A Comparison of Computer-Assisted Instruction and Traditional Instruction in Braille Transcription

Susan Kay Vlahas Ponchillia

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A COMPARISON OF COMPUTER-ASSISTED INSTRUCTION AND TRADITIONAL INSTRUCTION IN BRAILLE TRANSCRIPTION

by

Susan Kay Vlahas Ponchillia

A Dissertation
Submitted to the
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A COMPARISON OF COMPUTER-ASSISTED INSTRUCTION AND TRADITIONAL INSTRUCTION IN BRAILLE TRANSCRIPTION

Susan Kay Vlahas Ponchillia, Ed.D.
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The purpose of this study was to compare the teaching effectiveness of computer-assisted instruction (CAI) with the effectiveness of traditional instruction of braille transcription for sighted persons. Since the traditional method (TM) of teaching and learning braille transcription requires a great deal of time for both instructor and student, it was hoped that computer-assisted instruction would be as efficacious as the traditional method while shortening time requirements for instructor and student. A review of the literature revealed that computer-assisted instruction has been successfully used in teaching many subjects including languages, providing immediate feedback and reducing learning time. In studies where CAI was found less effective than traditional methods, it is hypothesized that the use of more than one measure of student achievement may provide more accurate comparisons of CAI vs. TM.

Three research hypotheses were based on the assumption that using computer-assisted instruction for learning braille transcription would lead to the same or better achievement of braille skills and involves less time expenditure for both student and instructor. Twenty-seven sighted university students volunteered to take a 6-lesson braille transcription course. The subjects were randomly assigned to either
the computer-assisted or traditional method of instruction. The students in the CAI group used The Braille Training Program (Ponchillia & Holladay, 1983) with a microcomputer to learn braille transcription while subjects in the TM group were given parallel instruction via lecture/textbook format.

Data were collected on: (1) student achievement as measured by number of errors on braille transcription tests, (2) the time it took students to complete the course as measured by self-reports, and (3) the time it took the instructor to conduct the course(s).

The results showed no significant difference in the achievement of either group, while amount of time required of both student and instructor using CAI was greatly reduced, thus supporting the literature.
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DEDICATION

To Paul and my family,
I have been blessed with your total support
and understanding.
ACKNOWLEDGEMENTS

This dissertation is the culmination of numerous activities, all of which have contributed to my professional growth. I have never worked so hard nor learned so much. However, my growth and successful attempt at conducting research would not have been possible without the support and assistance of many people.

My special thanks go to my chair, Dr. Elizabeth Patterson, who inspired me, corrected me, and improved me. I appreciate her commitment. I don't think anyone else took my dissertation camping! I am also very grateful for the assistance provided by each of my committee members, Dr. Alonzo Hannaford, Dr. Abraham Nicolaou, and Dr. Howard Poole. I received support and encouragement freely from each.

The WMU Department of Special Education has a progressive, knowledgeable faculty. The emphasis on computers and other new technology was especially helpful to me, and I commend Dr. Eisenbach for encouraging student use of computers.

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Susan Kay Vlahas Ponchillia
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CHAPTER I

INTRODUCTION

Background

History of Braille Transcription

Braille is a system of embossed dots used as a reading and writing system for blind persons, which was accepted as the uniform type for blind Americans in the early 1900's (Irwin, 1955; Lowenfeld, 1973; Zahl, 1950). Adoption of the present form of braille, known as Standard English Braille, occurred only after much debate regarding the arrangement of the dots used and whether words should be fully spelled out or a system of contractions utilized. Finally, in 1932, Louis Braille's alphabet and Grade Two (Standard English Braille) prevailed (Lowenfeld, 1973). Thus, most books embossed for blind persons in this country today are in Grade Two Braille, which is comprised of the 26 letters of the alphabet and 189 contractions (See Appendix A, Grade Two Braille Sheet). Once a generally uniform system for braille was established, it then became necessary to train individuals in that system so that books and other materials could be prepared.

The first organized training program for hand transcribers of braille was begun after World War I. The American Red Cross instituted a service of training volunteers to transcribe reading matter into braille for the war blinded. This service was later extended and administered jointly by the American Red Cross and the Library of
The Library of Congress acted as a clearinghouse and information center, providing a correspondence course for the sighted volunteers, and producing a manual for transcribing, as well as for proofreading. The Red Cross enlisted volunteers from its chapters throughout the country to transcribe books (Zahl, 1950). This service grew until World War II when the American Red Cross felt unable to continue their part in the program. The Library of Congress continued in its role as a clearinghouse both for braille books and for the transcription program and assumed the training responsibilities formerly administered by the Red Cross.

Today, free correspondence courses leading to certification in braille transcribing (literary, music, and math braille) and braille proofreading are offered through the Library of Congress. Most individuals who become trained as braille transcribers by the Library of Congress are primarily nonprofessionals interested in volunteering their services to blind persons in school or community (Dorf, Note 1). Thousands of volunteers throughout the United States produce books for libraries and individual readers who use adapted books (Facts: Books for Blind and Physically Handicapped Individuals, 1981). During the fiscal year 1980, over 400 volunteers became braillists, braille proofreaders or tape narrators through the National Library Service for the Blind and Physically Handicapped, at the Library of Congress in Washington, D.C. (Facts, 1981).

In addition to the people trained through the Library of Congress Braille Transcription Program, there is another group of transcribers...
comprised primarily of professionals who learn braille transcription in a university setting. This group includes teachers of visually impaired children, rehabilitation teachers of blind adults, and others who wish to pursue a career in working with blind children or adults. These persons usually receive their braille training from the university program in which they are enrolled. Today, it is estimated that each year, approximately 300 persons receive their instruction in braille transcription in U.S. universities.

Change in Emphasis on Braille Usage

In the past, braille has been one of the core classes in curricula for teachers of the visually impaired and has always been considered to be the most important skill that blind children must learn. Knowledge of braille was also considered necessary for low-vision children because of the belief that remaining vision may be lost and braille would inevitably be needed in later life.

While the American Printing House for the Blind reported that there were approximately 41,000 visually handicapped children in U.S. schools during the 1983-84 school year (APH Annual Report, 1983), the American Foundation for the Blind reported that only about 4% of those children are severely visually impaired (Facts About Blindness, 1980). Only 30% of those severely impaired youngsters actually learn and use braille. Scott (1982) noted that braille is not used as extensively as in previous years. There are two reasons for this. The first is the smaller number of totally blind children in the visually handicapped population, and
the second is the availability of new technology which allows other
means of reading or receiving information such as the Kurzweil Reading
Machine and compressed speech tape recordings. There is also a growing
tendency of educators to avoid teaching tactual means of reading to low-
vision (partially sighted) readers if they are able to use magnification
or other special techniques to read print.

This means that while teachers intending to work with the visually
impaired master the braille code, they may or may not use this skill
depending upon the visual ability of their students. University
educators are therefore concerned, because it appears that an inordinate
amount of time must be spent teaching a very precise skill to teachers
who may use it for only a very small number of students.

Problems with Teaching and Learning Braille Transcription

Time Factor

Whether in a college program or a correspondence program, teaching
and learning braille is time consuming for both instructors and students.
Most college and university teacher training programs provide 1-3 credit
hours of instruction in Grade Two Braille transcription (Spungin, 1981)
calling for approximately 30-60 hours of lecture/instruction time.
Many more hours are also required to correct each student's assignments.

The Library of Congress braille transcription correspondence
program is estimated to last from 8 months to 1 year. While
there are no figures on total number of hours spent by teachers or
students in teaching or learning Grade Two Braille via correspondence,
it too is a time consuming process. Additional time is also needed because each lesson must be sent to the Library of Congress for evaluation and results mailed back to the student.

Whether in a correspondence or university learning situation, production of braille is a time-consuming process. Production entails punching dots with either a slate and stylus or a braille typewriter, commonly known as a Perkins Braillewriter. The slate is a hinged metal or plastic template with holes through which one can emboss dots with the stylus. Most slates allow the braillist to produce four lines of braille 28 characters wide. One may produce a complete page of braille by using the available spaces on the slate, then moving the slate down to the page to produce the next four lines of braille. It is possible to emboss approximately 25 lines of braille per page. The Perkins Brailler allows a similar amount of braille per page. The Perkins Brailler is somewhat similar to a typewriter with the exception that from one through six keys are pressed in unison to produce the braille. Braille errors, whether produced by the slate method or the brailler, are not easily corrected by the braillist once produced. One may "erase" dots by smoothing them down in order to rebraille a corrected form, but it is not possible to insert extra characters due to the finite number of spaces available on a page of braille. In most cases, one must begin anew if mistakes are made; thus, much time may be spent rebrailling assignments.
Instructor time

The evaluation of student assignments is a particularly tedious task for the braille instructor which entails careful proofreading; the proofreader may spend up to an hour per student in correcting each assignment. Therefore, in a typical university class with 10 braille transcription students, an instructor could possibly spend from 150 to 200 hours per semester correcting assignments. This would be in addition to the time spent lecturing.

Delay of Feedback and Error Rate of Correction

Delay of feedback to transcriptionists on their performance is a problem in learning braille. In general, research shows that the more immediate the feedback is, the more helpful it is as a learning reinforcement (Van Houten, 1980). Researchers (Leach & Graves, 1973; Trapp, Milner, Joseph, & Cooper, 1978) have all reported studies which show the value of providing students with immediate feedback on their performance in acquisition of new skills. Because proofreading requires a great deal of time, a time lag frequently occurs between a student's transcription of a lesson and the subsequent feedback from the instructor/proofreader. In a university transcription course, the usual minimum time lapse between submitting the assignment and return of the corrected papers is from one class period to the next; this could range from 1 to 7 days. A student in a braille correspondence course who submits assignments directly to the Library of Congress may find the time lapse to be from 2 to 6 weeks (Dorf, Note 1). Another
problem in proofreading is the error rate of the person correcting braille assignments. Proofreading requires the careful observation of dot position(s), the appropriate use of short-form abbreviations and contractions, spacing, and application of braille rules. Although statistics are not available on error rates of proofreaders, a conservative estimate (Dorf, Note 1) would be approximately 10% per assignment. This means that a person who proofreads braille assignments does not identify one out of ten braille errors which the student made.

