between adjacent fingers too early.

4. It results in the use of many one-hand word patterns in early lessons before untrained fingers are able to execute even easy sequences with facility. (p. 39)

Whole sequence. In the "whole" sequence all keys are presented in the first one or two class periods. Robinson states that this method has the following disadvantages:

1. Overt memorization of the keyboard is not pertinent to the conditions of performance in which the fingers do the remembering.

2. Presentation is not synonymous with learning.

3. So many conflicting impulses to response and so many choices of response so early in learning confuse and inhibit the learner. (p. 30)

Skip around sequence. In 1927, Lessenberry developed the "skip around" sequence of presenting the keyboard. Since its development, some version of his plan has been used in almost all major textbooks. His plan called for the "introduction of some right-and some left-hand reaches, some up and some down reaches, some agile-and some not so agile-finger reaches, and some easy and some awkward reaches in each of several lessons" (Robinson, 1979, p. 40). His sequence is based on four principles:

1. Relative ease with which the new reach-strokes can be made and combined by the beginning student so that good keystroking techniques can be developed at once.

> 2. Frequency of use of the letters so that a reasonably wide range of common words can be used for early practice.
>
> 3. Adjacent keys are not taught as new reaches in the same lesson (except in the first lesson when teaching the home keys).
>
> 4. Keys to be controlled by the same finger-opposite hands are taught in different lessons, if possible; and where taught in the same lesson, the sequence is such that different directions of finger movements are required (y and g, for example). (p. 40)

The keyboard can be effectively covered in from five to ten lessons. It is generally felt that less than five lessons does not allow for sufficient learning of new keys before others are introduced, and more than ten lessons unnecessarily delays the normal typing of prose material (McLean, 1978, p. 17).

<u>Sight vs. Touch Typing</u>

For many years typewriting teachers insisted on teaching typewriting by the touch method which prohibited beginners from relying on psychologically important visual references to the keyboard and the typescript. West (1978) points out the fallacies of this approach:

> The research of the 1930's revealed the psychological fact that, for any motor skill whatever, beginners cannot rely on kinestheses, or muscular sensations, either to direct their motions or to verify them. Only after some learning has taken place on the basis of vision can muscular sensations begin to take over. . . . The beginner can rely on muscular sensations only one-fifth of the time (19.9%). Even the 30-wpm typist can depend on muscular sensations alone only 40 percent of the time. To insist on immediate touch (nonvisual) typing is an absurdity and a demand that is flatly impossible for anyone to obey. The consequences of conventional foolishness in that regard are only too

> painfully apparent in enormous increases in errors . . . serious depression of speeds, poor stroking technique, and high anxiety (because you can't learn if you don't look). (p. 6)

In traditional typewriting classes, the only method for achieving immediate knowledge of results during keyboard learning was to look at the transcript to verify that the appropriate key was struck. Also during early learning the time between stimulus, response, and reinforcement could be reduced by having students locate the proper key on the typewriter keyboard. By insisting on touch typing from beginning, teachers ignored these important principles of learning a motor skill.

Vocalization

During the early stages of learning, the real stimulus for stroking is the pronouncing of the letter or vocalization (West, 1969, p. 176). Vocalization is one of several mediators that intervene between the stimulus and response when learning new keys. According to Woodworth and Schlosberg the more intense the stimulus, the less delay there is in responding (West, 1969, p. 176). The intensity of the stimulus is increased through vocalization.

Vocal spelling of the letters is desired during the early stages of keyboarding. This vocalization can be encouraged by teacher dictation of the keys in a sharp, brisk, staccato voice. Students should be encouraged to continue their own self-vocalization after teacher dictation no longer meets the needs of the group. Sharp vocalization leads to ballistic stroking and quicker responses, focuses the student's attention on his typing free from distractions around him, and contributes to more effective learning.

Speed vs. Accuracy Approach

Should the primary emphasis in keyboarding be based on a speed approach, an accuracy approach, or a technique approach? Although many teachers and students are reluctant to accept it, research has proved that a speed approach is desirable to an accuracy approach.

The research supporting the speed approach dates back to the time and motion studies of Frank and Lillian Gilbreth and the typewriting research of Dvorak, Merrick, Dealey, and Ford during the 1930's (Dvorak, et. al., 1936). A study by Fulton supported the research of the Gilbreaths and Dvorak. Fulton's experiment involved subjects using a task that involved a ballistic movement. The group originally emphasizing speed was found to be reliably faster than the accuracy group and equally accurate (West, 1969, p. 93).

DuFrain found that in typewriting classes taught with the speed approach from the start that after ten weeks of instruction the speed group was 4 to 7 wpm faster and there was no significant difference in accuracy (West, 1969, p. 173).

Erickson conducted a study giving primary emphasis to speed, and "found in all cases students reached high levels of speed in relatively short periods of time and when emphasis was changed to accuracy, students readily attained appropriate levels of accuracy" (Robinson, 1979, p. 91).

Gades (1967) conducted a study in which short-duration, high-speed drills were used in first year typewriting. He found that the use of these high speed drills produced higher levels of speed and greater accuracy than the standard procedures.

West has summarized the research as follows: "In skills requiring ballistic movements, early emphasis on accuracy of movements is wrong, it does not work; it leads to poorer performance than is achieved under an initial emphasis on speed . . . . The acquisition of good stroking techniques at the typewriter requires immediate emphasis on speed of motion, not on accuracy of product" (West, 1969, p. 94).

Solley is quoted in Robinson (1979) as follows, ". . . speed probably should be emphasized from the initial stages of learning and that accuracy gained at slow speeds is generally lost when a movement becomes more rapid." Solley concluded that "when speed is a predominant factor in the performance of skill, early emphasis on speed is best" (p. 90).

West (1978) cites three major reasons for downplaying stroking accuracy in teaching typewriting.

1. With new technological methods of error correction, it is pointless to worry about something easily and quickly fixed.

2. The reliability of measures of errors is so low that consideration should not be given to them. Performance varies from moment to moment and hour to hour.

3. Errors in straight copy work should be more or less ignored because errors in such work are only

> negligibly correlated with stroking errors in production. Nothing about straight copy accuracy predicts production accuracy. (p. 7)

If the emphasis is on speed, how then does one develop accuracy? "Accuracy depends on the right speed" (West, 1978, p. 8). The right speed according to West is "one a little below (1-2 wpm) the speed at which too many errors are made" (p. 8).

McLean (1978) summarized the research on speed and accuracy into the following rules:

1. Do focus first on the development of speed (with generous error limits), then accuracy (recognizing that there will be some decrease in speed).

2. Do focus on speed until substantial improvement has been made before shifting the focus to accuracy; and vice versa.

3. Do improve accuracy by finding the "right" speed.

4. Do use speed-forcing techniques through pacing to develop optimal speed, to develop ballistic stroking, and to break any keyboard watching habit that may persist after several months. (pp. 22-23)

Pacing

As students are learning to type, they tend to be overly conscious of errors made. After many years of instruction stressing perfection, asking students to stress speed and ignore errors during beginning lessons causes confusion. Students tend to want to develop the reaches to individual keys quite slowly. A typical pattern is that they tend to "ponder unnecessarily over the location of a key, the choice of finger to use in striking the key, and the appropriate movement pattern to use in making the keystroking response unless the teacher actively intervenes" (Robinson, 1979, p. 50). Therefore, students must be paced (forced to type at a faster rate) to force them to develop proper ballistic stroking patterns that are essential to developing typewriting proficiency.

Several methods of pacing have been used effectively. One is teacher-paced dictation. During early lessons, many teachers type with the students on selected drill material calling aloud the keys to be typed in a sharp, brisk voice. This forces students to make an attempt to keep up and force the rate. Although this method works well during the first few days of instruction, differences in performances of students develop rapidly and other methods are more effective.

Effective strategies for forcing the typing rate, include the typing of practice drill material under conditions that call for more effective typing rates. One such strategy suggested by Robinson (1979, p. 51) is referred to as time-interval pacing. In this drill students are timed for short periods of time and are encouraged to complete successively longer sentences before time is called. Robinson suggests several values from drills such as this:

1. It puts gentle pressure on students to reduce the time interval between keystrokes.

2. It permits each student to work toward progressively higher goals based upon immediate past performance.

3. It provides goal-directed repetition.

4. It supplies immediate feedback.

5. It places desirable emphasis on shifting, spacing, and returning as well as on keystroking. (p. 51)

Effective pacing of students not only leads to improvements in speed but to more efficient typing techniques and motion patterns. Pacing is also helpful in decreasing students' dependence on sight typing and letter-by-letter typing. Through speed forcing, the student is encouraged to speed up responses which increase speed, improve techniques, and decrease dependence on sight typing. When programmed properly, the microcomputer can be used effectively in pacing students. Because programs can be individualized for each learner, microcomputer pacing could be even more effective than classroom teacher pacing or time-interval pacing drills.

Student Goal Setting

Within hours after typing instruction begins, it becomes obvious that some students possess more kinesthetic ability than others. For this reason, it is desirable for instruction to be individualized. This can be accomplished by having each student set individual goals for all tasks. According to West (1969 p. 8) and Robinson (1979 p. 90) speed and accuracy should not be stressed at the same time. Therefore, it is possible that at any one time each student in a class will be working toward different goals. On all typing tasks each student should be striving for goals based on their needs. This is another area where microcomputer instruction could be superior to traditional goal-setting methods. Each learner can set individual goals and these can be recorded by the computer and used to prescribe individualized practice materials.

Modeling

An effective strategy in the teaching of motor skills is modeling or demonstration of desired behavior. This strategy can be very helpful to students in learning to typewrite particularly in demonstrating correct techniques and the proper reaches to new keys.

Summary of Alphabetic Keyboarding Skill Acquisition Factors

The following items summarize the factors related to the acquisition of alphabetic keyboarding skill based on the literature review.

1. Materials used for keyboard presentation and practice should consist of normal prose in word and sentence format.
2. The keyboard should be presented in an order that allows for early typing of meaningful word and sentence material.
3. The "skip-around" approach seems to have the most merit.
4. The keyboard should be presented in five to ten lessons.
5. Students should not be prohibited from using visual references during keyboard learning.
6. Vocalization increases the intensity of the stimulus, leads to ballistic stroking, quicker responses, focuses the student's attention on his typing, and contributes to more effective learning.

7. A speed approach to typewriting has been shown by research to be superior to an accuracy approach.

8. Speed and accuracy should be developed separately.

9. Accuracy consists of typing at the right speed.

10. Pacing or speed forcing is desirable for developing speed, improving typing motions, and decreasing students' dependence on sight typing.

11. All typing tasks should be based on goals that are appropriate for each student.

12. Modeling is an effective strategy for presenting proper typing techniques and key reaches.

Microcomputer-Based Instructional Technology

This section of the literature review will examine recommended components of computer-based instructional programs. A summary of the recommended components is also included.

Gagne and Briggs have developed a list of components that should be included in every instructional program (Wade, 1980, p. 32).

1. Gain attention
2. Inform the learner of the objective
3. Stimulate recall of prerequisite learnings
4. Present the stimulus material
5. Provide learning guidance
6. Elicit the performance
7. Provide feedback about performance correctness
8. Assess the performance
9. Enhance retention and transfer

Not all of these components may be included in every lesson and the sequence of some of them may be rearranged; however, they provide general guidelines for instructional program development.

Caldwell has also recommended guidelines for microcomputer programs that will enhance the capacity of the microcomputer system (Caldwell, 1980).

1. Learner Control over the instructional sequence . . . . Students should be given the opportunity to advance, review, and exit lessons, except where such control defeats the purpose of the lesson.

2. The system should be totally individualized and offer highly adaptive and responsive learning environments.

3. Programs should be modularized and structured in coherent, hierarchical patterns.

4. All skills to be mastered should be carefully stated in performance objectives.

5. Progress should be measured in terms of mastery of performance objectives.

6. Strategies for diagnosis and prescription should be used.

7. Programs should be, when possible, multisensory in format.

8. Graphics should be used to box important sentences and paragraphs. Reverse highlighting and color are also effective for accentuating displays.

9. The text should be broken down into units that the student can call up by activating a key designed for this purpose.

10. Animations, graphics, cartoon characters, or other creative devices serve to create variety and interest. Used creatively these capabilities can contribute greatly to effective instructional programs.

11. Double space text material whenever possible to enchance the visual effect.

12. Use color to enhance the display or to highlight whenever possible. Color is useful in providing prompts and to direct attention to various portions of the screen. (p. 8)

Caldwell further suggests that whenever possible show the learners what to do rather than tell them. Use graphics and other abilities of the computer to make instructions clear. Provide for learner interaction by providing menus or options that allow the student to control the instructional sequence. Provide a variety of choices, if possible, for the activities in the program. The use of games might have a motivational effect.

Instructions to the learners should be as simple as possible. Any prompts provided should be informative instead of just saying "no" or "wrong, try again." Simplify the choice of answers by allowing learners to respond with the appropriate letter or number of the answer instead of having to type out words. Provide examples or demonstrations where necessary.