Application of Computer-Assisted Instruction to Braille Transcription

Computer-Assisted Instruction (CAI) is a recently developed teaching technology which may be able to reduce excessive instructional and learner time in teaching and learning braille transcription, delay of feedback, reduced correction error rate. CAI was defined by Taylor (1974) as "the use of the computer for direct instruction of students" (p. 3). Thomas (1977) described five types of CAI:

1. drill - in which the student responds in a rather quick fashion to brief items or questions under a sort of "flash card" format;

2. practice - in which the student answers more complex questions which may require some off-line computation or the completion of multiple steps in the problem solution;

3. tutorial programs - which resemble programmed instructional texts in that paragraph material, interspersed questions, and response-sensitive branching are present;

4. simulations - which model phenomena of a complex nature and in which random events typically are introduced; and

5. problem-solving programs - which eliminate complex calculations to foster student understanding of principles and rules (p. 104).
The use of microcomputers for braille transcription, based on concepts of CAI tutorial and practice, may reduce the amount of time needed by students to learn Grade Two Braille. CAI may also reduce the time and effort needed by the instructor because students can receive tutorial instruction via computer. Students can make use of the ability of a computer to present and evaluate practice problems, relieving the instructor of the necessity of tedious braille proofreading. CAI can also provide the student with almost instantaneous feedback on braille equality, which could increase achievement. A microcomputer can be programmed to display print sentences and wait for the user to input the braille equivalents. Print and braille sentences can then be exactly compared within seconds, providing the student with 100% accurate and immediate feedback.

The use of computer-assisted instruction in braille transcription could benefit potential braille transcribers whether students in university programs for special education and/or rehabilitation, or volunteer transcribers wishing to learn braille in their own community. The focus of the present study will be on the use of CAI in braille transcription in a university teacher training program.

Statement of the Problem and Research Questions

Because computer-assisted instruction appears to offer solutions for the problems often inherent in a braille transcription program, the purpose of the study is to compare the teaching effectiveness of computer-assisted instruction with the effectiveness of traditional braille instruction.
Three research questions of this study are:

1. Is there a significant difference in achievement of students learning braille transcription with computer-assisted instruction when compared to students learning braille transcription through the traditional method?

2. Is there a significant difference in amount of time spent by computer-assisted instruction students when compared to traditional method students learning braille transcription?

3. Is there a significant difference in amount of time expended by the instructor working with students using a computer-assisted instruction braille transcription program when compared to instruction of a braille transcription course taught by the traditional method?

Significance of the Study

The traditional method of teaching and learning braille transcription requires a great deal of instructor and student time, often has a delay of feedback to the learner, and contains a high error rate in correction of assignments. All of these factors affect student achievement. In order to eliminate such factors, it is important to research modern technological teaching methods such as computer-assisted instruction.

If it can be found that the use of computers to teach braille transcription is equal to or better than the traditional method, it would be possible to train a greater number of skilled brailists under improved teaching conditions for both instructors and students. Many schools as well as individuals own microcomputers on which braille
transcription software is available. It may be possible for transcribers to learn braille skills solely through use of a microcomputer. If CAI is found to take less time than normally required, it would allow university instructors and students to spend less time learning important braille skills. In addition, if the rate of feedback can be improved, and detection of mistakes improved, this may result in better qualified braillists. All of these teaching improvements would greatly benefit the training of future transcriptionists. More people are apt to complete training sooner and would be more accurate.

Summary

While a diminishing number of visually handicapped persons must use braille today, it is an important skill that must be acquired by all teachers of visually handicapped children so that they are prepared to teach and transcribe accurate braille when necessary. Learning braille in a traditional way requires a great deal of time by both braille instructor and student and there are problems with correction and feedback on student assignments. Computer-assisted instruction appears to offer a vehicle for solving some of these problems and could be especially useful in providing the accuracy and immediate feedback to learners. This study will be of the potential usefulness of CAI for learning braille transcription, as compared to traditional methods of instruction.
CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

This chapter is divided into five sections. The first provides a review of information related to traditional braille instruction, while the second section describes the current applications of computers in the field of blindness. The third section provides an introduction to computer-assisted instruction (CAI) and a brief description of its development. Section four describes the effectiveness of computer-assisted instruction in comparison to traditional methods of instruction. Finally, section five describes the effectiveness of computer-assisted instruction in the learning of a foreign language, a skill similar to learning braille.

Traditional Methods of Teaching Braille to Sighted Persons

Traditional methods (TM) of instruction in braille for sighted persons have changed little in the past three decades. Two basic methods are utilized: self-instructional methods using a programmed instruction text, and teacher-led instruction in which the instructor lectures and provides students with braille assignments and then corrects the braille assignments. In both methods, either tactual and/or printed-dot texts are used. Tactual texts are those usually designed for tactual braille readers and have embossed dots. Sighted students are
taught to read the embossed dots visually, since tactile reading of braille involves greater practice time and is unnecessary for sighted readers. Printed-dot texts have printed facsimiles of braille cells which are typically easier and cheaper to produce since embossing is not necessary. The student reads the dot patterns visually as if they were embossed.

One of the leading self-instructional texts, Programmed Instruction in Braille, by Ashcroft and Henderson (1963), was modeled after principles of programmed instruction for use with teaching machines. The text provides for independent mastery of small units, with adequate practice for mastery and immediate knowledge of success (Lowenfeld, Abel & Hatlen, 1969). Ashcroft and Henderson's book is a printed-dot text which first provides instruction on new symbols, contractions, and rules, and then provides a transcription exercise. The student transcribes hard copy braille, using a brailler or slate and stylus, and can compare the embossed dots with printed-dot duplicates at the back of the text. Typically, instructors using this text develop additional exercises or transcription tests for their students, since none are included in the text besides those which the student completes independently.

Another text, also widely used by instructors of braille transcription, is Instruction Manual for Braille Transcribers (Dorf & Scharry, 1979) from the Library of Congress Transcriber Training Program. This text provides a print text with photographic or ink-print braille symbols used as examples. Drills and exercises consisting of print
sentences to be transcribed are provided for the student and a tactual braille supplement is available. The supplement is used to compare and correct the brailled drills. This allows the braillist to monitor self-progress. However, the post-lesson exercises, or tests, must either be submitted to the course instructor or to the Library of Congress for correction before attempting the next lesson (Lowenfeld, Abel & Hatlen, 1969).

Two other texts used with sighted students are Dot Writing (Wise, 1960) which provides instruction and printed-dot examples, and Braille in Brief (Krebs, 1968) which provides embossed braille and printed text on facing pages. "Both are primarily useful for late-blinded adults and/or older children" (Harley, Henderson & Truan, 1979, p. 179). The present author has also found that the latter text is helpful in teaching sighted persons on an individual self-instructional basis. Neither of the last two texts offers embossed or printed-dot braille answers to assignments and exercises. Instructors must provide feedback on student performance, as well as design and proofread transcription examinations.

Use of Computers with Braille

Only one reference was found in the professional literature that described a computer program designed to introduce braille to sighted persons (Personal Computers for the Physically Disabled, 1981). This program was described as a simple program which displays the Grade One braille alphabet with accompanying audible Morse Code. The computer program was designed for use by Boy Scouts to earn merit badges.
While computers have not yet been used to teach braille except in the one case noted above, they have been used extensively for the production of braille. The production of braille by computers is becoming increasingly common (That All May Read, 1983). At the 1983 conference of the American Association of Workers for the Blind, no less than eight different braille output computers were displayed. All were designed to produce tactual braille from print input or allow interaction with computers through braille input/output capabilities. The former involve typing print text which can be done by any typist. The computer is programmed to produce an embossed braille equivalent of the input, thereby allowing untrained persons to "braille" books, newsletters, memos, etc. The latter application of computer technology allows blind computer programmers to receive braille computer output so that they can monitor their work on the computer. These various computer applications, however, reflect only one of the basic concerns of blind persons and professionals in the field of blindness - that is the problem of adequately providing braille books and other reading material to consumers and allowing computer access to them.

Development and Growth of Computer-Assisted Instruction

Computer-assisted instruction (CAI) has its roots in programmed instruction and the use of teaching machines. Programmed instruction (PI), developed in the early 1950's, allows independent mastery of small units with feedback and evaluation built in for the student. PI forces the student to participate in the learning process by requiring
the learner to respond to frequent questions. PI is primarily implemented with written textbooks where the student writes the answer in the textbook or in an accompanying workbook. Programmed materials are broken down into small steps which have been described as optimally sized increments (Pipe, 1966). Small steps for learning, combined with active participation on the part of the student and immediate knowledge of results, made PI one of the most potent forms of instruction, except that there are no contingencies which assure that the student responds to each frame. The answers are usually readily available, allowing students to skip over material.

Teaching machines were an outgrowth of programmed instruction and were considered to be an improvement on PI, since teaching machines, by virtue of their abilities, insisted that the student master a concept before moving on. Therefore, a student could not skip over material or look ahead for correct answers. Teaching machines presented only that material for which the student was ready, provided a constant interchange between the student and the program, and were also considered to be valuable in maintaining student interest through the use of feedback (Collagon, 1976).

One of the foremost developers of programmed instruction and teaching machines was B. F. Skinner. Skinner (1958) developed a linear teaching program composed of a small set of logical steps leading incrementally through the subject matter, a program based on his theory of operant conditioning. Students were immediately reinforced for correct responses as they progress through the material presented.
In the 1960's Norman Crowder developed the concept of intrinsic or branching programmed instruction. This approach to teaching consisted of multiple-choice questions and answers. The students' answers can be anticipated and material prepared for them in advance so that additional explanations can be provided if necessary (Collagon, 1976). The two approaches, linear programmed instruction and intrinsic or branching instruction, caused a controversy which was resolved in many ways by the use of the computer to provide instructional content (Flynn, 1982) in the late 1960's. Collagon (1976) stated that computer-assisted instruction could offer the best of both approaches to teaching. It provides the student with information to be learned in either linear or branching format as well as immediate feedback to specific responses. Collagon (1976) described CAI as the marriage between computer and programmed instruction which provides more human-like interaction between the student and machine.