Spitler and Corgan (1979) list eight characteristics that should be considered in authoring good programs.

1. Index
2. Fine index
3. Pretest
4. Lesson objectives
5. Lesson
6. Assisted quiz
7. Lesson summary
8. Final quiz (p. 15)

Summary of Microcomputer-Based Instructional Technology Components

Instructional programs that are developed for microcomputers should be systematically designed. The performance of the program should be measured against specific instructional objectives. These programs should be individualized, and learners can have control over the instructional sequence.

The capabilities of the computer allow multi-sensory presentations and student input. Student management during instruction, detailed response analysis, and recordkeeping can be provided by the computer.

CHAPTER III

Methodology

The purpose of this study was the systematic development and formative evaluation of a research-based model program for teaching alphabetic keyboarding skills via microcomputer. The procedures used in addressing this problem are detailed in this chapter. The topics discussed include: (a) research design, (b) subjects, (c) data collection, and (d) data analysis.

Research Design

This was a descriptive study using formative evaluation procedures in developing, revising, and validating the microcomputer program. The program was based on instructional strategies and psychological concepts identified from the review of the literature in psychomotor skill development in typewriting, typewriting alphabetic keyboarding skill acquisition, and microcomputer-based instructional technology.

The identified instructional strategies and psychological concepts were incorporated into a survey instrument for validation by subject-matter experts. Interviews were conducted with microcomputer specialists to determine the practicality and feasibility of developing a microcomputer program incorporating the validated instructional strategies.

Systematic Instructional Design

Systematic instructional procedures were used in program development. See Figure 1 for the flow chart followed in program development. Instructional objectives consisting of two primary objectives and six secondary objectives were written for the program. The two primary objectives were performance objectives for each lesson. Typewriting methods books were surveyed to determine appropriate standards for one-minute timed writings in the early stages of typewriting skill development. In addition, one-minute timed writings were administered to subjects enrolled in beginning typewriting classes in a community college during summer quarter, 1982. Information from the textbook survey and data from the analysis of timed writing scores were used in determining the criterion performance level for the program. A minimum performance rate of 65 strokes per minute was set as the criterion performance goal for each of the lessons. The two primary objectives are:

1. When words requiring the use of the home and the return keys and the space bar are displayed on the screen, the subject will be able to keyboard these words at a minimum rate of 65 strokes per minute.
2. When words requiring the use of the home, "e," "n," and the return keys and the space bar are displayed on the screen, the subject will be able to keyboard these words at a minimum rate of 65 strokes per minute.

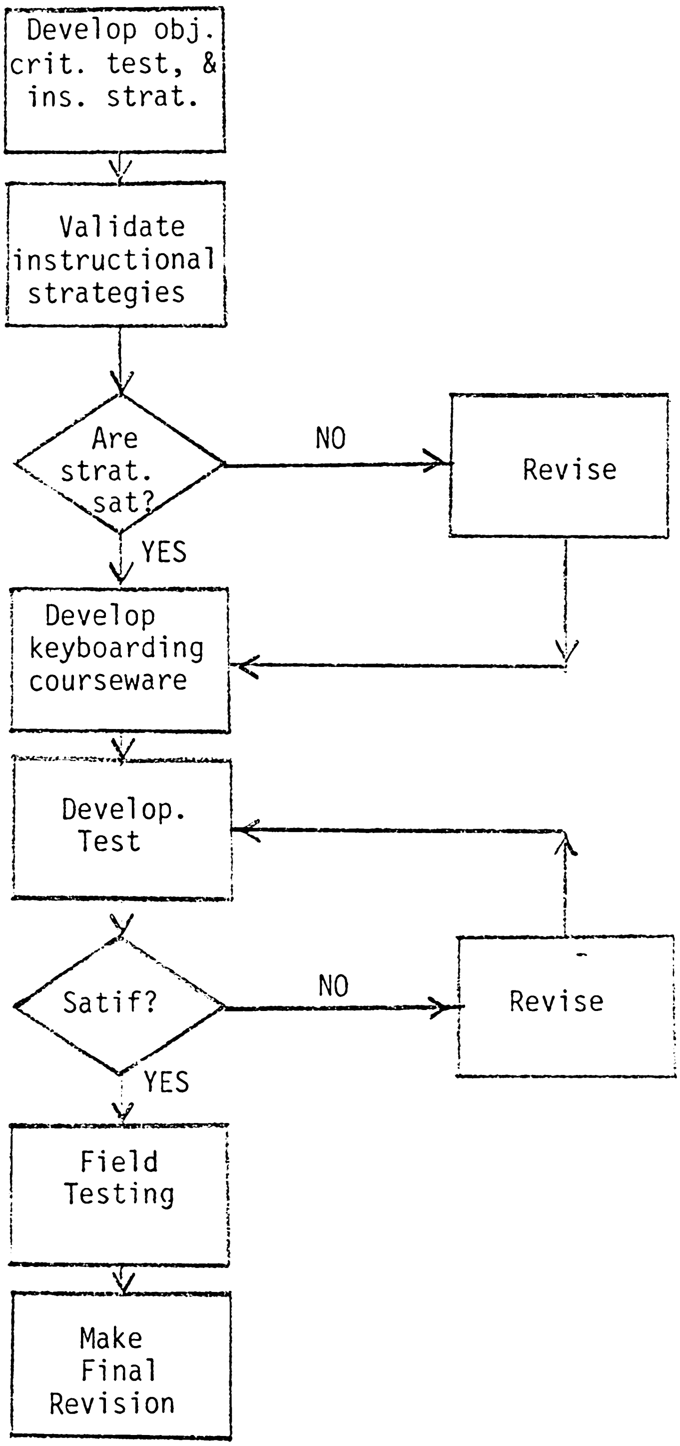

Figure 1

Flow Chart for Program Evaluation

Six secondary instructional objectives were also written for the program. They are as follows:

1. The subject will demonstrate correct body position while keyboarding.
2. The subject will demonstrate correct arm, wrist, and finger position while keyboarding.
3. The subject will demonstrate correct stroking techniques while keyboarding.
4. The subject will use the correct fingers in keyboarding the home keys, and the "e" and "n" keys.
5. The subject will demonstrate correct techniques in the use of the space bar.
6. The subject will demonstrate correct techniques in the use of the return key.

Criterion performance tests consisting of one-minute timed writings were developed. Timed writings for lesson 1 consisted of words constructed from the asdfjkl; keys and required the use of the space bar and the return key. Timed writings for lesson 2 consisted of words constructed from the asdfjkl;en keys and also required the use of the space bar and the return key. An effort was made to construct the timed writings from normal prose insofar as possible with the limited number of available letters. The criterion performance tests are included in Appendix A.

The sequence of instruction, program content, program strategies, and presentation techniques were planned. The program flow chart and instructional frames were written and submitted to a data processing specialist who assisted in the coding process. The first revision of the program was reviewed and edited by the researcher.

Formative Evaluation Design

A formative evaluation design was followed in program tryout and revision that consisted of three cycles: (a) initial developmental testing, (b) Field Test A, and (c) Field Test B. During the initial developmental testing cycles, the researcher met with each subject for an orientation session in which the purpose of the tryout was explained and a demographic questionnaire and the Kinesthesis-Sensitivity Test was completed. Each subject then reported to the microcomputer laboratory for program tryout. The researcher carefully monitored the progress of each subject during program tryout by observing everything that occurred and taking detailed notes regarding errors made, questions asked, long delays, or rereading of instructions. After the subjects completed the lesson tryout, they were interviewed by the researcher. These conversations were tape recorded, and each tape was reviewed prior to making the revisions to the lessons. In addition to researcher observation data, the following data were collected and analyzed from each subject participating in developmental testing: (a) subject demographic information, (b) Kinesthesis-Sensitivity Test scores, (c) time to complete the lessons, (d) criterion performance test scores, and (e) subject responses during the interviews. These data were analyzed to determine the need for additional developmental testing cycles.

During the developmental testing cycles, the program was also evaluated by seven college instructors. After they completed the program tryout, they also responded to the interview questionnaire.

Program Revisions

Revisions made to the program after the developmental testing cycles and classroom teacher evaluation were the most extensive. A goal of the researcher was to develop a program that was effective--that enabled subjects to meet program objectives--and efficient--that met the objectives in the least amount of time (Lumsdaine, 1965). Even if criterion performance standards were met, analysis of data from other sources could indicate types of revisions that were needed. It is possible for a program to meet the criterion level set for it and still have program design inadequacies or weaknesses. Possible revisions to a program might include alterations to (a) amount and type of practice material, (b) sequencing of learner tasks, (c) feedback and reinforcement, (d) transitions between tasks, (e) learner instructions and directions, (f) vocabulary of the program, (g) individualized practice tasks, and (h) motivational devices. Developmental testing cycles were continued until criterion level was reached, and the researcher was convinced that the program was ready for field testing. Developmental testing was completed during April, May, and June, 1983.

Field Testing

Field Test A was conducted during summer quarter, 1983. The subjects were assembled in a typewriting laboratory for orientation. During the orientation session, the purpose of the study was explained; and each subject completed the demographic questionnaire and the Kinesthesis-Sensitivity Test. The subjects then went to the microcomputer laboratory in the Learning Resources Center. The microcomputer laboratory contained eleven Apple microcomputers; therefore, subjects were tested class by class. No class had more than eleven non-typists enrolled. The researcher instructed the subjects on how to insert the program in the disk drive and how to turn on the computer and monitor. Each subject then worked independently through the microcomputer program for lessons 1 and 2. The researcher remained in the laboratory while the program was completed, but assistance was given only if a subject requested it. While the subjects were completing the program tryout, the researcher observed them and recorded on cards any problems they encountered. The researcher also completed a technique rating for each subject using a technique rating sheet. After the subjects completed the program tryout, they filled in the interview questionnaire. Each subject also recorded the time required to complete each lesson on the interview instrument.

After Field Test A, the program was revised and a second field test was conducted during fall quarter, 1983. The same procedures as those used in Field Test A were used in Field Test B.

Criterion Performance Level

Subject scores on the criterion performance tests were analyzed to determine whether the program reached the pre-established criterion level. Lumsdaine (1965, p. 287) cautions against using absolute standards for program validation; however, a level of 90/90 has become fairly common. The criterion performance level set for this program was 90/100. This means that 90 percent of the students will reach 100 percent of the performance objectives.

Subjects

The target population for the completed program was community college students. All the subjects participating in program tryout and revision were students at J. Sargeant Reynolds Community College, Parham Road Campus, Richmond, Virginia. Three groups of subjects were used: the initial developmental group, the Field Test A group, and the Field Test B group.

All subjects used in developmental testing were volunteers who responded to an announcement asking for assistance in testing a microcomputer program for teaching keyboarding. Green (1967, p. 73) reported that, depending on the number of cycles needed, between five and ten subjects are needed for developmental testing. Six subjects were used in the developmental testing cycles in this study. No screening was done, and the first six who responded were used.

Subjects participating in Field Test A were enrolled in day and evening classes in Typewriting I or Keyboarding (taught on selectric typewriters). During the first class session, the researcher visited each beginning class to determine if subjects with no prior typewriting instruction were enrolled. Subjects in this group were asked if they would be willing to participate in a study to test a microcomputer program for teaching keyboarding. In each class section, all subjects with no prior typewriting instruction volunteered. Because a limited number of subjects with no prior typewriting instruction were available, all subjects who qualified were used. Hartley (1972, p. 141) indicated that a minimum of fifteen students should be used during the field test. A total of twenty-nine subjects participated in Field Test A. The same procedures were used with thirty-one subjects for Field Test B.

Data Collection

The data collection instruments and procedures are discussed in the following sections.

Demographic Questionnaire

Subjects participating in program tryout and revision should be typical of the target population for which the program is designed; therefore, demographic data should be collected and analyzed. Each subject participating in this study completed a demographic questionnaire (see Appendix B). Age, sex, and race data were collected in addition to confirmation that the subject had had no prior typewriting instruction.

Kinesthesis-Sensitivity Test

Lumsdaine (1965, p. 308) indicated that "specification of prior knowledge and the ability of learners can both serve to identify the program baseline from which gains may be measured." Lumsdaine further stated that "the corresponding characteristics for the samples of students used in preliminary tryouts, or, particularly, in the effectiveness testing of the program, need to be separately specified so as to indicate the degree to which these learners were typical or atypical of the learners for whom the program is intended" (p. 308). It is impossible to analyze fully all the prerequisite capabilities of tryout subjects, but it is important to be as complete as feasible.

Because subjects selected for this study had had no prior typewriting instruction and the criterion tests consisted of keyboarding performance tests, no achievement pretest could be administered. However, in order to assess more accurately the subjects' entry level characteristics, the Olson Kinesthesis-Sensitivity Test was administered (Olson, 1975). This instrument is valid and reliable and can be used on the first day of class as a prognostic aptitude test for predicting straight-copy typewriting gross speed. Section A of the instrument was used in this study because it was found to be the best predictor for speed (Olson, 1975, p. 197). The test was administered by the researcher to all subjects during the orientation session. Subjects completed the test, which required seventeen minutes to administer, on IBM Selectric typewriters.

Subject-Matter Experts Survey

In an attempt to validate the use of the instructional strategies for microcomputer-based instruction, the selected strategies were incorporated into a survey instrument for evaluation by subject-matter experts.

The survey instrument, Specifications for Teaching Keyboarding Via Microcomputer, summarized those instructional strategies identified by the researcher as important in teaching keyboarding skills via microcomputer. The instrument consisted of forty-two items distributed among the following seven categories (Robinson & Johnson, 1982):

1. Technique
2. Modeling
3. Reinforcement
4. Pacing
5. Appropriateness of Practice Material
6. Differentiated Practice
7. Motivation

Each item was rated on its relative importance for inclusion in a microcomputer program for teaching keyboarding skills via microcomputer. The items were rated on a four-point scale ranging from unimportant (1) to very important (4). Opportunity was provided for modification of the instructional specifications or the inclusion of additional specifications. The Specifications for Teaching Keyboarding Via Microcomputer survey was reviewed by two business educators who are knowledgeable in typewriting instructional methods and microcomputer technology. They completed the questionnaire and furnished the researcher with comments on any items that were not clear. A copy of the instrument is included in Appendix C.

Five subject-matter experts were then selected to complete the survey instrument. These subject-matter experts were involved in teaching typewriting methods courses in a university or conducting typewriting research. Authors of major typewriting textbooks were eliminated from consideration because of the possibility of bias toward a particular method or approach. The list of representatives from each member institution of the National Association of Business Teacher Educators, published each year in the Business Education Forum (1982), was surveyed for candidates. The list of possible experts was narrowed to five educators, one each from Alabama, Virginia, Kansas, Illinois, and Minnesota. The five experts included four university business educators and one community college faculty member who had completed typewriting research recently.

All five experts were contacted by telephone, and the purpose of the survey was explained. All agreed to participate in the survey. A list of the names and addresses of the five subject-matter experts is included in Appendix D.

The Specifications for Teaching Keyboarding Via Microcomputer was mailed to the experts with a cover letter further explaining the purpose of the survey. The cover letter is included for reference in Appendix E.

Apple Microcomputer Specialists Interviews

In order to determine which of the instructional strategies could be programmed effectively for the Apple microcomputer, Apple microcomputer operating manuals were reviewed, and four microcomputer specialists were interviewed. These four specialists were actively involved in the development of instructional software for the Apple microcomputer. The interviews were conducted to determine: (a) whether the instructional strategies identified from the research and experts survey could be programmed for the Apple microcomputer, (b) the degree of difficulty in programming the instructional strategies, and (c) the cost of programming. A structured interview guide was developed for use in interviewing the microcomputer specialists. The instructional specifications were condensed from forty-two to twenty-one items by eliminating those that obviously could be programmed and combining items that were similar. Each item was rated on three scales. On the first scale the specialists rated whether the instructional strategies could be programmed on the Apple microcomputer--yes or no. If the item was rated "yes," then two additional ratings were completed. The second rating was on the cost of programming each item. Responses were rated on a five-point scale from low (1) to high (5). The third rating was on the difficulty of programming each item. Responses were rated on a five-point scale from easy (1) to difficult (5). A copy of the interview guide is included in Appendix F.

Personal interviews were conducted by the researcher with the Apple microcomputer programmers. They were questioned on the feasibility and practicality of developing the microcomputer program. Responses to the interview instrument were recorded by the researcher. Information collected during the interviews was used to assist in the selection of a programmer to code the program as well as to assist the researcher in making the final determination of the instructional strategies to be included in the program. The names and addresses of the four specialists are included in Appendix G.

Subjects' Interview Questionnaire

At the end of each lesson, each subject completed the questions on the interview questionnaire. This questionnaire was developed to structure the interviews with each subject in the developmental and field testing groups. Data from this instrument were used to determine any problems with the program. The instrument consisted of seven questions. A copy of this instrument is included in Appendix H.

Technique Rating Sheet

A technique rating sheet was adapted from a typewriting technique check sheet (Lessenberry, Wanous, Duncan, Warner, 1975 pp. 5-6). The instrument was divided into four main sections; (a) position at the computer, (b) keystroking, (c) space bar, and (d) return key (see Appendix I). The rating sheet contained a total of 17 items, and each item was rated on a scale from unacceptable (0) to excellent (4).

Time Required to Complete the Lessons

Each subject recorded the time required to complete each lesson. These time scores were entered on the subject's interview questionnaire.

Researcher's Observation

During the field test, all the researcher's observations about the performance of the subjects and program were recorded on cards. These comments were grouped by problem classification and tallied.

Subjects' Performance Data

In addition to the data collected from the instruments, subject performance data were collected during the testing cycles. Performance data included gross strokes, error strokes, and correct strokes on the criterion performance tests.

Data Analysis

Data collected during the research were analyzed for four purposes: (a) determining the subject characteristics, (b) identifying any needed program revisions, (c) comparing the performance of the two field test groups, and (d) determining if the program met criterion performance goal. A discussion of the data analysis procedures is included in the following sections.

Demographic Questionnaire

Age, sex, and race data from the demographic questionnaire were reported. Sex data were reported for males and females; race data were reported for white, black, and other; and age data were reported for five categories--under eighteen, eighteen to twenty, twenty-one to thirty, thirty-one to forty-five, and over forty-five. The number and the percentage of subjects in each category were computed.

Kinesthesis-Sensitivity Test

The test was scored for gross strokes, error strokes, and correct strokes. Mean scores, ranges, and standard deviations were computed for gross strokes, error strokes, and correct strokes by group and total population.

Subject-Matter Experts Survey

Mean response scores for each instructional specification were computed, and the items were ranked from high to low importance based on the subject-matter experts' ratings.

Apple Microcomputer Specialists Interviews

If the specialists indicated that the specification could be programmed, then mean ratings were computed on the cost and the difficulty of programming scales; and the items were ranked from high to low on cost and from high to low on difficulty to program.

Subjects' Interviews

Data from student performance may indicate that a program reached the instructional objectives; however, these data may not reveal any information about specific program design inadequacies. Information from the interview instrument was analyzed for this purpose. The analysis of interview results for each group consisted of a listing of all program problems mentioned by the subjects with frequencies of each response computed.

Technique Ratings

Individual and group mean scores were computed for each subdivision of the technique rating sheet as well as for overall mean technique ratings. These scores were inspected to determine if adequate technique instructions (ratings greater than 3.0 on a 4.0 scale) were included in the lessons. The technique scores of the two field test groups were compared to determine if the technique ratings of the two groups were similar.

Time Required to Complete the Program

The efficiency of the program was measured in part by the time required for program completion. In program development, an effort should be made to keep the time required for completion as brief as possible. Time required to complete each lesson was recorded for each tryout group. Mean time scores and ranges were computed for each group, and the time required to complete Field Test A was compared to the time required for Field Test B to determine the effect of program revisions on time required to complete the lessons.

Researcher's Observation

Researcher's observation of the subjects during field tests provided another source of data for program diagnosis and revision. Comments about program problems were recorded on cards, and the comments were tallied in order to make inferences about program design.

Subjects' Performance Scores

Subject performance on the criterion tests was used as an assessment of program performance. Scores for all one-minute timed writings were recorded for each subject; and mean gross strokes, total error strokes, and mean correct strokes were computed. Means and standard deviations were computed by group on gross strokes, error strokes, and correct strokes. These group mean scores were compared to the criterion performance goal to determine if the groups had reached the performance goals.

Pearson Product Moment Correlations

The Kinesthesis-Sensitivity Test was validated for predicting straight-copy typewriting gross speed (Olson, 1975, p. 180). It had not been validated for microcomputer keyboarding performance. In order to determine whether the Kinesthesis-Sensitivity Test was also a valid predictor of microcomputer gross strokes and correct strokes, correlations were computed between Kinesthesis-Sensitivity Test gross and correct strokes and criterion performance test gross and correct strokes.

Group Performance Comparisons

Subjects' performance scores were analyzed to see if the revisions to the program between Field Test A and B caused any significant improvement in performance. An analysis of covariance was computed with Kinesthesis-Sensitivity test scores as the covariant to control for initial aptitude differences. The significance of differences between the adjusted mean scores for Field Test A and B were computed for gross and correct strokes. A significance level of .05 was specified for rejection of the statistical null hypothesis.

Criterion Performance Data

The criterion performance test scores were analyzed to determine if the subjects reached criterion level. Individual mean scores for gross strokes on all timed writings were reported by field test groups. The results were presented in a table with all students who did not reach the criterion level identified.

CHAPTER IV

Results

The purpose of this study was the systematic development and formative evaluation of a research-based model program for teaching alphabetic keyboarding skills via microcomputer. The results of the research are organized in this chapter according to the four research questions.

Research Question One

The first research question was: What instructional strategies and psychological concepts for teaching typewriting are revealed in the literature? This question was addressed by the literature review of the principles of psychomotor skill development and typewriting alphabetic skill acquisition and reported in Chapter Two. In order to validate the principles of learning selected by the researcher, a list of forty-two instructional strategies was compiled and incorporated into a survey instrument, Specifications for Teaching Keyboarding Via Microcomputer. This instrument was mailed to five typewriting subject-matter experts.

Responses were received from all five experts and the results of the survey compiled. Table 1 reports those items rated "very important" by the experts and includes items with mean ratings of 3.5 to 4.0. Nineteen of the forty-two items received ratings above 3.5.

Table 1

Subject-Matter Experts Mean Ratings of

Specifications for Teaching Keyboarding Via Microcomputer

Rated Very Important (3.5 - 4.0)

	Specification	Mean Rating
1.	Positive and non-threatening feedback is provided.	4.0
2.	Early emphasis is on speed of motions not accuracy of product.	4.0
3.	Speed and accuracy are emphasized separately.	4.0
4.	Drill/practice materials consist of ordinary prose.	4.0
5.	Drill/practice materials are extensive, covering a wide vocabulary.	4.0
6.	Early typing of sentence material is required.	4.0
7.	The program adapts to the learner by adjusting the difficulty level of content.	4.0
8.	A feeling of success is created when goals are reached.	4.0
9.	The program is user friendly; i.e., creates a warm, supportive environment.	4.0
10.	Correct fingers to be used in making the strokes are explained.	3.8
11.	Reward or praise is given for correct responses or superior performance.	3.8
12.	Descriptive or quantitative feedback such as words or strokes per minute is given when feasible.	3.8
13.	The keyboard is presented in an order that allows for early typing of ordinary prose.	3.8
14.	Individual performance goals may be set by the student.	3.8

Table 1 (continued)

	Specifications	Mean Rating
15.	During new key presentations and practice drills, feedback as to the correctness of the stroke is given at the time the key is depressed.	3.6
16.	During new key presentations and practice drills, students may use visual references to locate new keys on the keyboard.	3.6
17.	During new key presentations and practice drills, verbal cues (vocalization) such as pronouncing of letters by the learner are explained and encouraged.	3.6
18.	Pacing or speed forcing is provided to develop optimal speed.	3.6
19.	Pacing or speed forcing is provided to decrease dependence on sight typing.	3.6

Table 2 reports those items rated "important" by the experts and includes items with mean ratings of 2.5 to 3.4. As shown in Table 2, nineteen items were rated "important."

Table 3 reports those items rated "little importance" by the experts and includes items with mean ratings of 1.5 to 2.4. As shown in the table, three items received ratings of 2.4, and one item received a rating of 2.0. None of the forty-two items received a mean rating of less than 2.0. Subject-matter experts had the opportunity to add additional items to the instrument; however, none of them did.