CAI has been utilized for approximately two decades (Kulik, Kulik & Cohen, 1980) and has undergone continuing change since its initial use. Large computers were used to provide computer-assisted instruction initially. Large computers, sometimes referred to as maxi-computers or main-frame computers, are the largest and most expensive machines and occupy large amounts of space, sometimes filling entire rooms (Graham, 1980). Gradually, with the development of microchips, it was possible to reduce the size of computers. Smaller computers, typically called microcomputers, became available to more people and were utilized for computer-assisted instruction (Bork, 1979).
The rapid growth in the number of microcomputers was made possible due to their small size and reduced cost. There has also been a corresponding growth in the development of instructional programs, or software. The rapid growth in the use of CAI was also due to greater flexibility of instruction time and scheduling, more individualization of student learning, and the ability of computers to provide immediate feedback. Southwell (1982), in citing advantages of CAI, stated, "Computers are usually available at times and places when teachers are not" (p. 89). Gerard (1967) supported CAI as a solution to the "desperate shortage of teachers" (p. 3) which existed at that time.

Magidson (1978) indicates that the educational promise of CAI lies in its ability to individualize and personalize the instructional process and to simulate experiences not readily available. Filep (1967), focusing on the advantages of CAI in individualizing instruction, stated, "the computer can analyze and adapt teaching sequences to the learning abilities of each person, thus insuring true compatibility of individual and education" (p. 102). A well-designed CAI lesson is perfectly capable of individualizing instruction; each learner can get the full attention of an instructional system which is able to react appropriately to a variety of different answers. The interactive nature of a CAI lesson keeps students constantly involved in their learning. "Even at the level of simple fill-ins, a CAI format brings a game-like quality to learning, thus strengthening motivation and persistence" (Allen, Allen & Ross, 1970, p. 319). Students are no longer able to sit back passively, but must play an active part in the lesson. They
actually determine what will happen in their own lesson, and can do lessons at their own pace while their CAI lesson monitors their progress and prevents them from moving ahead to more advanced instruction until mastery is demonstrated (Southwell, 1982). Estrine (1975) pointed out how this makes CAI particularly suited to adult learning styles.

CAI is particularly suited to provide immediate feedback. Each learner can get the full attention of an instructional system which is able to react appropriately to a variety of different answers. In responding to students, a computer program can be more consistent than most teachers and will not become impatient or exasperated at having to go over and over the same elementary material. B. F. Skinner, as quoted by Sturges (1976) stated, "... computers can provide the immediate feedback which has a powerful beneficial effect on this kind of learning" (p. 2). Other factors which have contributed on a consistent basis to the growth of CAI include improvement of electronic computing capabilities and growing financial support from government and industry (Cartwright & Cartwright, 1974; Filep, 1967; Hollen, Bunderson & Dunham, 1971; Magidson, 1978; Stolurow, 1967; Thomas, 1979).

Despite the rapid development of CAI technology, the use of computers for individualized instruction has not been accepted to the extent possible. Splittgerber (1979) stated, "A large gap exists between the potential and the actual implementation of computers into the public schools" (p. 21). Three reasons he gave for this gap are (1) economical, (2) educational, and (3) technical.
The economic issue was raised because of the expense of the equipment required in the past. During the 1960's the usual equipment included a large mainframe or maxi-computer as well as an appropriate number of individual input and output devices, such as teletypewriters or printers. However, in recent years, equipment costs have gone down drastically due to the availability of low-cost microcomputers. DeLaurentis (1980) states, "Integrated technology gave birth not only to the microprocessor, but also to the affordable personal computer which, despite its size, rivals larger computers in computing ability" (p. 10). Joiner, Sedlak, Silverstein and Vensel (1980) suggested that the reduction in the cost of owning microcomputers, together with their increased capabilities, make them an ideal and available technology for assimilation into Special Education practices.

In regard to the second reason for low usage, Splittgerber in 1979 stated, "Educationally, the delivery systems have dominated the computer field at the expense of instructional design and development" (p. 22). He indicates that, initially, programmers not knowledgeable in instructional design provided the software. Teachers who are expected to be more knowledgeable in instructional design appeared to lack the professional incentives to undertake the development of CAI materials. That reason no longer holds true today, since teachers are becoming much more adept at programming. In addition, software producers are now either employing computer programmers who are also skilled in instructional design, or recruiting teams of educators and programmers who work together to produce software.
Technological issues center around the number of students who need access at one time, the complexity of languages used, and the lack of quality CAI software (programs). However, with microcomputers, it is possible to provide one machine per student because of low cost, small size, user friendliness, and simple programming languages. There continues to be a need for quality educational software for the computer (Sturdivant, 1980; Hannaford & Taber, 1983).

Recent studies (Anderson, Klassen, Hansen & Johnson, 1981; Cavin, Cavin & Lagowski, 1980; DeLaurentis, 1980; Huntington, 1979; Joiner, Sedlak, Silverstein & Vensel, 1980) indicate that during the last several years there has been greater acceptance of computer-assisted instruction with the use of microcomputers rather than large mainframe computers because of their size, low cost, user friendliness (i.e., ease of use by neophytes), and simple programming (DeLaurentis, 1980; Huntington, 1979). It appears that the previously mentioned reasons for the resistance to CAI no longer hold true and an increase in usage of computer-assisted instruction in all areas of education is to be expected.

Accurate, up-to-date statistics on CAI usage in schools and universities are elusive (Magidson, 1978). The results of a study which was supported by the National Science Foundation to survey academic and administrative computing in higher education indicated an increase in CAI usage from 10% in 1970 to between 70% and 75% in 1977 (Hamblen, 1977). Courses in which the computer was most utilized included (in order of greatest usage) computer science, engineering, business, mathematics/statistics, social sciences, physical sciences and education.
(Magidson, 1978). Magidson also noted increased use not only in schools and universities but also in public libraries, community resource centers, and in industrial training programs which have shown great interest in CAI (1978).

The growth of CAI has been accompanied by a substantial membership growth in associations concerned with the development of computer-based education, such as the Special Interest Group on Computer Uses in Education (SIGCUE) of the Association for the Development of Computer Based Instructional Systems (ADCIS), and the Association for Educational Data Systems.

Studies on the Effectiveness of Computer Assisted Instruction

Acceptance of CAI is still a controversial issue for many educators. Some are wary of the uncritical adoption of yet another form of educational technology (Taylor, 1974). To some critics, computers are expensive gadgets that increase the cost and complexity of instruction without increasing its quality. Others worry that rigidly programmed machines will force learners into a stifling mold (Kulik, Kulik & Cohen, 1980). The need for systematic comparisons of computer-based and traditional teaching approaches became apparent in the late 1960's, and evaluations began appearing in print. The effectiveness of CAI has been studied with various populations of students in many subject areas.

Kulik et al (1980) indicate that:

In a typical evaluation study, a researcher divided a class of students into an experimental and a control group. Members of the experimental group used computer terminals
and subjects in the control group received traditional instruction. The researcher then compared responses of the two groups on a common examination or on a course evaluation form (p. 526).

Many of the studies following this format were undertaken at the elementary and secondary school level. An early study reported by Atkinson (1968) was based on comparison of CAI and traditional instruction in the teaching of reading. Visual display terminals were used to provide computer-assisted instruction of initial reading skills to first graders in the experimental group, while a control group received traditional classroom instruction in the same reading skills. The group receiving CAI reading instruction performed significantly better on the California Achievement Test and on a test specifically developed for the study. The researchers also compared the cumulative rates of progress of the two groups. Rates of progress for the fastest, medium, and slowest students showed consistency of progress over time for both the CAI and the TM groups, suggesting the capability of CAI to accommodate individual differences.

Another early study (Suppes & Morningstar, 1969) compared CAI and traditional mathematics programs for grades one through six in a Mississippi school for the academic year 1967-68. In each of the six grades, the improvement in grade placement achieved by students randomly assigned to CAI was significantly greater \((p < .01)\) than that achieved by students receiving traditional instruction. The differences in grade placement improvement were in favor of the CAI method.
Morgan and Richardson (1972), in describing the Montgomery County Public Schools (Maryland) Project REFLECT, reported significantly higher gain scores on standardized tests for students using tutorial CAI. The subjects of the study were in a remediation program for an advanced algebra course. The subjects in the control group received traditional instruction, while the experimental group received computer-assisted instruction under the supervision of the same instructor.

Vinsonhaler and Bass (1972) summarized the results of 10 independent studies of computer-assisted instruction. All experimental groups in the studies used a mode of CAI described as drill and practice. Drill and practice systems may be defined as CAI systems designed to assist a learner in the maintenance and improvement of a skill. All control groups received instruction through traditional methods. The studies involved over 30 experiments with approximately 10,000 subjects instructed in the areas of language arts and mathematics. Vinsonhaler and Bass found "generally, CAI groups show performance gains of one to eight months over groups receiving traditional instruction" (p. 29).

A study reported by Wilson and Fitzgibbon (1970) evaluated the performance of fourth- and fifth-grade students in mathematics and English. Three groups were selected: a control group receiving traditional instruction in math and English; an experimental group receiving drill and practice CAI in both English and mathematics; and another experimental group receiving CAI in math but not English. This final group was selected as an intermediate control in an attempt to examine the possible effect of an experimental school setting on the
results. The study was conducted over a four-month period during the regular school year. It was stated:

One would expect a four-months gain in grade equivalent scores over the four-month treatment period. However, both control group and intermediate control group gained three months or one month less than expected; the CAI group gained seven months, three months more than expected (1970, p. 578).

Other studies (Lewellen, 1971; Vinsonhaler & Bass, 1972) supported findings of better performance of CAI students on standardized tests when compared to performance of students who received traditional instruction.

While studies at the elementary and secondary level consistently show the advantage of computer-assisted instruction over traditional instruction in many subjects, it has proven harder to show the educational advantage of computer-based instruction at higher levels of education (Kulik et al, 1980). Jamison, Suppes & Wells (1974), for example, reviewed 11 studies of computer-assisted instruction in college classrooms; but the results of the studies defied easy summary. Some studies have shown either positive or negative results of CAI, but Jamison and his colleagues (1974) concluded that, overall, CAI was at least as effective as traditional instruction when used as a replacement.