Research Question Two

Research question two was: Can these strategies and concepts be incorporated into an instructional program for teaching keyboarding via microcomputer? These steps were followed in addressing this question:

1. Development of instructional objectives
2. Development of criterion performance tests
3. Development of program contents
4. Survey of Apple microcomputer specialists
5. Development of program sequences
6. Development of program strategies
7. Preparation of program flow chart and storyboard
8. Coding of the program for microcomputer

Table 2

Subject-Matter Experts Mean Ratings of

Specifications for Teaching Keyboarding Via Microcomputer

Rated Important (2.5 - 3.4)

	Specification	Mean Rating
1.	Correct posture is explained.	3.4
2.	Correct wrist and arm position are explained.	3.4
3.	Correct finger positions are explained.	3.4
4.	Pacing is accomplished through having each student set individual practice goals and then strive to reach them.	3.4
5.	Practice activities may be repeated at the option of the student.	3.4
6.	Correct keyboarding techniques are illustrated through simulated demonstrations.	3.2
7.	Reaches to new keys are illustrated through simulated demonstrations.	3.2
8.	Pacing or speed forcing is provided to force proper stroking techniques.	3.2
9.	The student has the option of selecting specific learning activities.	3.2
10.	The student selects appropriate drill/practice material.	3.2
11.	Where feasible, the program is multisensory.	3.2
12.	The student controls the learning situation.	3.0
13.	The student has the option of exiting from an activity once individual goals have been reached.	3.0

Table 2 (continued)

Specification	Mean Rating
14. The program is fun to use.	3.0
15. The program makes creative use of graphics.	3.0
16. Continuous pacing is provided by the computer on drill/practice materials.	2.8
17. During new key presentations and practice drills, opportunity is given for typing the correct response immediately after an incorrect key is depressed.	2.6
18. External oral pacing is used during new key presentations.	2.6
19. Error analysis is given when feasible.	2.5

Table 3

Subject-Matter Experts Mean Ratings of

Specifications for Teaching Keyboarding Via Microcomputer

Rated Little Importance (1.5 - 2.4)

Specification	Mean Rating
1. Sounds and tones used for reinforcement are pleasant.	2.4
2. The program makes creative use of color.	2.4
3. The program makes creative use of humor.	2.4
4. The program makes creative use of animation.	2.0

Instructional Objectives

Eight instructional objectives were developed for the program. The two primary objectives were measured by subjects' performance on the criterion performance tests. The performance results were used to determine whether the program met performance criteria. The two primary objectives are listed below:

1. When words requiring the use of the home keys, return keys, and the space bar are displayed on the screen, the subject will be able to keyboard these words at a minimum rate of 65 strokes per minute.
2. When words requiring the use of the home, the "e," the "n," and the return keys and the space bar are displayed on the screen, the subject will be able to keyboard these words at a minimum rate of 65 strokes per minute.

Six secondary objectives were also developed for the program. These six objectives were measured by the researcher's observation and rating of the subjects on a technique rating sheet (see Appendix I) during the field test. The purpose of these objectives was to determine the subjects' technique ratings and to use these ratings in program revisions. The six objectives are:

1. The subject will demonstrate correct body position while keyboarding.
2. The subject will demonstrate correct arm, wrist, and finger position while keyboarding.

3. The subject will demonstrate correct stroking techniques while keyboarding.
4. The subject will use the correct fingers in keyboarding the home keys, and the "e" and "n" keys.
5. The subject will demonstrate correct techniques in the use of the space bar.
6. The subject will demonstrate correct techniques in the use of the return key.

Criterion Performance Tests

The criterion performance tests were developed to measure the subjects' performance on the two primary instructional objectives. The tests consisted of one-minute timed writings constructed from words containing the home, the "e," the "n," and the return keys and the space bar. The criterion performance level for the timed writings was a minimum stroking rate of 65 strokes per minute. Refer to Appendix A for copies of the criterion performance tests.

Program Content

The program contained instruction on how to keyboard the home, "e," "n," and return keys and the space bar. Correct keyboarding techniques were also stressed through technique cues. The space bar was presented to the participants first followed by the return key. Next the home keys (asdfjkl;) were taught. The researcher wanted to include one upward and one downward stroke and one additional stroke with each hand. Therefore, the "e" key was chosen because it requires an upward reach with a finger of the left hand, and the "n" key was included because it requires a downward reach with a finger of the right hand.

Apple Microcomputer Specialists Interview Results

Data from the survey of the four microcomputer specialists were analyzed. Except for items 5 and 6, all twenty-one specifications listed on the interview guide were unanimously rated as capable of being programmed on the Apple microcomputer. One rater indicated that items 5 and 6 could not be programmed. Table 4 reports the mean ratings on the cost and difficulty of programming scale.

As indicated in Table 4, those specifications rated most costly and difficult to program were those requiring moving graphics, animation, and color.

Program Sequence

The program was presented in two lessons. The final version of the program included the following modules:

1. Lesson 1
    a. Learn the location of the home keys, the space bar, and the return key.
    b. Practice keyboarding the home keys, the space bar, and the return key.
    c. Build speed on drill consisting of the home keys, the space bar, and the return key.
    d. Measure progress with one-minute timed writings on criterion performance test 1.

Table 4

Mean Ratings of the Cost and Difficulty of Programming

Selected Specifications as Rated by Microcomputer Specialists

Specification	Cost Mean Rating	Difficulty Mean Rating
1. Keyboarding techniques can be demonstrated by moving graphic designs.	5.00	5.00
2. Reaches to new keys can be demonstrated by a graphic design showing the finger movement.	5.00	5.00
3. Animated characters can be programmed.	4.75	4.75
4. The program can be developed in color.	4.75	4.75
5. The computer records the students' progress and places them in the program in proper sequence.	4.00	3.66
6. Incorrect strokes can be indicated and analyzed.	3.60	3.60
7. Practice materials can be prescribed by the computer based on computer analysis of keyboarding drills.	3.50	3.50
8. The computer can pace drills in order to force speed development.	3.25	3.25
9. Individual student records can be computed and recorded by the computer.	3.25	3.25
10. Feedback can be given at the time a key is depressed by having the keyboard lock.	3.00	2.33
11. Words per minute can be computed.	3.00	2.75
12. Drills can be timed by the computer.	3.00	3.00

Table 4 (continued)

Specification	Cost Mean Rating	Difficulty Mean Rating
13. Different sounds or tones may be used to differentiate between correct and incorrect strokes.	2.66	2.66
14. Response latency; i.e., the time between the screen stimulus and the keyboard response can be computed.	2.60	2.60
15. After an incorrect key is depressed the program resumes in proper sequence when the correct key is depressed.	2.50	2.75
16. Strokes per minute can be computed.	2.50	3.50
17. Correct techniques; i.e., posture, wrist and arm position, finger position, can be demonstrated by graphic illustrations.	2.25	2.25
18. Feedback, praise or reward can be given based on computer analysis and performance.	2.25	2.25
19. Parts of the keyboard can be highlighted with flashing signals.	2.00	2.00
20. Parts of the keyboard can be highlighted with color intensity.	1.33	1.33
21. Feedback can be given at the time an incorrect key is depressed by a sound or tone.	1.25	1.25

Note. Scale: Low (1) High (5)

e. Increase skill through supplemental speed building practice.

f. Measure progress with one-minute timed writings on criterion performance test 2.

2. Lesson 2

a. Learn the location of the "e" and "n" keys.

b. Practice keyboarding the "e" and "n" keys.

c. Build speed on drill emphasizing the "e" and "n" keys.

d. Measure progress with one-minute timed writings on criterion performance test 3.

e. Increase skill through supplemental speed building practice.

f. Measure progress with one-minute timed writings on criterion performance test 4.

Program Strategies

The information from the review of research, the subject-matter experts survey, and the microcomputer specialists interviews was used as the basis for designing the program.

As shown in Table 1, page 71, nineteen specifications for teaching keyboarding were rated "very important" by the subject-matter experts. All nineteen specifications were included in the program except for specifications 6 and 14. Specification 6, the early typing of sentence material, was not feasible for the early lessons developed in this study because too few letters of the alphabet had been taught to form sentences. An attempt was made to compensate for this, however, by the use of phrases in the criterion performance tests. Specification 14, the setting of individual performance goals, also was not included in the program. During lessons 1 and 2, subjects do not have adequate background to set realistic performance goals.

Table 2, page 74, reported nineteen specifications rated "important" by the subject-matter experts. Five of these specifications were not included in developing the program. These five specifications and the justifications for not including them are:

1. <u>Specification 4</u>

   Pacing is accomplished by having each subject set individual practice goals and then strive to reach them.

   <u>Justification for not including</u>

   Pacing is not realistic in the very early keyboarding lessons. Pacing in these early lessons was accomplished via the speed building practice rather than by having participants set goals.

2. <u>Specification 6</u>

   Correct keyboarding techniques are illustrated through simulated demonstrations.

   <u>Justification for not including</u>

   Because simulated demonstrations were difficult to program, keyboarding techniques were presented through narrative discussion. Throughout the lessons, subjects were reminded of proper keyboarding techniques through technique cues that appeared at frequent intervals on the screen.

3. Specification 7

Reaches to new keys are illustrated through simulated demonstrations.

Justification for not including

The home keys were presented initially through an illustration of the fingers in correct position over the diagram of the keyboard. As each additional key was presented, the same diagram was shown with the new key highlighted. Instructions were given as to the correct finger to be used in making the reach. Illustrations of moving fingers were not used in presenting the new keys because of the difficulty and the cost of programming.

4. Specification 18

External oral pacing is used during new key presentations.

Justification for not including

Pacing in the program was provided through the use of tones in the speed drills. No oral directions or instructor's pacing were included in the program.

5. Specification 19

Error analysis is given when feasible.

Justification for not including

The primary purpose of lessons 1 and 2 was to develop rapid stroking techniques; therefore, no error analysis was reported to the subjects in these very early lessons. Error analysis should be incorporated into keyboarding programs after the very early lessons.

Table 3, page 76, lists four specifications rated "little importance" by the subject-matter experts. Because they were rated of "little importance," specifications 2 (creative use of color), 3 (creative use of humor), and 4 (creative use of animation) were not included in the program. Specification 1 (sounds and tones used for reinforcement are pleasant) was used because reinforcement was important to the design of the program. Tones were used throughout the program for reinforcement.

The completed program consisted of lessons 1 and 2 on one diskette. The program was self-contained in that no additional subject instructions or documentation were made available.

Presentation Techniques

Each of the two lessons was divided into five phases. Each phase is discussed below:

1. Phase 1--Learn the new keys

   Each new key to be learned is shown highlighted on an illustration of a keyboard displayed on the screen. Students are instructed to strike each key as it is highlighted. Incorrect strokes result in a beeping sound, and the correct key remains highlighted until it is struck. Once the correct key is struck, the next key appears.

2. <u>Phase 2--Practice the Keys Presented</u>

   The characters to be keyboarded appear below an illustration of the keyboard. Students are instructed to strike the keys. If an incorrect key is struck, a beep sounds and the character is highlighted on the keyboard illustration. The key remains highlighted until the correct key is struck. Students have the option of repeating the drill.

3. <u>Phase 3--Build Speed on Keys Presented</u>

   Students are instructed to type quickly the characters displayed and not to worry about errors for now. The drill is constructed so that a beep sounds each time the student's speed falls below 75 strokes per minute. Positive praise was used throughout the drill to indicate adequate performance. If the student's speed is too slow, the sentence must be repeated. Students have the option of repeating the drill if they wish.

4. <u>Phase 4--One-minute timed writings</u>

   Students are instructed to type at a comfortable rate. They are timed for one minute on the criterion performance test. They have the option of taking another timed writing. Speed analysis is provided. If a student's speed is below fifteen words per minute (75 strokes), the subject is automatically recycled into supplemental speed practice. With fifteen to twenty-five words per minute, subjects have the choice of taking supplemental practice or proceeding to the next lesson.

If a subject types more than twenty-five words per minute, instructions are given to go to the next lesson.

5. Phase 5--Supplemental practice

This drill uses the same procedure as the speed practice. At the completion of the drill, the subject can take two additional timed writings on the criterion performance tests.

Program Flow Chart and Storyboard

The next stage in the development of the program involved two steps, flow charting and storyboarding.

A flow chart of each lesson was written. Included in this flow chart was a detailed analysis of how subjects should progress through each lesson. The flow chart detailed each step of the program as well as the branching sequences.

From the detailed flow chart, a storyboard that specified the presentation visuals and script for each frame was constructed. Illustrations were drawn for each visual to be included in the program, and the program instructions and drill material were written.

Program Coding for Microcomputer

The flow charts and the storyboard were submitted to a programmer who coded the program for the Apple microcomputer. The entire program was written in BASIC (Beginners All purpose Symbolic Instruction Code) except for a subroutine for the storage of timed writings, which was written in machine language.

Research Question Three

Research question three was: Can the program be improved through the process of formative evaluation? This question is addressed through a discussion of program tryout and revision. The following topics are discussed: (a) subject description, (b) initial developmental testing results, (c) Field Test A results, and (d) Field Test B results.

Description of the Subjects

Two topics are included in this discussion of subjects: (a) demographic profile results, and (b) Kinesthesis-Sensitivity Test results. During the orientation session, demographic data were collected from the subjects and the Kinesthesis-Sensitivity Test was administered. Demographic data were analyzed in order to determine age, sex, and race on the subjects participating in the tryout of the program. The Kinesthesis-Sensitivity Test was administered in lieu of a keyboarding pretest that could not be given because the subjects were nontypists. The results of this test were analyzed in order to provide data on the subjects' aptitudes for keyboarding and also to provide data on the similarities or dissimilarities of the groups participating in the study.

Demographic profile. As shown in Table 5, a total of 68 subjects participated in the program, six in the initial developmental testing group, 30 in Field Test A, and 32 in Field Test B. Thirty-two percent were males, and sixty-eight percent were females. The subjects ranged in age from under 18 to over 45, with 31 percent between 18 and 21,

Table 5

Subject Demographic Profile

Category	Developmental n	Developmental %	Field Test A n	Field Test A %	Field Test B n	Field Test B %	Total n	Total %
Sex								
Male	2	33	12	40	8	25	22	32
Female	4	67	18	60	24	75	46	68
Race								
White	3	50	26	87	26	81	55	81
Black	3	50	4	13	5	16	12	18
Other	--	--	--	--	1	3	1	1
Age								
<18	--	--	5	17	1	3	6	9
18-20	2	33	8	27	11	34	21	31
21-30	1	17	10	33	11	34	22	32
31-45	2	33	6	20	7	22	15	22
>45	1	17	1	3	2	6	4	6

32 percent between 21 and 30, and 22 percent between 31 and 45. The community college population in Virginia is composed of 42 percent male students and 58 percent female. Thirty percent of the subjects are between 18 and 21, 45 percent are between 22 and 34, and 16 percent are between 35 and 44 (Virginia Community College System, Fall Census Data, 1983). Thus, the demographic profile of the subjects closely parallels the demographic profile of subjects in the Virginia Community College System.

Kinesthesis-Sensitivity Test results. The test is scored for gross strokes, error strokes, and correct strokes. Table 6 reports the summary of ranges, means, and standard deviations for the three groups. One subject in Field Test A and one subject in Field Test B did not follow directions in taking the test; therefore, their test scores are invalid and are not reported.

As shown in Table 6, subjects in Field Test B achieved the highest scores on the test. Subjects in the initial development group scored next highest and subjects in Field Test A scored lowest. Subjects in Field Test B scored higher on gross strokes (M = 646), made fewer errors (M = 38) and, therefore, achieved higher correct strokes (M = 608).

Mean scores on the Kinethesis-Sensitivity Test were also computed for the total population participating in the study. The mean of the gross stroke scores for the total group was 602, (SD 224). The total group error stroke mean was 35, (SD 21), and the total group correct stroke mean was 561 (SD 232). Olson (1975, p. 148) reported gross stroke mean scores of 634 (SD 145), error scores of 83 (SD 81), and

Table 6

Kinesthesis-Sensitivity Test

Summary of Ranges, Means, and Standard Deviations

Categories	Number	Range	Mean	Standard Deviation
Gross Strokes				
Development	6	385- 907	619	219
Field Test A	29	359-1024	552	144
Field Test B	31	203-1340	646	277
Errors				
Development	6	11- 68	44	24
Field Test A	29	8- 98	46	27
Field Test B	31	13- 89	38	21
Correct Strokes				
Development	6	329- 896	575	241
Field Test A	29	305- 986	507	155
Field Test B	31	136-1234	608	281

correct stroke mean scores of 551 (SD 150). In comparing the population in this study with the population used in the Olson study, the subjects in the Olson population were faster but not as accurate as the subjects in this study; but the correct stroke scores were in the same range--551 in the Olson study compared to 561 in this study.

Initial Developmental Testing

The first developmental testing cycle consisted of the tryout of the first version of lesson 1 with five non-typists. Time required to complete the lesson was recorded by the researcher. Criterion performance test scores consisting of gross strokes on the one-minute timed writing at the end of the lesson were also recorded. An analysis of the time data scores indicated that the mean time required to complete the lesson was 24 minutes with a range of 20 to 50 minutes. The mean of the criterion performance scores (one-minute timed writings) was 120 gross strokes with a range of 80 to 190 strokes. Based on the gross stroke mean score of 120, the program surpassed the performance level of 65 gross strokes per minute.

Lesson 1 was also subjected to tryout by seven college instructors. These included three university faculty members, two community college secretarial science instructors, one community college typewriting laboratory assistant, and one community college curriculum specialist. These persons also responded to the interview instrument (see Appendix H).

Program Revisions

Even though the program met the criterion level, some revisions were called for before the field test. The data for these revisions to lesson 1 came from three sources: (a) researcher's observation of the subjects as they completed the program, (b) subjects' input during the interview at the end of the lesson, and (c) faculties' responses to the interview instrument.

Following is a list of problems encountered and the corrective actions taken in revising the initial program:

1. Problem: One-minute timed writing speed scores (criterion performance test scores) were not completely accurate because each line of the timed writing was timed independently. Corrective Action: The program was rewritten so that the timing mechanism in the computer would commence with the first stroke of the timed writing and end after exactly one minute.
2. Problem: The stroke-by-stroke error analysis on the criterion performance test was not needed in early lessons because subjects were too concerned about errors. If error analysis is included at this stage, errors should be reported by words instead of strokes. Corrective Action: The error analysis was eliminated from the analysis of the timed writing scores reported to subjects.
3. Problem: In the instructor's computer analysis of each subject's timed writing scores only the speed and stroke-by-stroke error analysis were reported. Corrective Action: In

order to have a complete record of each subject's criterion performance test, the program was rewritten so that the text of each timed writing would be included on an instructor printout.

4. Problem: Only the first and last timed writing scores were recorded in the instructor's computer analysis--some subjects repeated the timed writings more than twice. Corrective Action: The program was changed to enable the instructor to obtain a printout of all timed writings.

5. Problem: Only one timed writing was included in each lesson. It was found desirable for an additional timed writing to be available so that any repeated timed writing would include new material. Corrective Action: An additional timed writing was added to each lesson.

6. Problem: The speed drills were too repetitious for slower typists because they were forced to remain on each sentence until they reached the predetermined goal of 15 words (75 strokes) per minute. Corrective Action: The procedure for the speed drill was changed so that each subject would type each sentence a maximum of twice.

7. Problem: Reinforcing beeps on speed drills set at each quarter minute were too infrequent; and the speed goal was set too low, i.e., 65 strokes per minute. Corrective Action: The frequency of the reinforcing beeps was changed to every five

seconds, and the speed goal was reset for 75 strokes per minute.

8. Problem: In the speed drills and timed writings, subjects were not prompted to strike the return key before beginning a new line. Corrective Action: A statement was included in the instructions at the beginning of each section to strike the return key at the end of each line. Also the return key was highlighted on the keyboard illustration when the subject reached the end of each line.

9. Problem: Some subjects were not using the correct fingers on the keys. Corrective Action: A graphic review of the location of the keys was added to the program and recalled frequently during the lesson. Additional technique reminders were also included in the lesson.

10. Problem: The technique cues were displayed at the bottom of the drill frames and subjects often did not stop to read them. Corrective Action: The technique cues were moved to a separate frame; and after reading them, subjects were required to press the space bar to continue. The technique cues were also highlighted to make them more noticeable.

11. Problem: Some subjects were not using correct fingering techniques while keyboarding. Corrective Action: Additional technique cues on correct fingering techniques were added.

12. Problem: Three instructional frames did not remain on the screen long enough for the subjects to read them.

Corrective Action: The program was corrected so that the subjects could control the timing of the frames by pressing the space bar to continue.

13. Problem: Eight subject instructions were not clear. Corrective Action: They were rewritten.

14. Problem: "Press any key to continue" was changed to "press the space bar to continue." This eliminates any confusion about which key to press and encourages subjects to develop skill in using the space bar by keeping their hands in proper position. Corrective Action: This instruction was changed throughout the program.

After these identified problems with the first version of lesson 1 were corrected, the lesson was tested by an additional subject. The same procedures were followed as in the previous tryouts. No new problems with the program were identified, and no additional revisions were made to the lesson.

Lesson 2 was then programmed using the same format as lesson 1. This lesson was further tried with two subjects selected from the first developmental testing group. The mean time to complete lesson 2 was 43 minutes, and the mean score on the criterion performance tests was 83 gross strokes. No major new problems were identified; and because the program reached the pre-established criterion level, it was considered to be ready for the field test.

Field Test A

Data for program diagnosis and revision were collected during Field Test A. These data were analyzed according to: (a) subjects' performances on the criterion tests, (b) time required to complete the program, (c) researcher's technique ratings, (d) subjects' interviews, and (e) researcher's observation.

Subjects' performance scores. The subjects' performance data for lessons 1 and 2 are shown in Table 7 which reports the mean gross strokes, mean correct strokes, and total errors for all timed writings in lessons 1 and 2. The individual mean scores on gross strokes on all timed writings ranged from 53 to 161 with a group mean of 85 (*SD* 24). The individual mean scores on correct strokes ranged from 45 to 156 with a group mean of 77 (*SD* 25). The individual total error scores ranged from 3 to 105 with a group mean of 30 (*SD* 21).

Subjects' performance scores on the criterion tests were used as an assessment of the performance of the program. The performance goal for the program was 65 gross strokes per minute. The mean gross stroke score of 85 and the mean correct stroke score of 77 indicate that the program exceeded the performance goal. Therefore, no program revisions were identified from the analysis of subjects' performance scores.

Time analysis. The time data collected for the tryout shows the mean time required to complete lesson 1 was 42 minutes with a range of 19 to 66 minutes. The mean time for lesson 2 was 50 minutes with a range of 22 to 95 minutes. The wide range of scores was attributed to

Table 7

Subjects' Performances on All Timed Writings

Field Test A

Subject	Individual Mean Gross Strokes	Individual Mean Correct Strokes	Individual Total Errors
1	83	74	20
2	58	45	51
3	161	156	19
4	54	48	24
5	85	80	21
6	81	65	63
7	75	69	12
8	75	71	18
9	141	135	25
10	74	72	8
11	81	54	105
12	53	47	16
13	69	63	23
14	70	62	31
15	94	83	45
16	80	75	19
17	84	78	22
18	103	89	55
19	103	93	41
20	76	70	27
21	70	59	44
22	103	96	27
23	98	91	27
24	94	82	36
25	72	69	10
26	70	46	48
27	71	67	15
28	113	106	29
29	81	81	3
Group			
M	85	77	30
SD	24	25	21

the fact that some subjects repeated certain sections of the program several times.

Technique ratings. While the field-test subjects were completing lesson 2, the researcher completed the technique rating sheet (see Appendix I) for each subject. The ratings were analyzed so that technique flaws could be detected and additional technique cues could be added to any revision.

The items rated under "position at the computer" received the lowest rating with a mean score of 3.35 followed by "keystroking" items with a mean rating of 3.53, "return key" items with a mean rating of 3.67, and "space bar" items with a mean rating of 3.77. The lower rating on "position at the computer" was partly due to the excessive height of the tables in the microcomputer laboratory. The overall mean technique rating of 3.58 indicated to the researcher that the keyboarding techniques of the Field Test Group A were satisfactory.

Subjects' interviews. After the subjects in Field Test A completed the tryout, each subject filled out the subject's interview questionnaire (see Appendix H). Data from this instrument were used to analyze program problems encountered by this group.

Table 8 summarizes the problems encountered by the subjects in Field Test A. The first column includes those items mentioned by the subjects as a problem area; the second column indicates the frequency of responses.

Researcher's observation. As the subjects in Field Test A completed the tryout of the keyboarding program, the researcher observed

Table 8

Summary of Program Problems Identified

From Subjects' Interview Data

Field Test A

Item	Frequency
Dislike the beeps in the speed drills	6
Too much repetition on some sentences	4
Computer keyboard too stiff	3
Program too difficult	3
Need to lengthen or finish the program	2
Need a break in program, or a rest screen	2
Need to be able to go all the way back to beginning	1
Words flashing under screen distracting, wait until the drill is finished, then give praise	1
Would like to be able to correct errors	1
Would like to be able to take additional timed writings in lesson without the supplemental practice	1
Need more practice and timed writings	1
Should count mistakes in timed writings	1
Need less of a pattern when teaching new letters, tended to second guess	1
Need more encouragement	1
Should be able to go back to prior lessons	1

their progress and recorded on cards any problems the subjects encountered. Following is a discussion of needed program revisions that were identified by the researcher during the observations of the subjects during Field Test A:

1. The program needed to provide the subjects with more direction in selecting the appropriate options in the lessons. Typically the options at the end of each section offered the subjects a choice of: (a) repeating the section, (b) continuing with the lesson, or (c) ending the lesson. Some subjects seemed confused about which option should be followed and asked the researcher for assistance in making the decision.
2. Lesson 2 took too much time to complete. This problem could be alleviated by rearranging the sequence of lesson 2 by combining the two speed building sections.
3. Additional timed writings needed to be added to each lesson because some subjects repeated the timed writings and there was not enough variety in the timed writing material.
4. Rest frames needed to be added to the program at appropriate intervals. Subjects could, of course, stop at any point in the program to rest, but many did not. As a result, they became quite tired.
5. The speed building section needed to be reassessed. There was still too much repetition for slower subjects.

6. A problem existed with the recycling procedures in lesson 2. At times slower subjects were not automatically recycled into the supplemental drills.
7. Some microcomputers in the microcomputer laboratory had been equipped with Videx enhancer boards, and the program would not always function properly on these machines.
8. Other minor problems such as incorrect word usage, typographical errors, unclear instructions, and the timing of certain frames on the screen needed to be corrected.

Revisions After Field Test A

Performance data collected during Field Test A indicated that the program was performing satisfactorily. The revisions that needed to be made, therefore, were those that would eliminate any confusion by the subjects and enable them to complete the program in less time. Revisions made to the program after Field Test A are discussed in the following sections.