PLATO (Programmed Logic for Automatic Teaching Operators) and TICCIT (Time-shared Interactive, Computer Controlled Information Television) were two large-scale computer-assisted instruction systems backed by the National Science Foundation (NSF) in the late 1960's (Kulik et al, 1980; Bitzer & Skaperdas, 1971; and Stetton, 1971).
The intent of the NSF was to support CAI on a scale sufficient enough to permit a realistic evaluation of its potential in college teaching programs. With the support of the NSF, researchers at the Educational Testing Service carried out major evaluations of these two systems (Alderman, 1978; Murphy & Appel, 1978). The evaluation gave university educators an additional perspective and demonstrated that institutions of higher education would accept CAI as an additional teaching resource (Kulik et al, 1980).

Because Kulik and his colleagues (1980) felt another, more generalized study of the value of CAI in higher education was needed, they conducted a meta-analysis to integrate findings from 59 independent evaluations of CAI studies in college teaching. The meta-analysis was based on Glass' (1976) description of a statistical analysis of a large collection of results from individual studies for the purpose of integrating findings. Researchers carrying out a meta-analysis locate studies of an issue by clearly specified procedures. They characterize features of the studies and study outcomes in quantitative or semiquantitative ways. The meta-analysis described by Kulik et al (1980) was based on studies which satisfied the three following criteria: (1) the studies took place in actual college classrooms; (2) they reported quantitatively measured outcomes in both computer-based and conventional classes; and (3) the studies did not have methodological flaws such as aptitude differences between control and treatment groups. Kulik and his colleagues found that computer-based instruction made small but significant contributions to the course achievement of college
students and also produced positive effects on the attitudes of students toward instruction and toward the subject matter they were studying. They also found that computer-assisted instruction substantially reduced the amount of time needed for instruction (Kulik et al., 1980).

Lorber (1970) also found positive results of CAI tutorial in comparison with the traditional method of instruction in teaching the basic elements of tests and measurements to prospective teachers. Students in the CAI group achieved a higher mean score on the Measurement Competency Test administered at the end of the course and were also found to spend less time in instruction than the control group which had received traditional instruction via classroom lectures.

Edwards and Judd (1972) reported an evaluation of a course in special education for undergraduates. In this study, students were randomly assigned to one of three groups. One group received a course handbook and participated in a discussion section; one group participated in discussion only; and one group received CAI and the handbook but did not participate in discussion sections. The resulting evidence favored the group which received CAI rather than the groups provided with the opportunity for discussion.

Similar positive results of CAI in college settings were discussed by Wilson and Fitzgibbon (1970); Arnold (1970) in their reports of studies they conducted; and Edwards, Norton, Taylor, Weiss and Dusseldorp (1975) in a review of research on the effectiveness of CAI.
While some studies have not demonstrated the superiority of CAI in achievement, they have demonstrated advantages in other areas such as a reduction in the time required by instructors or students to complete instruction. Proctor (1968) compared CAI with a lecture-discussion strategy for presentation of general curriculum concepts at Florida State University. There was no difference between the groups on achievement or retention, but a significantly smaller amount of instructional time was required by the CAI group. Kockler (1973) found similar results in assessing the effect of CAI on attitudes toward CAI and mathematics. Fletcher and Suppes (1972), Krupp (1972) and Sango (1969) all found positive results when measuring rate of learning and/or time required by groups using computer-assisted instruction programs and traditional instruction groups.

Since learning braille is similar to the skill of learning a new (written) language, the use of computer-assisted instruction in the acquisition of foreign languages was explored in the literature. Morrison and Adams (1968) reported on a pilot study of a CAI program for university students in introductory German. The experimental group received instruction via computer, while the control group attended a German class based on a traditional lecture mode. The treatment and control groups were compared in terms of language achievement, course grades, tests of German achievement at the end of the course, and student opinion of the two kinds of laboratories. The results indicated that the students in the CAI section were, in most cases, comparable to those in the control (traditional) section and, in some cases, outperformed the control group.
Other successful applications of CAI have been found in classes studying German or Arabic (Allen, 1972), Russian (Suppes & Morningstar, 1969), and English (Magidson, 1978). In the study which Suppes and Morningstar (1969) conducted, a college level Russian language course was taught using either CAI or the traditional method of instruction. They found the CAI course evidently more motivating than the classroom presentation of the same course. This was based on the finding that 73% of the CAI students who originally enrolled in the course completed all three quarters of instruction during the first year, compared with 32% of the students enrolled in classroom presentation of the course. Suppes and Morningstar also found that CAI students made significantly fewer errors on the year-end final examination than did students receiving classroom instruction.

Abboud, Bunderson, and Victor (1971) reported on a study which compared CAI and non-CAI groups of university students in Arabic handwriting. An excerpt which reiterates the author's observations about reinforcement of skills:

In conventional classroom practice, reinforcement, whether positive or negative, is rarely immediate and very often is not given at all. A teacher trying to teach a foreign language to a class of 12 to 15 students or more finds it very difficult to correct the Arabic handwriting of every student in the class for every letter or word he attempts. The student writes an exercise which may not be returned to him for a few days. By the time it is returned, he has already gone on to learn a new letter or form and is not interested in rewriting the whole exercise. Probably his only interest by then will be the grade given him. In a very small class of two or three students, the teacher can
situation is rarely possible in any university at the present time. Practice does not make perfect unless the desired behavior is reinforced immediately. The student must know whether he is right or wrong within a very short period of time, or he may learn undesired responses (p. 11).

In summary, it seems that the reported effectiveness of CAI for language instruction has not yet motivated wide acceptance. Olsen (1980) conducted a survey regarding the use of computer-assisted instruction of foreign languages during the winter of 1978-79. Only 10-15% of the 1,810 foreign language departments at four-year colleges and universities in the U.S. were using or planning to use CAI. Reasons discerned by Olsen for the low percentage of use included cost (of time and money), negative attitudes about the ability of a computer to teach languages, and lack of trained personnel who can create or modify CAI programs in language instruction. At the time of Olsen's survey, cost was indeed an important determinant of CAI usage. As mentioned before, computer hardware has been expensive and appropriate software is limited. However, as Engel and Andreissen (1981) noted in their more recent report of a related study, the advent of inexpensive microcomputers allows adaptive learning aids to come within reach of a larger public.

The negative attitudes in regard to the ability of a computer to teach languages may also have diminished since the time of Olsen's survey. Microcomputers today are more versatile and can perform different tasks such as reception of speech and delivery of speech output. The leading microcomputer manufacturers and software suppliers now offer low-cost language CAI programs intended for use on home
computers. No recent statistics, however, are available on the use and success of these software packages.

Finally, the resistance to CAI because of untrained personnel may no longer exist, since many persons have taken advantage of numerous opportunities to learn the simple computer programming techniques being used now. Olsen (1980) stated, "The trend is definitely toward an increased use of computers in a wide range of subjects, including language" (p. 343).

Olsen (1980) also asked his survey subjects how CAI was being used in their foreign language programs. He found that computer-assisted instruction was used most often in the basic language courses and that CAI programs being used dealt with grammar and vocabulary, ranging from simple substitution tasks to sophisticated exercises in morphology and syntax. Much work has gone into the preparation of computerized vocabulary drills. The consensus of the participants in Olsen's study was to avoid monotonous translation drills such as German-English or English-French. The CAI users in Olsen's study agreed that the computer enables the student to learn more in a shorter time than is usual for a regular course. "The computer's effectiveness in assisting self-paced learning has resulted in numerous programs completely independent of any course format or textbook" (Olsen, 1980, p. 345).

The use of microprocessors instead of large mainframe computers for computer-assisted instruction was strongly supported by the respondents in Olsen's 1980 survey. "Many of them extol the microprocessor for its flexibility and rapidly increasing sophistication
processor for its flexibility and rapidly increasing sophistication ..." (p. 343). A second advantage of using microcomputers was low cost.

Tsai and Pohl (1977) published an extensive review of the literature on this type of computer-assisted instruction used to teach programming. The studies they reviewed involved a comparison of CAI and lecture format. They found some negative or neutral results which did not support CAI as a more effective alternative instructional method. Dowsey (1972) and Schurdak (1975) also conducted studies in which lecture-taught students significantly out-performed CAI-taught students. Tsai and Pohl hypothesized that one of the primary reasons for finding CAI less effective was the use of unidimensional measurements of achievement. That is, "reported differences in student achievement (ostensibly due to differences in teaching methods) may, in fact, be the result of differences in the types of measures of achievement" (Tsai & Pohl, 1977, p. 66). As a result of their observation, Tsai and Pohl (1977) conducted a study which used compound measures of achievement as opposed to a single measure. Their work involved measurement of achievement of college students' learning a computer programming language in three different formats: (1) traditional lecture, (2) computer-assisted instruction, and (3) traditional lecture supplemented by CAI. While Tsai and Pohl (1977) found no significant differences in student achievement among the three teaching methods when using either homework scores or term project scores, they found that when achievement was measured by either hour quiz scores or
Pohl stated:

The results of this study, then, not only fail to support the findings of previous research, but also demonstrate that differences in learning achievement can be measurement specific. That is, significant differences in learning achievement under different teaching/learning environments may be detected only with certain types of performance evaluation instruments. This point has not been fully considered in the literature to date and may well account for some of the seemingly contradictory results among research studies (1977, p. 70).

This review of the literature has revealed that:

1. The use of CAI either often improved achievement or showed no difference when compared to the traditional classroom approach.

2. The use of CAI reduced learning time when compared to the traditional method.

3. The use of CAI has been successfully used in teaching foreign languages, a related skill.

4. In studies where CAI was found less effective, it is hypothesized that the use of more than one measure of achievement may provide more accurate comparisons of CAI vs traditional methods of instruction.

Summary

While a review of the literature has indicated that several traditional texts and/or programmed texts are available for teaching braille transcription, there are no generally available computer-assisted instruction programs. The use of CAI, in general, is rapidly becoming more popular due to the availability of more computer systems, lower cost of computers, and the existence of applicable software. Many
studies of the effectiveness of CAI have been completed and, typically, compare CAI with traditional methods of instruction in various subject matter areas or skills. Computer-assisted instruction of written language, a related skill, has been found to be successful and is expected to be more so as microcomputers and software become more accessible. Dependent measures such as achievement and amount of time have been typically used. Computer-assisted instruction has commonly been found to be more effective than traditional instruction. In studies where CAI was found to be less effective, single measures of achievement have been considered inadequate; and some researchers recommend using two or more.
Design

The design selected for the study, two group posttest-only, was described by Ary, Jacobs, and Razavich (1972) as being one of the most powerful of all experimental designs. It requires two groups of subjects, each assigned to a different condition. No pretest is used; the randomization is intended to control for all possible extraneous variables and assure that any initial differences between the groups are attributable only to chance and therefore will follow the laws of probability.