1. Problem: The researcher observed that some subjects seemed to get tired while completing the lessons. Two subjects also commented, on the interview questionnaire, that the program needed rest frames or breaks in the program. Even though the subjects could take a break at any time, most of them did not.
   Corrective Action: Rest frames were added to the program. The frames instructed the subjects to drop their hands to their sides and to strike the space bar when they wished to

resume the lesson. These frames were built into the program at frequent intervals.

2. Problem: A second need was for more explicit subject instructions. Although none of the subjects mentioned the need for clearer instructions, during Field Test A several subjects asked the researcher what they should do when the choice frame appeared. It was not clear to them whether they should repeat a section, go to a new section, or end the lesson. Corrective Action: Additional instructions were written for each section explaining the alternatives available.

3. Problem: The criticism that was mentioned by more subjects, six, than any other was that they disliked the beeps in the speed drills. Corrective Action: Because the beeps were essential in pacing the subjects in the speed drills and in forcing them to increase their speed, the beeps were not eliminated but an additional instruction explaining the purpose of the drill and the beeps was added.

4. Problem: The second most frequent criticism, made by four subjects, was too much repetition on some sentences. The researcher also observed that slower subjects repeated the sentences in the speed building section too often. Corrective Action: The instructional sequence for the speed building section was redesigned so that each sentence would be practiced once and if the speed was too slow, subjects would

retype it only once. At the end of the section, however, subjects could choose to repeat the whole section.

5. Problem: Additional timed writings were needed in each lesson. Corrective Action: Two additional timed writings were written for each lesson. The program was also altered so the text of all timings were recorded in the instructor's record analysis.

6. Problem: Lesson 2 contained two speed building sections. The two sections could be combined into one and the practice time reduced. Corrective Action: Lesson 2 was altered so that only one speed building section was included.

7. Problem: Some subjects who should have been automatically recycled into supplemental practice were allowed to continue with the lesson. Corrective Action: The recycling problem was corrected in the program.

8. Problem: Twenty minor instructions were unclear. Corrective Action: These instructions were rewritten.

Field Test B

After the foregoing revisions were made, the program was field tested a second time. This field test was conducted during fall quarter, 1983. The discussion of data collected and analyzed during Field Test B includes some comparative data analysis with Field Test A. The following topics are discussed: (a) subjects' performance scores, (b) Pearson product moment correlations, (c) time analysis,

(d) technique ratings, (e) subjects' interview results, (f) researcher's observation, and (g) Field Test A and Field Test B performance comparison.

Subjects' performance scores. The performance data for Field Test Group B is reported in Table 9 which reports mean gross strokes, mean correct strokes, and total errors for all timed writings in lessons 1 and 2. The individual mean scores on gross strokes on all timed writings ranged from 47 to 189 with a group mean of 100 (SD 38). The individual mean scores on correct strokes ranged from 39 to 184 with a group mean of 90 (SD 34). These scores indicate that the program exceeded the performance goal. The individual total error scores ranged from 5 to 130 with a group mean of 52 (SD 29).

Pearson product moment correlations. Pearson product moment correlations were computed between the Kinesthesis-Sensitivity Test gross strokes and correct strokes scores and the criterion performance test gross strokes and correct strokes scores for Field Test Groups A and B.

Olson (1975, p. 180) found significant ($p < .01$) correlations between Kinesthesis-Sensitivity Test scores and straight-copy typewriting gross speed. The Kinesthesis-Sensitivity Test was not validated for predicting microcomputer keyboarding performance. In order to justify the use of the Kinesthesis-Sensitivity Test scores for determining the initial kinesthetic aptitudes of the subjects in the microcomputer keyboarding program, correlations were computed between the Kinesthesis-Sensitivity Test scores and the criterion performance

Table 9

Subjects' Performances on All Timed Writings

Field Test B

Subject	Individual Mean Gross Strokes	Individual Mean Correct Strokes	Individual Total Errors
1	54	47	52
2	78	75	23
3	88	87	5
4	86	83	29
5	89	71	130
6	70	67	29
7	47	39	63
8	75	65	61
9	69	61	62
10	87	81	40
11	189	184	34
12	74	64	76
13	71	65	42
14	115	110	32
15	69	61	68
16	113	98	118
17	98	89	66
18	156	153	14
19	176	168	69
20	110	105	16
21	138	132	51
22	141	127	109
23	179	168	82
24	87	82	40
25	84	81	30
26	59	55	27
27	109	100	60
28	81	75	47
29	84	78	35
30	72	66	46
31	153	146	53
Group			
M	100	90	52
SD	38	34	29

test scores. Significant correlations ($p < .01$) were found between the two measures on gross and correct strokes for both Field Test groups.

Table 10 presents the correlation and coefficient of determination results. The greatest degree of relationship was found ($r = .93$) between Kinesthesis-Sensitivity Test scores and Field Test Group B on gross strokes. The coefficient of determination (r^2) indicates the percentage of variability accounted for by the relationship between the two scores being correlated.

As shown in Table 10, all of the r^2s indicate that more than 50 percent of variability could be attributed to the relationship between the two measures. This evidence supports the use of the Kinesthesis-Sensitivity test in predicting microcomputer keyboarding performance.

Time analysis. The time data analysis for Field Test B shows the mean time required to complete lesson 1 was 39 minutes with a range of 24 to 72 minutes. The mean time for lesson 2 was 39 minutes with a range of 9 to 83 minutes.

One problem frequently experienced in program development is the tendency for subsequent revisions to increase the time required to complete the lessons (Lumsdaine, 1965). As shown in Table 11, the program revisions in this study increased the efficiency of the program by reducing lesson time.

Technique ratings. During the completion of lesson 2, subjects in Field Test B were also rated on the technique rating chart by the researcher. Table 12 shows a comparison of the technique ratings for Field Test A and Field Test B.

Table 10

Pearson Product Moment Correlations

Between the Kinesthesis-Sensitivity Test Scores

and Mean Criterion Performance Test Scores

Group	Pearson *r*	Coefficient of Determination
Field Test A		
Gross	.77 *	.59
Correct	.81 *	.66
Field Test B		
Gross	.93 *	.87
Correct	.79 *	.62

* $p < .01$

Table 11

Mean Time in Minutes Required to Complete the Lessons

Group	Lesson 1	Lesson 2
Field Test A	42	50
Field Test B	39	39

Table 12

Technique Ratings by Groups

Group	Field Test A	Field Test B
Position at computer	3.35	3.61
Keystroking	3.53	3.59
Space bar	3.77	3.74
Return key	3.67	3.75
Overall mean technique rating	3.58	3.63

Subjects in Field Test B scored slightly higher on "position at computer," "keystroking," and "return key." Students in Field Test A scored slightly higher on "space bar." The overall mean technique rating for Field Test A group was 3.58 and Field Test B group was 3.63.

Subjects' interviews. Subjects participating in Field Test B also completed the subject interview questionnaire. In response to the questions about what they disliked or would change in the program, two subjects in this group compared to six in Field Test A commented that they disliked the beeps in the speed drills. The additional explanation of the purpose of the beeps that was included in the revised version may have contributed to the fact that subjects were more tolerant of the speed beeps.

Two subjects also mentioned that they would like additional timed writings added to the program even though the revised program had four timings in each lesson. The only other negative comment from the subjects in this group was that the "touch" of the computer keyboard was "too easy." The researcher had no control over keyboard touch.

Researcher's observation. The researcher observed that during Field Test B there was less confusion by the subjects in completing the program. The explanations of the options that were added during revisions seemed to clarify the appropriate choice for the subjects. They were able to complete the tryout with minimum assistance.

The inclusion of rest breaks also facilitated the subjects' progress through the lesson. The pace was much more relaxed. They took rest breaks between sections and appeared less fatigued at the end of the lesson.

The skill building drills were not as repetitious for the slower subjects. The choice of a maximum of two repetitions on each line was appropriate. Many subjects did repeat the complete drill, but they did not seem to experience any boredom with the drill.

The explanation of the purpose of the beeps, which was added during revision, enabled the subjects to be more tolerant. In fact, they seemed to enjoy the challenge of trying to "beat the computer" as they increased their speed.

The alteration in the sequence of instruction and the elimination of the second speed building section in lesson 2 enabled subjects in Field Test B to complete lesson 2 in the same time as lesson 1. Subjects in Field Test B also completed lesson 2 in less time than subjects in Field Test A.

Group performance comparisons. Comparisons were made between Field Test Group A and Group B criterion performance test scores to see if the revisions to the program made a significant difference in performance between the groups. The Kinesthesis-Sensitivity Test scores were used to control for initial aptitude, and an analysis of covariance was computed for gross and correct strokes on all criterion performance tests. Adjusted means on both gross strokes (*M* Group A = 91, *M* Group B = 94) and correct strokes (*M* Group A = 83, *M* Group B = 87) were slightly higher for Group B but differences did not reach the apriori significance level.

Research Question Four

Research question four was: Upon completion of the program tryout, was the established criterion level reached? The pre-established criterion level for subjects' performances stated that 90 percent of the subjects would reach the objectives for the lesson. The subject scores on the criterion performance tests in Lesson 1 and 2 were analyzed. The objectives for the lessons on which the criterion level was based are listed below:

1. Lesson 1 Objective--When words requiring use of the home, return keys, and the space bar are displayed on the screen, the subject will be able to keyboard these words at a minimum rate of 65 strokes per minute.
2. Lesson 2 Objective--When words requiring use of the home, "e," "n," and return keys and the space bar are displayed on the screen, the subject will be able to keyboard these words at a minimum rate of 65 strokes per minute.

Table 13 reports the results of the criterion performance tests for Field Test A. The mean scores of the gross strokes on all one-minute timed writings were used in determining whether the criterion level was reached. As shown in Table 13, twenty-seven subjects (93 percent) achieved the objective of 65 gross strokes per minute on Lesson 1. In Lesson 2, 26 subjects (90 percent) in Field Test A achieved the criterion level.

Table 13

Mean Gross Stroke Scores on Timed Writings

Field Test A

Subject	Lesson 1 Timed Writings	Lesson 2 Timed Writings	All Timed Writings
1	79	87	83
2	67	49 [a]	58 [a]
3	161	161	161
4	66	43 [a]	54 [a]
5	85	85	85
6	79	84	81
7	67	82	75
8	80	71	75
9	135	147	141
10	76	71	74
11	74	87	81
12	55 [a]	48 [a]	53 [a]
13	62 [a]	75	69
14	67	73	70
15	89	100	94
16	85	74	80
17	79	89	84
18	105	101	103
19	96	110	103
20	76	77	76
21	68	72	70
22	102	104	103
23	99	97	98
24	98	87	94
25	73	72	72
26	70	72	71
27	71	70	70
28	106	120	113
29	81	82	81

[a] Student did not reach criterion level

When the gross strokes mean scores for all timed writings in Lesson 1 and 2 are considered, 26 subjects (90 percent) achieved the objectives and reached the criterion level and three (10 percent) did not. Thus, based on Field Test A subjects' performances, the program met the pre-established criterion level of 90 percent.

As shown in Table 14, which reports the results of the criterion performance tests for Field Test B, twenty-eight subjects (90 percent) achieved the objective of 65 gross words per minute on lessons 1 and 2. Three subjects (10 per cent) did not reach minimum criterion levels. When the scores for all timed writings are analyzed, twenty-eight subjects reached criterion level. Because of the lesson design, these subjects probably could have reached the goal of 65 gross strokes per minute if they had had more time, but they had to rejoin their scheduled classes and could not continue with the microcomputer program. Thus, 90 percent of the subjects in Field Test B reached criterion level; therefore, the program met the pre-established criterion level of 90 percent.

Table 14

Mean Gross Stroke Scores on Timed Writings

Field Test B

Subject	Lesson 1 Timed Writings	Lesson 2 Timed Writings	All Timed Writings
1	57 a	50 a	54 a
2	70	85	78
3	85	90	88
4	87	86	86
5	86	93	89
6	68	73	70
7	39 a	54 a	47 a
8	72	78	75
9	66	72	69
10	86	88	87
11	173	204	189
12	72	76	74
13	70	71	71
14	110	118	115
15	70	69	69
16	113	113	113
17	91	105	98
18	157	155	156
19	150	203	176
20	122	88	110
21	135	141	138
22	129	153	141
23	162	188	179
24	87	88	87
25	74	98	84
26	57 a	61 a	59 a
27	110	107	109
28	82	81	81
29	73	89	84
30	67	77	72
31	152	156	153

[a] Student did not reach criterion level

CHAPTER V

Summary, Conclusions, and Recommendations

Study Summary

The purpose of this study was the systematic development and formative evaluation of a research-based model program for teaching alphabetic keyboarding skills via microcomputer. The study summary is organized around the four research questions guiding the study.

1. What instructional strategies and psychological concepts for teaching typewriting are revealed in the literature? Principles of psychomotor learning in typewriting that were considered appropriate by the researcher for inclusion in this program were identified from the review of literature on psychomotor skill development, typewriting alphabetic keyboarding skill acquisition, and microcomputer instructional technology. From this literature review, forty-two principles appropriate for the early stages of teaching alphabetic keyboarding were identified by the researcher. These principles were written as forty-two instructional specifications and incorporated into a survey instrument for validation by subject-matter experts. The instructional specifications were subdivided on the instrument into seven categories: (a) technique, (b) modeling or demonstration, (c) reinforcement, (d) pacing, (e) appropriateness of practice materials, (f) differentiated practice, and (g) motivation (Robinson & Johnson, 1982). Of the forty-two instructional specifications

rated by the subject-matter experts, nineteen were rated "very important," nineteen were rated "important," and four were rated "little importance."

2. Can these strategies and concepts be incorporated into an instructional program for teaching keyboarding via microcomputer? Personal interviews were then conducted with microcomputer instructional programmers to determine the feasibility of including the instructional specifications in the microcomputer program. Ratings from the programmers indicated that all of the specifications could be programmed on the microcomputer available, Apple II; however, some specifications would be very difficult and, therefore, costly to program. The specifications rated most difficult and costly to program were those requiring moving graphics, animation, and color. Therefore, these specifications were not used in program development. This was a delimiting factor of the study.

The program was developed based on the literature review, subject-matter expert validations, and programmer ratings of the instructional specifications. Of the instructional specifications rated "very important" by the subject-matter experts, (Table 1, page 71) only two were not used in the program. These were a specification of early typing of sentence material and a specification of setting of individual performance goals by the subject. In the judgment of the researcher, these specifications are not essential in the early stages of the program but should be incorporated in later lessons.

Of the specifications rated "important" by the subject-matter experts, five were not used (see Table 2, page 74). Two of these specifications required the use of moving graphics. Because of the cost and difficulty of programming these specifications, they were not included in this program. Other specifications rated "important" included pacing the subjects by having them set individual practice goals and the presentation of error analysis to the subjects. These specifications were also thought to be unnecessary in lessons 1 and 2 but should be included in later lessons. The final specification involved the use of external oral pacing during new key presentations. The program as developed did not include any taped or instructor pacing.

Four items were rated "little importance": (a) sounds and tones used for reinforcement are pleasant, (b) the program makes creative use of color, (c) the program makes creative use of humor, (d) the program makes creative use of animation. It is interesting to note that two of these specifications, the use of color and animation, were rated "little importance" by the subject-matter experts and also very costly and difficult to program according to ratings of the programmers. Also no effort was made to build humor into the program. The other specification that was rated unimportant, sounds and tones used for reinforcement are pleasant, was used in program development. Sounds were used as one method of reinforcement in the program.

Instructional objectives and criterion performance tests were written. A minimum criterion performance level of 65 strokes per minute on one-minute timed writings was specified.

The model program was presented in two lessons and provided instruction on keyboarding the home, the "e," the "n," and the return keys and the space bar. Each lesson included the following phases: (a) learn the location of the new keys, (b) practice keyboarding the keys, (c) build speed on practice drills, (d) increase skill through supplemental practice, and (e) measure progress with one-minute timed writings. A flow chart and a storyboard that specified the program visuals and script for each frame were developed. The program was written in BASIC and coded for the Apple II microcomputer.

3. Can the program be improved through the process of formative evaluation? A formative evaluation design was used in program tryout and revision. Sixty-six community college nontypists participated in program tryouts. Two sources of background information were collected for each subject: demographic data and keyboarding aptitude data.

Program tryout and revision consisted of three cycles: initial developmental testing, Field Test A, and Field Test B. Performance data from the initial developmental testing cycles indicated that all subjects surpassed the criterion performance goal of 65 strokes per minute on one-minute timed writings. Additional diagnostic and revision data that were analyzed for each subject included time required to complete the program, researcher's technique ratings, subjects' interviews, and researcher's observations. Based on these data, fourteen problems that needed to be corrected were identified. Corrections were made prior to field testing.

Field Test A included twenty-nine subjects. Their mean performance scores exceeded the performance goal of 65 gross strokes per minute. They achieved a group mean of 85 gross strokes and 77 correct strokes. The mean time required to complete lesson 1 was 42 minutes, and the mean time required to complete lesson 2 was 50 minutes. The overall mean technique rating of 3.58 on a four-point scale indicated to the researcher that the keyboarding techniques of subjects in Field Test A were satisfactory. Diagnostic and revision data analysis from subjects' interviews and researcher's observations revealed eight problems requiring correction. The corrections were made and a second field test was conducted.

Field Test B included thirty-one subjects. Their mean performance scores also exceeded the performance goal of 65 strokes per minute. They achieved a group mean of 100 gross strokes and 90 correct strokes. The mean time to complete lessons 1 and 2 was 39 minutes each. The program revisions made after Field Test A enabled subjects in Field Test B to complete the tryout more efficiently as evidenced by the reduction of four minutes in mean time for completion of lesson 1 and the reduction of six minutes in mean time for completion of lesson 2. No technique problems were identified during Field Test B. Overall mean technique ratings of 3.58 and 3.63 on a four-point scale were found in Field Test A and B, respectively.

Diagnostic data analysis from the subjects' interview results and researcher observations did not reveal problems that would warrant an additional revision and field test.

Pearson product moment correlations were computed between the Kinesthesis-Sensitivity Test and the criterion performance test gross strokes and correct strokes for Field Test A and B. Significant correlations ($p < .01$) were found between the measures on gross and correct strokes for both field test groups.

Comparisons were made between criterion performance test scores of subjects in Field Test A and B to see if the revisions made to the program after Field Test A made a significant improvement in performance scores of Field Test B subjects. An analysis of covariance was computed with Kinesthesis-Sensitivity Test scores as a covariant to control for initial aptitude differences. Field Test B subjects scored slightly higher on gross strokes (Group A M = 91, Group B M = 94) and correct strokes (Group A M = 83, Group B M = 86).

4. Upon completion of the program tryout, was the established criterion level reached? The established criterion level of 90/100 indicated that 90 percent of the subjects would reach 100 percent of the objectives for the lesson. Subject scores on the one-minute timed writings (criterion performance tests) in each lesson were analyzed to determine if the criterion level was reached. Ninety percent (n = 26) of the subjects in Field Test A achieved the

objectives and reached criterion level, and ninety percent ($\underline{n}$ = 28) of the subjects in Field Test B also reached criterion level.

Conclusions

Based on the findings of the study, these conclusions were drawn.

<u>What instructional strategies and psychological concepts for teaching typewriting are revealed in the literature?</u>

<u>Conclusion</u>. There are a number of psychomotor learning principles and learning strategies in the related literature that have implications for microcomputer keyboarding program design. These can be identified and validated for use in teaching keyboarding skills via microcomputer.

<u>Can these strategies and concepts be incorporated into an instructional program for teaching keyboarding via microcomputer?</u>

<u>Conclusion</u>. Given the state of microcomputer technology, all instructional specifications identified in this study could be programmed; however, budgetary restraints and time involved in development prevented the inclusion of specifications that involved moving graphics, animation, and color.

<u>Can the program be improved through the process of formative evaluation?</u>

<u>Conclusion</u>. The use of a systematic instructional design model facilitated the development of the program. The program was improved

as a result of formative evaluation based on diagnostic data analysis. After the initial developmental testing, fourteen problems that needed to be corrected were identified. After Field Test A, eight problems were identified; however, no problems were identified after Field Test B.

Conclusion. After the Field Test A revisions were made, the mean time to complete lesson 1 was reduced from 42 to 39 minutes and mean time for lesson 2 from 50 to 39 minutes. The greater reduction in time to complete lesson 2 was attributed to the extensive revisions made in lesson 2.

Conclusion. Significant positive correlations were found between the Kinesthesis-Sensitivity Test and criterion performance test scores for both gross and correct strokes. Therefore, the Kinesthesis- Sensitivity Test may be considered a valid predictor of gross and correct strokes in skill acquisition on microcomputers.

Upon completion of the program tryout, was the established criterion level reached?

Conclusion. Keyboarding programs designed with proper recycling procedures should enable all subjects with minimum initial aptitude to reach criterion level if adequate time is provided. Ninety percent of the subjects in Field Test A and ninety percent of the subjects in Field Test B reached criterion level for the program.

Conclusion. Based on data analyzed from subject performance, time to complete the program, subject interview data, and researcher observation, the microcomputer is an effective medium for teaching initial keyboarding skills.

Recommendations

Based on the findings of this research, the following recommendations are made.

1. Prior to instructional program development, related literature and research studies should be surveyed to determine appropriate content and methods for instruction. Subject-matter expert input should be included in the instructional program development process, and program developers should set criterion performance goals for the program prior to development and tryout.
2. A formative evaluation design model should be used for instructional program development.
3. A validated aptitude test or achievement test should be given to subjects prior to program tryout in order to determine their prior knowledge or psychomotor skill level.
4. Several sources of data for program diagnosis and revision should be analyzed. Suggested sources may include data from subject performance on criterion tests, time to complete the program, subject interviews, and researcher observations.
5. Initial developmental testing is important to the formative evaluation process. Field tests should not be conducted until problems with the program have been identified and corrected. Field

tests should be conducted in a setting closely related to the setting for which the program is designed.

6. Teachers of typewriting or keyboarding should consider microcomputer-based instruction as a teaching method.

7. The completed program should be compared with the traditional approach in teaching typewriting or keyboarding using these major dependent variables: student performance level, time to reach criterion level, and subject interest and motivation.

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APPENDICES

Appendix A

Criterion Performance Tests

Lesson 1

Timing 1

ADD A SAD SALAD; ASK A SAD LAD; ALL DADS FALL; A LASS ASKS A DAD; ADD A FAD FLAK; ADD A FAD FLASK; A SAD LASS FALLS; A DAD ASKS ALL SAD ADS; ALL LADS ADD AS FLASKS

Timing 2

A SAD DAD ASKS A LASS; ADD A SALAD; FADS ADD A FLASK; ASK A SAD LAD; ADD AS FLAK; ALL SAD DADS ADD FLASKS; A SAD LASS ASKS A FAD; A LASS ADDS A SAD SALAD; AS A SAD

Timing 3

DAD ASKS ALL SAD LADS; A LASS ASKS A LAD; ASK A SAD LASS; ADD FADS; ALL DADS ADD A SAD FLASK; ALL LADS FALL ALAS; ADD FAD SALADS; A LAD ASKS DAD; ASK A LASS ALAS; A LAD; AS ALL DADS ADD A SALAD; ADD FADS

Timing 4

A FLASK FALLS; A LASS ADDS A SAD SALAD; A SAD LAD ASKS A FAD; DADS ADD A FLASK; AS A LAD ADDS A SAD SALAD; A SAD LAD ADDS A FAD; ALL DADS FALL; A SAD FLASK FALLS; A FAD FALLS; AS A LAD ASKS; ALL DADS FALL;

Lesson 2

Timing 1

FAKE JADE AND SNAKES; AS SAD SAND LANDS; ALL SANDALS AND FANS; A LAKE FADES; JADE SANDAL; SEALED LAND LEASE; ALL SAD FADED JEANS; AS A FAN SEED SALE; LEND A DESK A LEASE; AS A SEAL FLED; FEED A JADE SNAKE JADE SANDALS AND JEANS; LEND LEASED LAND

Timing 2

JADE SANDALS AND JEANS; LEND LEASED LAND SALE SAND FELL LAND FLED; A FANNED LAND; A SAFE FADED ELF; A SALE FELL AND LANDED A SEEDED LAKE; A JADED LAND FADED; FEEDS AND SEES A SALE; SANDS AND LANDS LANDED; ALAS; A SAD LASS LANDED A JADED FAN;

Timing 3

ALAS; A SAD LASS LANDED A JADED FAN; ALL DADS ASK A LAND LEASE; AND ALL LADS LEND FADED JEANS AND SANDALS; A SAD LAD FALLS AS A SEALED SAFE SELLS; A SAD ELF ASKS A FAKE SNAKE; AND A FADED SADDLE LENDS ALL A SAFE DAD FALLS; A FLAK ADDS A SEED AN SAND

Timing 4

A SAFE DAD FALLS; A FLAK ADDS A SEED AND FEED SALE; AS A FLASK ADDS; AS ALL LADS; FEED A SEAL; ALL SAND DELLS LEAK A FLAK; A LAKE ENDS A LAND LEASE; ADD SAD SADDLE FASES; A FAN FELL AS AN ELF FLED; AND AS

Appendix B

Demographic Questionnaire

NAME: ______________________________ SOCIAL SECURITY NUMBER: ________

Have you had prior typewriting instruction? YES NO

Sex: M F

Age

under 18 ______________

18 - 20 ______________

21 - 30 ______________

31 - 45 ______________

over 45 ______________

Appendix C

Subject-Matter Experts Survey

SPECIFICATIONS FOR TEACHING KEYBOARDING VIA MICROCOMPUTER

Instructions

Based on your judgment and experience, please rate the importance of each of these items for inclusion in an instructional program designed for teaching alphabetic keyboarding via microcomputer.