The main advantage of this design is randomization, which assures statistical equivalence of the groups prior to the introduction of the independent variable (Tuckman, 1978). Other advantages are that the design controls for the effects of history and maturation, and it is recommended for situations in which a pretest is not appropriate (Ary et al, 1972).

In the present study, the independent variable was type of instruction: either traditional instruction or computer-assisted instruction. Thus, one of the two groups was to be randomly assigned to computer-assisted method of instruction, while the other received a traditional method of instruction in braille transcription. Dependent
variables selected for the study were achievement, student time, and instructor time.

Description of Treatments

Traditional Method

One group in this study received braille instruction through the traditional lecture method (TM). This is the method used at Western Michigan University and many other university training programs for braille transcriptionists.

Students in this group were provided with braille paper and the text, Instruction Manual for Braille Transcribing, and Supplement: Drills Reproduced in Braille (Dorf & Scharry, 1979). These are the same materials used by future braille transcribers for the Library of Congress, Division for the Blind and Physically Handicapped.

The text covers 18 lessons, but students in this experiment were asked to complete only the first six. Each lesson has three parts: (1) instructional material, (2) drills, and (3) a final exercise. Each drill is reproduced in braille in the supplement so that the transcriber can practice his/her new skills and check for accuracy. No answers are provided for the exercises, and students submit each exercise to the instructor for correction before continuing on to the next lesson.

Students in the traditional method group met with the instructor on a regularly scheduled basis which was usually once a week for a period of 1 hour. During that time, lectures were given, questions were answered, and assignments of the exercise were made. Students
were loaned Perkins braille writers for the duration of the study so that they could complete the assignments at home. After completion of the third and sixth lessons, students were required to complete 3-part examinations, which they commonly called the "midterm" and "final". These examinations were given on campus in order to control time and other conditions.

Computer-Assisted Instruction Method

The computer-assisted instruction (CAI) group was provided instruction via a braille transcription program designed for use on a microcomputer, The Braille Training Program (Ponchillia & Holladay, 1983). This program is "user friendly" meaning it is easy to use by anyone operating it. This program is automatically loaded into the microcomputer and offers the user several choices via a menu, thus eliminating the need to know and understand computer commands. Each student was provided a 5 1/4" floppy diskette containing the program. The program was designed to be used with either Apple II+ or Apple IIe microcomputers with at least 48K of memory.

Each diskette contained the full set of programs including an introduction to the series of lessons; six braille transcription lessons which included instructional text, drills and exercises; and "Crib Sheets" providing displays of braille symbols to be used for reference. In addition, a short program entitled "Tally" was included. The Tally program tallied student errors on each lesson and could be accessed only by the instructor upon completion of the program by the student.
The Braille Training Program (BTP) is based on the text, Instruction Manual for Braille Transcribing (Dorf & Scharry, 1979), and covers the same material per lesson, as well as the same sentences for drills and exercises. The Braille Training Program was designed for sighted persons wishing to learn braille independently via microcomputer. One feature of the BTP is that the user is shown braille dot displays on the microcomputer screen in order to provide illustrations. Another special feature is that the BTP allows the user to practice brailling by pressing combinations of six keys simultaneously. The microcomputer displays the user's input so that proofreading can be done by the student before receiving feedback on the correctness of the transcription. The microcomputer's unique capabilities allow the student to delete, correct and insert the correct braille configurations before pressing the key indicating completion of the assignment.

Once automatically loaded into the computer, the BTP displays the following Main Menu:

0 - Introduction to the System
1 - The Braille Alphabet )
2 - Capitals, Punctuation & Numbers )
3 - Single-letter Contractions ) [Lessons 1-6]
4 - Part- and Whole-word Contractions )
5 - Part-word Contractions )
6 - Part- and Whole-word Lower-sign Contractions)
P - Play with Grade Two Braille
C - Crib Sheets in Braille
A brief description of the menu follows:

**Introduction.** This selection provides the student with introductory information about the Braille Training Program, briefly explains how to use the Apple Microcomputer, i.e., use of the Return Key, and explains the six-key input feature which allows the user to input braille symbols by pushing from one to six keys at once.

**Lessons 1-6.** Upon selection of each of these lessons, the user is shown a mini menu offering four options: (1) Instruction, (2) Drill, (3) Exercise, and (4) Return to Main Menu. The first three choices directly parallel the format of the Dorf and Scharry (1979) manual, giving the student instruction first; then opportunity to practice on the drill exercises in which errors are noted and correct answers displayed; and finally, a test of braille skills on the post-lesson exercise. Student errors on each post-lesson exercise were counted and recorded on each individual's disk. The final choice in the menu, Return to Main Menu, allows the student to return to the main menu to select another lesson.

**P - Play with Grade Two Braille.** This selection from the main menu allows six-key braille input by the user and automatically displays the corresponding print letters or words. By choosing this feature, users could simply practice their braille by choosing to input any words or sentences and checking the print equivalent to see whether they were brailing anything meaningful. Subjects in the study were not required to use the "P" option, but could use it if they wished to practice brailing.
C-Crib Sheets in Braille. Selection of this option provides the user with the following separate reference menu:

0-Go Back to Main Menu
1-Using the Apple like a Perkins
2-The Braille Alphabet
3-Punctuation
4-Single-letter Contractions; Contractions for And, For, Of, The, and With
5-Part-word Contractions
6-Whole-word Contractions

Each of the choices offered by the Crib Sheet menu provides a display of braille symbols with their print equivalents. The displays are reference lists for the user who may need to refer to the crib sheet feature of the BTP to look up a forgotten sign or contraction while completing a drill or exercise.

Students in the CAI group were given initial instruction by the researcher which included an introduction to the operation of the microcomputer. The location and availability of microcomputers on which to work was also discussed with each student. The introduction took less than 1 hour. Students were instructed to work on their own, but were given the instructor's schedule of office hours and telephone numbers and urged to ask for assistance at any time. In the CAI group, the subjects were also required to report to the instructor after the third and sixth lessons in order to complete the two examinations on campus. The two examinations were comprised of three sections each, one of which requires the student to produce hard copy braille using a
Perkins brailler for this transcription task. Brief instructions on using the brailler were given at that time. The other two parts of the exam required (a) reading a sample of braille, and (b) locating contractions in a print word list.

Subjects

The subjects were undergraduate student volunteers enrolled in Special Education courses at Western Michigan University. Special Education students were notified of the opportunity to participate through announcements in their Special Education courses and through posters which were placed near their classrooms (See Appendix B for sample poster and application). Students were told they would have the opportunity to learn braille, participate in a research project, and receive the necessary materials and a certificate upon completion (See Appendix H for sample certificate).

The subjects were recruited on two separate occasions (during Fall semester, 1983, and Winter semester, 1984) in order to ensure enough data for analysis. Twenty students volunteered during the fall semester and eleven during the winter semester. All of the volunteers were full-time students, either of junior or senior standing, and consented to a commitment of up to 6 weeks for completion of the braille lessons.

All of the volunteers were asked to complete the "Subject Interview Form" (SIF) so that historical and biographic information could be gathered for descriptive purposes (See Appendix C for Sample of SIF and summary of Pertinent Information). The SIF also served as a screening
device because it surveyed previous braille knowledge of the subjects. Four student volunteers who were able to read some Grade Two braille were considered to have too much knowledge of braille to participate in the study and were excused. The remaining volunteers were randomly assigned to either the control or experimental groups using the table of random numbers (Games & Clare, 1967).

The TM group consisted of 10 females and 1 male. Information from the SIF indicated that seven of the group had previously used a computer to learn a skill or unit of instruction while four had no previous experience. Those with previous experience were then asked about frequency of computer use. None used a computer daily or several times a month, one used a computer several times a semester, and three indicated one or two occasions of computer use per year. When asked their opinion of learning with the aid of a computer, none responded negatively, four stated they were very positive; and seven felt somewhat positive. The subjects were also asked about previous experience with braille. Most had at least seen braille, although two had no previous exposure to braille. Three persons indicated they knew some braille symbols.

The CAI group was comprised of 12 females and 4 males. Of these 16 people, 5 had never used a computer to learn a skill or unit of instruction previously while eleven indicated no previous use. When frequency of use was surveyed, of those with previous experience, three said they used one several times a month and five used a computer once or twice a year. None was a daily user. When asked their opinion of learning with the aid of a computer, two of the group had no opinion,
five were somewhat positive and five very positive. Four did not answer. When knowledge of braille was surveyed, two said they had no previous experience with braille, thirteen had seen braille previously, and only one indicated knowledge of Grade One braille.

As a further check that all subjects did not know braille, they were asked to attempt to read Grade One and Grade Two braille samples. Eight of the subjects in the TM group knew none of the symbols, one knew 85% of the Grade One alphabet, and two knew 100% of the 18 samples of Grade One braille. Fourteen of the CAI group could read no symbols, and two persons identified one and six Grade One alphabet letters, respectively. None could read any of the grade Two braille. In summary, both groups were judged to be equal in that most knew no braille, a few knew some Grade One braille and none knew Grade Two braille.

Description of Dependent Variables

Measurement of Achievement

The first dependent variable in this study was achievement. Achievement for the purpose of this study is defined as: 1) ability to transcribe braille into print; 2) ability to transcribe print into braille; and 3) ability to identify parts of a print word which can be contracted. All three measures were used to provide interval data on student performance. The lower the number of errors, the better the student performance.

A total of 12 tests of achievement were administered to the subjects of the study in the form of six post-lesson exercises and two 3-part examinations.
A post-lesson exercise was required after each of the six lessons and consisted of print phrases or sentences which were to be transcribed into braille. The traditional method group completed their post-lesson exercises on the Perkins brailler at home, and the CAI group subjects were required to complete theirs on the Apple microcomputers available throughout campus.

Two examinations, one completed after lesson three, and the final one completed after lesson six, consisted of three parts; 1) transcription of braille to print, 2) transcription of print to braille, and 3) identification of contractions within print words. All subjects completed the examinations on campus under the observation of the instructor and used the Perkins brailler for hard copy braille transcription for the second part of the exam.

The post-lesson exercises and part two of the exams of both groups were corrected using the same technique of tallying errors whether done by the computer or instructor: each sentence which contained mistakes of any kind was considered an error. Modification of the more typical correction techniques used by braille instructors was done in the interest of uniformity and comparability. The technique described was used because it is the way the microcomputer software was designed to scan for errors. The usual way that braille performance is measured is by tallying every braille mistake in every word, rather than considering any sentence with one or more mistakes one error.

The Braille Training Program consistently makes no errors in detection of such brailling mistakes. The computer's ability to scan and

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compare the student's input with the correct version is virtually faultless. The misplacement of one dot, insertion or deletion of just one space is detected as an error by the computer.

Human error is a possibility in the correction of hard copy braille. In order to determine the reliability of the researcher's correction rate, and interobserver reliability coefficient was computed on this researcher's error detection rate. Interobserver reliability is the degree of agreement between two or more people in their scoring of a variable (Achenbach, 1978). "Certain standards of rater reliability have gained formal acceptance in the literature. When they are reported, \( r \) is usually above .95, anything much below is considered to be unacceptably low rater reliability" (Meyers & Grossen, 1978, p.198). A random sample (33%) of the TM group lesson exercises and both group examinations was selected for a test of reliability (Birkimer & Brown, 1979). Two totally blind competent braille users were asked to identify any errors on each assignment using the same criteria as that of the instructor/researcher and the BTP. Totally blind persons were asked so that the penciled notes of the instructor/researcher on the subjects papers were not detected. The raters had no information regarding subject identity or group assignment. The results provided an Interobserver Agreement score of 98.2%, indicating an almost perfect agreement between the raters. (It should be noted that the braille samples which were not agreed upon were those with incomplete erasures of the raised braille dots, rather than incorrectly formed contractions).
Measurement of Student Time

The second dependent variable was the amount of student time which was defined as total amount of time spent by students learning braille transcription. Each student was given a time sheet and asked to record any time spent working on their braille studies (See Appendix D for sample of Student Time Sheet).

Students in the TM group were asked to indicate time spent in lecture or consulting with the instructor, practicing braille drills, studying, and time spent completing homework assignments and examinations.

Students in the CAI group were asked to note any time spent using the computer, consulting with the instructor or studying, and time spent completing examinations.

Total time of each student was converted to minutes and compared between the two groups (See Appendix F for Student Time Raw Data). No attempt was made to monitor or control for error or exaggeration of time spent by students. Students were told that it was important to note all time, and only had to write when they began and ended a period of studying, brailling, etc. They were not asked to calculate their total time.

Measurement of Instructor Time

The third dependent variable measured in the study was instructor time which is defined as the total amount of time spent by the instructor in providing either group with braille instruction.
The instructor recorded all time spent lecturing and assisting the traditional method group, as well as time spent correcting exercises and examinations. Likewise, all time was recorded that was spent assisting the CAI group, using the computer to retrieve performance data, and correcting examinations (See Appendix G for Instructor Time Raw Data).

Hypotheses

Three hypotheses were formulated from the problem statement and research questions. The research questions and the hypotheses follow:

Research question one. Is there a significant difference in achievement of students learning braille transcription with computer-assisted instruction when compared to students learning braille transcription through the traditional method?

Hypothesis one. The achievement of students learning braille transcription with computer-assisted instruction will be significantly greater than achievement of students learning through the traditional method.

Research question two. Is there a significant difference in amount of time spent by computer-assisted instruction students when compared to traditional method students learning braille transcription?

Hypothesis two. The amount of time spent by computer-assisted instruction students learning braille transcription will be less than the amount of time spent by students learning braille transcription with a traditional method.
Research question three. Is there a significant difference in amount of time expended by the instructor working with students using a computer-assisted instruction braille transcription program when compared to instruction of a braille transcription course taught by the traditional method?

Hypothesis three. Less time will be spent by the instructor with students learning braille transcription with a computer-assisted instruction program than with students who learn braille transcription with the traditional method.

Data Analysis

This study involves a comparison of two independent groups with one experimental variable (method of instruction) using interval data on three dependent variables, 1) student achievement, 2) student time, and 3) instructor time. The t-test is an appropriate statistic to use to determine significant differences between group means (Meyers & Grossen, 1978). The t-test is a parametric statistic which allows the researcher to compare two independent means to determine the probability that the difference between two independent means is a real difference rather than a chance difference (Tuckman, 1978). Assumptions of the independent sample t-test are that the scores on the variables tested are interval data distributed according to a normal curve, and that subjects are randomly assigned to treatments from which independent observations can be made (Games & Klare, 1967). Therefore, the t-test was used in this
study to compare the interval data obtained on: 1) group means of achievement on each braille exercise, 2) group means of achievement separately on each of the three parts of both examinations, 3) group means of time required by students to complete their braille transcription course, and 4) total time spent by the instructor per treatment group. This resulted in a total of 12 t-tests.

The .05 level of significance was used to test the three hypotheses. This level was chosen because it is considered an acceptable level in behavioral research (Tuckman, 1978). If a more stringent level of significance were selected, such as alpha = .01, a type II error of accepting an incorrect null hypothesis could occur (Glass & Stanley, 1970). A .05 level of significance helps avoid this type of error. A less stringent level of significance, however, increases the probability of making a Type I error, rejecting a correct null hypothesis, which could lead to serious problems if the hypothesis were used in curriculum decisions.

Limitations

Generalizations based on the findings of the present study are limited by the following factors:

Size. The sample size is limited, possibly due to the length of time and amount of effort to which the volunteers were asked to commit themselves. A small sample could affect the overall results since there is more tendency to deviate from the mean.
Sex. Although random assignment controls for sex composition when assigning subjects to groups, there was a higher number of females in the sample overall. However, this factor is generally consistent in the overall population of braille transcribers.

Report of time spent. Students were asked to submit self-reports of time spent completing the study. Therefore, no statements as to the accuracy of the reports can be made.

Volunteer sample. The sample was comprised of volunteers, as opposed to a sample randomly chosen from the total population. Therefore, there is a possibility that the sample may be biased by the fact that only volunteers were tested.
CHAPTER IV

RESULTS

Introduction

The purpose of this study was to compare the teaching effectiveness of computer-assisted instruction with the effectiveness of traditional braille instruction. Three research hypotheses were developed based on the assumption that using computer-assisted instruction (CAI) for learning braille transcription would lead to the same or better achievement of braille skills with a smaller time expenditure for both student and instructor. Data were collected on: (1) student achievement as measured by number of errors on braille transcription tests, (2) the time it took students to complete the course as measured by self-reports, and (3) the time it took the instructor to conduct the course(s). This chapter presents the directional research hypotheses and their corresponding null hypotheses. In addition, the results of the t-tests will be presented with the decisions made regarding each hypothesis.

Achievement

RESEARCH HYPOTHESIS 1. The first research hypothesis stated: The achievement of students learning braille transcription with computer-assisted instruction will be greater than achievement of
students learning through the traditional method. The corresponding null hypothesis states: There will be no difference in achievement between students learning braille transcription with computer-assisted instruction and students learning through the traditional method.

The null was tested with the t-tests conducted on scores obtained from a 3-part final examination of braille transcription ability (see Table 1). The mean error scores on each part are as follows: Part 1 (Problem Word List) CAI group mean = 3.18, TM group mean = 2.54; Part 2 (Transcription of Braille to Print) CAI group mean = 0.00, TM group mean = .4545; and Part 3 (Transcription of Print to Braille) CAI group mean = 3.00, TM group mean = 3.00. None of the t-test results was significant (tcrit = 2.09, df = 20) at the p < .05 level (T1 = 0.83; T2 = 1.24; T3 = 0.00), thus the null hypothesis must be retained and the research hypothesis cannot be accepted.

In addition to the 3-part final examination, error scores on six post-lesson exercises and a mid-term examination were recorded. The t-tests conducted on student performance throughout the duration of the study showed mixed results; these results were as follows: Lesson One. The mean error score for the CAI group on post-lesson exercise one was 3.63, while the TM group received a mean of 2.90. The results of the t-test were 0.48, not significant at the p < .05 level. Therefore, no significant difference was found in achievement between the CAI group and the TM group on Lesson One (see Table 2).
### TABLE 1

Errors on 3-Part Final Examination

<table>
<thead>
<tr>
<th>Part</th>
<th>Group</th>
<th>n</th>
<th>Mean</th>
<th>Sd</th>
<th>t</th>
<th>prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CAI</td>
<td>11</td>
<td>2.72</td>
<td>1.27</td>
<td>0.83</td>
<td>.47</td>
</tr>
<tr>
<td></td>
<td>Problem words</td>
<td>TM</td>
<td>11</td>
<td>6.81</td>
<td>2.47</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>CAI</td>
<td>11</td>
<td>0.00</td>
<td>0.00</td>
<td>1.24</td>
<td>.23</td>
</tr>
<tr>
<td></td>
<td>Br1 to prnt</td>
<td>TM</td>
<td>11</td>
<td>0.45</td>
<td>1.21</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CAI</td>
<td>11</td>
<td>3.00</td>
<td>1.41</td>
<td>0.34</td>
<td>.69</td>
</tr>
<tr>
<td></td>
<td>Prnt to br1</td>
<td>TM</td>
<td>11</td>
<td>3.00</td>
<td>1.26</td>
<td></td>
</tr>
</tbody>
</table>

* p < .05

### TABLE 2

Errors on Post-Lesson Exercise One

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Mean</th>
<th>Sd</th>
<th>t</th>
<th>prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI</td>
<td>11</td>
<td>3.63</td>
<td>3.07</td>
<td>0.48</td>
<td>.64</td>
</tr>
<tr>
<td>TM</td>
<td>11</td>
<td>2.90</td>
<td>3.90</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p < .05
Lesson Two. The mean error score for the CAI group on post-lesson exercise two was 4.72. The TM group had a mean of 6.27. The t-obtained from the t-test conducted on error scores of the CAI and TM groups was .97, lower than the critical value at the $p < .05$ level. This indicates no significant difference in achievement between CAI and TM groups on Lesson Two (see Table 3).