CIRCLE THE ANSWER THAT BEST RELECTS YOUR JUDGMENT

ITEM	RATING
	Very Important 4
	Important 3
	Little Importance 2
	Unimportant 1

TECHNIQUE

1. Correct posture is explained.	1	2	3	4
2. Correct wrist and arm position are explained.	1	2	3	4
3. Correct finger positions are explained.	1	2	3	4
4. Correct fingers to be used in making the strokes are explained.	1	2	3	4

MODELING

5. Correct keyboarding techniques are illustrated through simulated demonstrations.	1	2	3	4
6. Reaches to new keys are illustrated through simulated demonstrations.	1	2	3	4

REINFORCEMENT

7. During new key presentations and practice drills, immediate feedback as to the correctness of the stroke is given at the time the key is depressed.	1	2	3	4

Page 2

ITEM	Rating
8. During new key presentations and practice drills, opportunity is given for typing the correct response immediately after an incorrect key is depressed.	1 2 3 4
9. During new key presentations and practice drill, students may use visual references to locate new keys on the keyboard.	1 2 3 4
10. During new key presentations and practice drill, verbal cues (vocalization) such as the pronouncing of letters by the learner are explained and encouraged.	1 2 3 4
11. Positive and non-threatening feedback is provided.	1 2 3 4
12. Reward or praise is given for correct responses or superior performance.	1 2 3 4
13. Descriptive or quantitative feedback such as words or strokes per minute is given when feasible.	1 2 3 4
14. Error anlysis is given when feasible.	1 2 3 4
15. Sounds and tones used for reinforcement are pleasant.	1 2 3 4
PACING	
16. Early emphasis is on speed of motions not on accuracy of product.	1 2 3 4
17. Pacing or speed is provided to develop optimal speed.	1 2 3 4
18. Pacing or speed forcing is provided to force proper stroking techniques.	1 2 3 4

Page 3

ITEM	RATING
19. Pacing or speed forcing is provided to decrease dependence on sight typing.	1 2 3 4
20. External oral pacing is used during new key presentations.	1 2 3 4
21. Continuous pacing is provided by the computer on drill-practice materials.	1 2 3 4
22. Pacing is accomplished through having each student set individual practice goals and then strive to reach them.	1 2 3 4
APPROPRIATENESS OF PRACTICE MATERIALS	
23. Speed and accuracy are emphasized separately.	1 2 3 4
24. The keyboard is presented in an order that allows for early typing of ordinary prose.	1 2 3 4
25. Drill/practice materials consist of ordinary prose.	1 2 3 4
26. Drill/practice materials are extensive, covering a wide vocabulary.	1 2 3 4
27. Early typing of sentence material is required.	1 2 3 4
DIFFERENTIATED PRACTICE	
28. The student controls the learning situation.	1 2 3 4
29. The student has the option of selecting learning activities.	1 2 3 4
30. The student has the option of exiting from an activity once the individual goals have been reached.	1 2 3 4
31. The program adapts to the learner by adjusting the difficulty level of content.	1 2 3 4

ITEM	RATING
32. The student selects appropriate drill/practice material.	1 2 3 4
33. Individual performance goals may be set by the student.	1 2 3 4
34. Practice activities may be repeated at the option of the student.	1 2 3 4
MOTIVATION	
35. A feeling of success is created when goals are reached.	1 2 3 4
36. The program is user friendly.	1 2 3 4
37. Where feasible, the program is multisensory.	1 2 3 4
38. The program is fun to use.	1 2 3 4
The program makes creative use of	
39. color.	1 2 3 4
40. graphics.	1 2 3 4
41. animation.	1 2 3 4
42. humor.	1 2 3 4

In the space below, list any additional items or comments.

____

____

____

____

Appendix D

Names and Addresses of Subject-Matter Experts

Dr. Don Campbell
University of Alabama
University, AL 35486

Dr. Gary McLean
420 Vocational Technical Building
1954 Buford Avenue
St. Paul, MN 55108

Dr. Norma Olson
4510 West 65 Street
Shawnee Mission, KA 66208

Dr. Willie O. Pike
Southern Illinois University - Edwardsville
Box 107
Edwardsville, IL 62025

Dr. Walter Shell
Vocational Technical Division
Virginia Tech
Blacksburg, VA 24061

Appendix E

Letter of Introduction to Subject-matter Experts

October 26, 1982

Dear :

As a part of a research project at Virginia Polytechnic Institute and State University, a model program for teaching alphabetic keyboarding via microcomputer is being developed. This program will be based on research and theories in the psychology of psychomotor skill development, principles of typewriting skill acquisition, and microcomputer-based instructional technology.

From the review of the research, a list of specifications that seem appropriate for inclusion in this model program has been developed. As a part of the validation procedure for this research, you and four other subject matter experts are being requested to provide further input into this list of specifications.

I would appreciate your completing the instrument that is enclosed. Your input will be extremely helpful in conducting this research. Please return the instrument in the enclosed envelope by November 5, 1982.

Sincerely yours,

Jo Ann Sherron

Enclosures

Appendix F

Apple Microcomputer Specialists Interview Guide

APPLE II MICROCOMPUTER SPECIFICATIONS

In order to determine the feasibility and practicality of including certain specifications in a program for teaching keyboarding via an Apple II microcomputer, please rate the following items on the scales provided. Scale A concerns computer capability. If marked no, disregard scales B and C and move to the next item.

ITEM	SCALES
1. Correct techniques; ie., posture, wrist and arm position, finger position, can be demonstrated by graphic illustration.	A. Computer Capable ______yes______no B. 1 2 3 4 5 Low (COST) High C. 1 2 3 4 5 Easy (PROGRAMMING DIFFICULTY) Difficult
2. Keyboarding techniques can be demonstrated by moving graphic designs.	A. Computer Capable ______yes______no B. 1 2 3 4 5 Low (COST) High 1 2 3 4 5 C. Easy (PROGRAMMING DIFFICULTY) Difficult
3. Reaches to new keys can be demonstrated by a graphic design showing the finger movement.	A. Computer Capable ______yes______no B. 1 2 3 4 5 Low (COST) High C. 1 2 3 4 5 Easy (PROGRAMMING DIFFICULTY) Difficult
4. Parts of the keyboard can be highlighted with flashing signals.	A. Computer Capable ______yes______no B. 1 2 3 4 5 Low (COST) High C. 1 2 3 4 5 Easy (PROGRAMMING DIFFICULTY) Difficult
5. Parts of the keyboard can be highlighted with color intensity.	A. Computer Capable ______yes______no B. 1 2 3 4 5 Low (COST) High C. 1 2 3 4 5 Easy (PROGRAMMING DIFFICULTY) Difficult

ITEM		SCALES
6. Feedback can be given at the time a key is depressed by having the keyboard lock.	A.	Computer Capable ______yes______no
	B.	1 2 3 4 5 Low (COST) High
	C.	1 2 3 4 5 Easy (PROGRAMMING DIFFICULTY) Difficult
7. Feedback can be given at the time an incorrect key is depressed by a sound or tone.	A.	Computer Capable ______yes______no
	B.	1 2 3 4 5 Low (COST) High
	C.	1 2 3 4 5 Easy (PROGRAMMING DIFFICULTY) Difficult
8. After an incorrect key is depressed the program resumes in proper sequence when the correct key is depressed.	A.	Computer Capable ______yes______no
	B.	1 2 3 4 5 Low (COST) High
	C.	1 2 3 4 5 Easy (PROGRAMMING DIFFICULTY) Difficult
9. Different sounds or tones may be used to differentiate between correct and incorrect strokes.	A.	Computer Capable ______yes______no
	B.	1 2 3 4 5 Low (COST) High
	C.	1 2 3 4 5 Easy (PROGRAMMING DIFFICULTY) Difficult
10. Strokes per minute can be computed.	A.	Computer Capable ______yes______no
	B.	1 2 3 4 5 Low (COST) High
	C.	1 2 3 4 5 Easy (PROGRAMMING DIFFICULTY) Difficult
11. Words per minute can be computed.	A.	Computer Capable ______yes______no
	B.	1 2 3 4 5 Low (COST) High
	C.	1 2 3 4 5 Easy (PROGRAMMING DIFFICULTY) Difficult
12. Incorrect strokes can be indicated and analyzed.	A.	Computer Capable ______yes______no
	B.	1 2 3 4 5 Low (COST) High
	C.	1 2 3 4 5 Easy (PROGRAMMING DIFFICULTY) Difficult
13. Response latency; ie., the time between the screen stimulus and the keyboard response can be computed.	A.	Computer Capable ______yes______no
	B.	1 2 3 4 5 Low (COST) High
	C.	1 2 3 4 5 Easy (PROGRAMMING DIFFICULTY) Difficult

ITEM		SCALES
14. Drills can be timed by the computer, ie., 1 minute.	A.	Computer Capable ______yes______no
	B.	1 2 3 4 5 Low (COST) High
	C.	1 2 3 4 5 Easy (PROGRAMMING DIFFICULTY) Difficult
15. Practice materials can be prescribed by the computer based on computer analysis of keyboarding drills.	A.	Computer Capable ______yes______no
	B.	1 2 3 4 5 Low (COST) High
	C.	1 2 3 4 5 Easy (PROGRAMMING DIFFICULTY) Difficult
16. Feedback, praise or reward can be given based on computer analysis and performance.	A.	Computer Capable ______yes______no
	B.	1 2 3 4 5 Low (COST) High
	C.	1 2 3 4 5 Easy (PROGRAMMING DIFFICULTY) Difficult
17. The computer can pace drills in order to force speed development.	A.	Computer Capable ______yes______no
	B.	1 2 3 4 5 Low (COST) High
	C.	1 2 3 4 5 Easy (PROGRAMMING DIFFICULTY) Difficult
18. Animated characters can be programmed.	A.	Computer Capable ______yes______no
	B.	1 2 3 4 5 Low (COST) High
	C.	1 2 3 4 5 Easy (PROGRAMMING DIFFICULTY) Difficult
19. Individual student records can be computed and recorded by the computer.	A.	Computer Capable ______yes______no
	B.	1 2 3 4 5 Low (COST) High
	C.	1 2 3 4 5 Easy (PROGRAMMING DIFFICULTY) Difficult
20. The program can be developed in color.	A.	Computer Capable ______yes______no
	B.	1 2 3 4 5 Low (COST) High
	C.	1 2 3 4 5 Easy (PROGRAMMING DIFFICULTY) Difficult
21. The computer records each student's progress and places them in the program in proper sequence.	A.	Computer Capable ______yes______no
	B.	1 2 3 4 5 Low (COST) High
	C.	1 2 3 4 5 Easy (PROGRAMMING DIFFICULTY) Difficult

Appendix G

Names and Addresses of Apple Microcomputer Specialists

Dr. John Ambrose
J. Sargeant Reynolds Community College
P. O. Box 12084
Richmond, VA 23214

Dr. Marc A. Rozner
Systems Analysis and Programming
1506 Confederate Avenue
Richmond, VA 23227

Mr. Bryant Rudolph
First Step Computers
Stratford Hills Shopping Center
Richmond, VA 23220

Mr. Louis Terrell
Custom Programming
Route 1, Box 71K
Woodford, VA 22580

Appendix H

Subjects' Interview Questionnaire

NAME

LESSON ONE

START TIME_____STOP TIME_____

LESSON TWO

START TIME_____STOP TIME_____

1. What did you like about the program?
2. Was there anything that you disliked?
3. Did you find the program interesting or boring?
4. Was the program too easy or too difficult?
5. Were there any parts that were unclear or caused you trouble?
6. Do you have any suggestions for changes or revisions?
7. Would you like to learn to type by this method?

Appendix I

Technique Rating Sheet

NAME________________________

RATINGS

EXCELLENT	4 Points
GOOD	3 Points
AVERAGE	2 Points
ACCEPTABLE	1 Point
UNACCEPTABLE	0 Points

POSITION AT COMPUTER	RATING
1. Sits in a comfortable, relaxed position directly in front of computer.	______
2. Keeps feet on floor for proper body balance.	______
3. Keeps elbows in relaxed, natural position at sides of body to provide correct hand position.	______
4. Keeps wrists low and relaxed, but off frame of computer.	______
5. Keeps fingers well curved, upright, and in typing position.	______
Point average	______

KEYSTROKING	
1. Keeps fingers curved and upright over home keys.	______
2. Makes quick, snappy strokes with immediate key release.	______
3. Maintains uniform keystroking action (force).	______
4. Keeps hands and arms quiet, wrists low.	______
5. Strikes each key with proper controlling finger.	______
Point average	______

SPACE BAR	
1. Keeps the right thumb curved-on or close to space bar.	______
2. Strikes space bar with a quick, down-and-in (toward the palm) motion of right thumb.	______
3. Releases space bar instantly.	______
4. Does not pause before or after spacing stroke.	______
Point average	______

RETURN KEY

1. Returns quickly at ends of lines. ______
2. Keeps eyes on copy during and following return. ______
3. Starts new line without break or pause. ______

Point average ______

TOTAL AVERAGE ______

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