**TABLE 3**

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Mean</th>
<th>Sd</th>
<th>t</th>
<th>prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI</td>
<td>11</td>
<td>4.72</td>
<td>3.71</td>
<td>.97</td>
<td>.41</td>
</tr>
<tr>
<td>TM</td>
<td>11</td>
<td>6.27</td>
<td>3.77</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* $p < .05$

Lesson Three. A significant difference in achievement between the CAI and TM groups was found on post-lesson exercise three. The CAI group made significantly fewer errors (mean = 3.45) than the TM group (mean = 7.81) and the results of the t-test were 2.89, greater than the critical value at the $p < .05$ level (see Table 4).
Examination One. Achievement performance of the CAI and TM groups was mixed on the three parts of the examination administered after the third lesson, midway through the study. On part one, Problem Word List, the CAI group received a mean of 1.00 errors, while the TM group received 1.09. The t-test resulted in a t-obtained of 1.17, lower than the critical value at the $p < .05$ level. Therefore, no significant difference was found between groups. Both groups had an error mean of less than one (CAI = .28, and TM = .82) on part two of the examination (Transcription of Braille to Print). The obtained value of the t-test was 1.35, lower than the critical value at $p < .05$, and not significant. A significant difference was found between groups on part three (Transcription of Print to Braille). An error mean of 2.27 was found for the CAI group, while the TM group had a mean of 3.45. The t-test showed results of 2.48, greater than the critical value of $t$ at the .05 level (see Table 5).
Lesson Four. The CAI group performed significantly better (mean = 4.00) than the TM group (mean = 7.00) on post-lesson exercise four. The t-obtained was 2.27, a higher value than the critical t value, thus significant (see Table 6).

<table>
<thead>
<tr>
<th>Part</th>
<th>Group</th>
<th>n</th>
<th>Mean</th>
<th>Sd</th>
<th>t</th>
<th>prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CAI</td>
<td>11</td>
<td>1.00</td>
<td>1.18</td>
<td>0.17</td>
<td>.87</td>
</tr>
<tr>
<td></td>
<td>TM</td>
<td>11</td>
<td>1.09</td>
<td>1.37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>CAI</td>
<td>11</td>
<td>0.28</td>
<td>0.47</td>
<td>1.36</td>
<td>.19</td>
</tr>
<tr>
<td></td>
<td>TM</td>
<td>11</td>
<td>0.82</td>
<td>1.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CAI</td>
<td>11</td>
<td>2.27</td>
<td>1.48</td>
<td>2.16*</td>
<td>.04</td>
</tr>
<tr>
<td></td>
<td>TM</td>
<td>11</td>
<td>3.45</td>
<td>1.03</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p < .05

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Mean</th>
<th>Sd</th>
<th>t</th>
<th>prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI</td>
<td>11</td>
<td>4.00</td>
<td>2.82</td>
<td>2.27*</td>
<td>.03</td>
</tr>
<tr>
<td>TM</td>
<td>11</td>
<td>7.00</td>
<td>3.34</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p < .05
Lesson Five. The data collected on performance of the groups on post-lesson exercise five showed that the CAI group again made fewer errors (mean = 4.00) than the students in the TM group (mean = 6.63). However, the t-test results indicate this difference was not significant (t_{obt} = 1.79) (see Table 7).

\begin{table}[h!]
\centering
\caption{Errors on Post-Lesson Exercise Five}
\begin{tabular}{lrrrr}
\hline
Group & n & Mean & Sd & t & prob \\
\hline
CAI & 11 & 4.00 & 2.40 & 1.80 & .19 \\
TM & 11 & 6.63 & 4.22 & & \\
\hline
\end{tabular}
\end{table}

* \( p < .05 \)

Lesson Six. The CAI group made significantly fewer errors (mean = 2.72) than the TM group (mean = 6.18) while completing the post-lesson exercise. The t-test was significant (\( t = 4.05 \)) when compared to the critical \( t \) value (see Table 8).

\begin{table}[h!]
\centering
\caption{Errors on Post-Lesson Exercise Six}
\begin{tabular}{lrrrr}
\hline
Group & n & Mean & Sd & t & prob \\
\hline
CAI & 11 & 2.72 & 1.27 & 4.05* & .001 \\
TM & 11 & 6.18 & 3.09 & & \\
\hline
\end{tabular}
\end{table}

* \( p < .05 \)
Overall, the results of the twelve t-tests conducted on the six post-lesson exercises and the two 3-part examinations yielded eight non-significant values of the t-obtained and four which proved to be significant. These results indicate that the CAI group performed equal to or better than the TM group throughout the study. However, the CAI group made fewer errors (351) than the TM group (537) overall.

Student Time

The research hypothesis relating to the time it took for students to complete the braille transcription course states:
The amount of time spent by computer-assisted instruction students learning braille transcription will be less than the amount of time spent by students learning braille transcription with a traditional method.

The corresponding null hypothesis states:
There will be no significant difference between the amount of time spent by students learning braille transcription with CAI and amount of time spent by students learning braille with a traditional method.

The null was tested by comparing the mean of the time reported by each group while learning braille transcription (see Table 9). The mean time for the CAI group was 1130 minutes; and for the TM group, 1529. The $t$-obtained was 4.57, indicating a significant difference when compared to the critical $t$. Since the CAI group
### TABLE 9

Student Time Spent Learning Braille Transcription

Measured in Minutes

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Mean</th>
<th>Sd</th>
<th>t</th>
<th>prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI</td>
<td>11</td>
<td>1130</td>
<td>221.60</td>
<td>4.57*</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>TM</td>
<td>11</td>
<td>1529</td>
<td>186.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p < .05

completed the braille course in significantly less time than the TM group, the null hypothesis was rejected and the research hypothesis was accepted.

**Instructor Time**

The research hypothesis based on instructor time states:

Less time will be spent by the instructor of students learning braille transcription with a computer-assisted instruction program than with students who learn braille transcription through a traditional method.

The null hypothesis states:

There will be no significant difference between amount of time spent by the instructor of students learning braille transcription with computer-assisted instruction and amount of time spent with students learning braille transcription with a traditional method.
The null was tested by comparing the mean of the time spent by the instructor working with students from each group. The mean instructor time per student in the TM group was 394 minutes, while mean instructor time per CAI student was 124 minutes. These data resulted in an obtained $t$ of 15.69, much greater than the critical $t$ of 2.09, indicating a significantly smaller amount of instructor time spent with students in the CAI group (see Table 10).

**TABLE 10**

Instructor Time
Measured in Minutes

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Mean</th>
<th>Sd</th>
<th>$t$</th>
<th>prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI</td>
<td>11</td>
<td>124</td>
<td>26.81</td>
<td>15.69*</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>TM</td>
<td>11</td>
<td>394</td>
<td>47.35</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* $p < .05$
CHAPTER V

DISCUSSION

Introduction

The present study was designed to compare the effectiveness of computer-assisted instruction with the effectiveness of traditional instruction of braille transcription. Sighted volunteers interested in learning braille transcription were randomly assigned to groups which utilized either the computer-assisted instruction or traditional method approach to teaching. Twenty-two of the volunteers completed all requirements of the study. The results of their performance and the amount of time it took for them and the instructor were analyzed. This chapter will provide conclusions regarding the results and relationship of these results to previous studies. Problems encountered in the study, implications for use in university or other settings, and recommendations for future research are also presented.

Conclusion

Achievement of subjects learning braille transcription with computer-assisted instruction was not found to be significantly different from the subjects receiving the traditional method of instruction, which means the achievement of the CAI students was at least as high as that of students who learned braille with the traditional method. In addition, the time it takes for both students
and instructor using computer-assisted instruction to complete the course is significantly less than for the students and instructor using the traditional method. The finding that the achievement of students using CAI is not different from that of students using the traditional method and the finding that CAI requires less time of both students and instructor are in agreement with the results of many other similar studies (Fletcher & Suppes, 1972; Jamison, Suppes & Wells, 1974; Kockler, 1973; Krupp, 1972; Kulick, Kulick & Cohen, 1980; Sango, 1969; Vinsonhaler & Bass, 1972).

Since the computer-assisted instruction approach to teaching braille transcription offers the opportunity for students to achieve the same as students learning braille with the traditional method, but with less time put forth by both student and instructor, computer-assisted instruction appears to be a useful and efficient alternative method for teaching braille transcription.

The author was interested to note the enthusiastic comments made by students who were assigned to the CAI group. The subjects in this group frequently made comments such as, "I just love learning braille with the computer", "I dream about braille in my sleep", and "It's so great to braille the sentence and get the 'correct' response!" One subject described how she moved her fingers as if pressing the six computer keys while she jogged. Similar comments were not expressed by subjects in the group learning braille transcription with the traditional method.
Two interesting findings became apparent during the course of the study which should be taken into future consideration. One of these relates to the observation that the students assigned to the computer-assisted instruction group took a longer period of time overall to complete their course than the students in the TM group. That is, although the CAI group utilized less time per lesson than the TM group, the period of days over which the CAI students worked was longer (the mean time span of the CAI group was 50.45 days, compared to 37.55 days for the TM group). This difference was due to the structure or control of the scheduling. In the TM group, at the end of each lesson, the instructor confirmed the time and day of the following lesson, thereby giving each TM student a time frame in which to study and complete the post-lesson exercise. It was expected that the students would complete the previous exercise before meeting with the instructor for the next lesson and were therefore responsible for submitting an exercise each time. All subjects were told that they should complete at least one lesson per week. Students in the CAI group were free to schedule as many or few lessons as desired, and most of them began their course enthusiastically, completing two-three lessons in the first week. However, it was apparent after the study began that there was tendency of the students in the CAI group to put off braille lessons when their regular coursework requirements or examinations demanded more of their time. Students in both groups seemed to comment equally about their curricular demands, but the students in the TM group were more apt to meet with the instructor for their braille lessons regardless of other
demands. The key impetus for this behavior seems to be the personal contact with the instructor.

Another observation related to subject mortality. None of the 11 students assigned to the TM group dropped, but 5 out of the 16 students in the CAI group did not complete the course. The typical pattern observed was the enthusiastic beginning of the CAI program until other coursework or activities became time consuming. Then, after postponing subsequent lessons, students seemed to become discouraged and, finally, asked to be excused from the study. All those who terminated their participation in the study cited regular class loads as the reason for terminating. Again, the key factor in this difference between the two groups may be the personal contact with the instructor which the TM students had. Perhaps the students in the TM group felt more personal commitment to the instructor. Students may be less likely to disappoint a human than a machine.

Implications

It appears that CAI of braille transcription is a useful alternative to traditional methods of instruction in the college classroom, especially in situations where instructor and/or student time is limited. Since the acquisition of braille transcribing skills with CAI can be accomplished in less time, the time saved can be spent on other important skills and topics necessary in university special education and blind rehabilitation programs.
Such a method would be especially useful in small colleges which have only a few enrollees in braille transcription courses. A small enrollment for such a course makes it costly to offer it frequently. In addition, instructors must make a great time commitment to proofread and grade student lessons. The CAI method of instruction would provide an efficient means of offering a braille course frequently with minimal time expenditure of faculty.

The CAI method of teaching braille transcription may also be useful for the non-student population wishing to learn braille. This group might include future volunteer transcribers and parents or others who have braille-reading family members. Often, opportunities for this group to enroll in a formal braille course are limited because of location or scheduling. There are many public schools, blindness agencies and private individuals from which access to microcomputers can be attained. It may be possible for an individual to use the Braille Training Program on a self-instructional or tutored basis. This option would provide more effective instruction than a correspondence course because of the immediate feedback capabilities of the microcomputer.

The Braille Training Program (BTP) may prove to be a useful instructional supplement in a course taught using traditional methods. Used in this manner, the BTP may serve to provide a review of course content and would also provide opportunity to practice braille transcription to receive immediate feedback on performance.
Another implication is that the BTP may serve as an efficient means for relearning braille transcription skills for those who need to brush up on previously learned braille skills, but who do not want to participate in a formal introductory course of braille instruction. In this case, the user could simply review the instructional material, then practice using the braille correction feature of the BTP.

Recommendations

Recommendations can be made in regard to both the use of the CAI method of instruction and to future research. In relation to use of CAI as an instructional method, it is recommended that tighter controls or monitoring of CAI students be done in order to combat their tendency to postpone or terminate their lessons. One suggestion is to schedule brief weekly or bi-weekly meetings to review each student's performance. However, these measures may not be necessary in situations where students will receive course credit and final grades at a predetermined time. The subjects of this study were volunteers who were interested in braille but were not taking the course for credit. They were free to terminate at any time and were carrying normal course loads in addition to the braille research study commitment. It is possible that the subjects in this group would be more likely to terminate than a target group of future teachers or transcribers.

Several recommendations for future research are made. First, replication of the study with different populations would be helpful in making generalizations about the utility of computer-assisted instruction.
of braille transcription. It is suggested that the study be conducted with students enrolled in curricula for the visually handicapped who take the course for credit and are evaluated on performance. The results of such a study would yield information relative to the problem of subject mortality. If students receiving credit for the course encounter no difficulty in continuing without extra instructor contact or monitoring, then no major modifications in teaching a CAI course would be necessary. However, if subject mortality continues to be a problem, then it would be necessary to modify the structure of the present format to be of value to future braille transcription students wishing to use computer-assisted instruction.

Another population to sample for a replication of this study would be the non-student population. The subjects of this study were relatively young and enrolled at a university in which computer literacy is becoming a priority. The persons in the non-student population who often desire instruction in braille instruction are usually older persons without previous exposure to computers. An ideal study would compare achievement and time of students in groups taught with either of the following three methods: (1) computer-assisted instruction with minimal instructor assistance, (2) traditional lecture method with regularly scheduled meetings, and (3) correspondence method in which lessons are sent to proofreaders at the Library of Congress Transcriber Training Program. The results could be used by braille instructors in making methodological decisions of future benefit to blind persons.
Since it has been found that the achievement of students in either CAI or TM groups is not different, it would also be helpful to have information on retention over time. A comparison of retention of braille skills achieved by students using either TM or CAI would be further helpful in examining the value of CAI. Because the Braille Training Program (Ponchillia & Holladay, 1983) provides immediate feedback and repetition of skills, it may also be helpful in terms of future retention of these skills. A study comparing the achievement of students in either a TM or CAI group at 6- and 12-month intervals after completion of a braille transcription course is suggested.

Finally, a comparison of CAI with the traditional method in relearning previously acquired transcription skills is recommended. As discussed earlier, there are many teachers who use their skills infrequently due to the nature of the population of blind persons. A study using a sample of persons who have not used braille skills over a period of time and who desire to relearn braille is suggested. Subjects would be assigned to either a computer-assisted instruction method of instruction or to a traditional method for a preset period of time, and then their achievement measured using the same methods as in the present study. It is expected that CAI would prove to be the most efficient, which would offer busy teachers a useful means of relearning braille transcription skills.
Reference Note

REFERENCES


Magidson, R. M. One more time: CAI is not dehumanizing. Audiovisual Instruction, 1977, 22 (8), 20-22.


Appendix A

Grade Two Braille Code Sheet
<table>
<thead>
<tr>
<th><strong>1 2 3 4 5 6 7 8 9 0</strong></th>
<th><strong>abcde fgh l</strong></th>
</tr>
</thead>
</table>

| **about** | **above** | **according** | **across** | **after** | **afternoon** | **afterward** | **again** | **again st** | **ally** | **almost** | **already** | **also** | **although** | **altogether** | **always** | **ance** | **and** | **ar** | **as** | **ation** | **bb** | **be** | **because** | **before** | **behind** | **below** | **beneath** | **beside** | **between** | **beyond** | **ble** | **blind** | **braille** | **but** | **by** |
|------------|-----------|---------------|-----------|-----------|--------------|--------------|----------|-------------|---------|----------|-------------|---------|-------------|--------------|--------|--------|-------|-----|-----|--------|---|---|---------|--------|---------|--------|---------|-------|------|-------|-------|---|
| about ab  | above abv  | according ac  | across acr| after af  | afternoon afn| afterward afw| again ag  | against agnt| ally | almost aim | already aim | also al | although alth| altogether alt| always alw | ance | and | ar | as | ation | bb | be | because bec | before bef | behind beh | below bel | beneath ben | beside bes | between bet | beyond bey | ble | blind bl | braille brl | but | by |
| about ab  | above abv  | according ac  | across acr| after af  | afternoon afn| afterward afw| again ag  | against agnt| ally | almost aim | already aim | also al | although alth| altogether alt| always alw | ance | and | ar | as | ation | bb | be | because bec | before bef | behind beh | below bel | beneath ben | beside bes | between bet | beyond bey | ble | blind bl | braille brl | but | by |

Available FREE on request from
MATVI: Michigan Association of Transcribers for the Visually Impaired • P.O. Box 20151 • Lansing, MI 48901

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APPENDIX B

Subject Recruitment Poster and Application

ATTENTION!

SPECIAL EDUCATION STUDENTS!

A unique opportunity is available to students in Special Education. As part of a research project, a free mini-course on Braille reading and writing will be offered. This six-week course will provide sighted students with introductory information about the Braille code.

Benefits: Free textbooks and supplies will be given to volunteers and may be retained upon completion of the course. You may find that participation in such a study and acquisition of this new skill will aid you in securing a teaching position after graduation. Also, you will receive a certificate of completion to hang on your wall!

Please complete the attached application blank if you can answer "YES" to the following questions:

1. Can you spend 4-8 hours per week on this activity? (some of this time will be spent on a computer or attending class in Sangren Hall)

2. Can you commit yourself fully to this project for six weeks?

3. Can you assure that you will complete the required lesson and accompanying quiz each week?

Contact Sue Ponchillia, Department of Special Education (383-1680), if you have any questions.
APPLICATION FOR PARTICIPATION
IN BRAILLE RESEARCH STUDY

NAME

LOCAL ADDRESS

PHONE

Please indicate below the times during which I can contact you easily.

Return to: Sue Ponchillia
3511 Sangren Hall
(or)
Department of Special Education
3506 Sangren Hall

Call 383-1680 (SPED Office) or 327-2552 (Sue's home) if you have any questions.
## APPENDIX C

Summary of Pertinent Information from Subject Interview Form

<table>
<thead>
<tr>
<th></th>
<th>CAI (n=16)</th>
<th>TM (n=11)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Previous Use of Computer:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>No</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td><strong>2. Frequency of Use of Computer:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Almost Daily</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Several Times a Month</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Several Times a Semester</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Once or Twice a Year</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Never</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>No Answer</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td><strong>4. Opinion of Learning with a Computer:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Positive</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Somewhat Positive</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>No Opinion</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Somewhat Negative</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Very Negative</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>No answer</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td><strong>6. Previous Braille Experience:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Have Seen Braille Previously</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>Know the Braille Alphabet</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Know Grade Two Braille</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>7. Performance on Braille Sample:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Could read none of the characters</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>Grade One Alphabet letters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-6 letters</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>7-12 letters</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>13-18 letters</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Grade Two Braille contractions</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Name_________________________________________ SS#_________________
Local Address__________________________________________________________
Phone_______________________________________________________________

*******************************************************************************

Please answer the following questions as completely and candidly as possible. This information will be used when the results of the study are examined, but your name will not be identified.

1. Have you previously used the computer to learn a skill or unit of instruction?  YES _____  NO _____
   If YES, please describe__________________________________________________

2. How often do you use a computer? (check one)
   ____ almost daily
   ____ several times a month
   ____ several times a semester
   ____ once or twice a year
   ____ never
   Comments______________________________________________________________

3. Do you feel you may need assistance in using the computer?
   YES _____   NO _____

4. How do you feel about learning with the aid of a computer? (check one)
   ____ very positive
   ____ somewhat positive
   ____ no opinion
   ____ somewhat negative
   ____ very negative
   Comments______________________________________________________________
5. Have you ever learned a language or code (such as Morse Code) before?
   YES______  NO______
   If YES, please list or describe_____________________________________
       ________________________________________________________________

6. What is your previous braille experience? (check one)
   ____I've seen a picture of the braille alphabet before.
   ____I've tried to read or write braille before.
   ____I know the braille alphabet symbols.
   ____I know what Grade I and Grade II braille are.
   ____I can read/write Grade II braille.

7. Why did you volunteer for this study?____________________________________
   ________________________________________________________________

8. What is your previous experience with blind people? (check one)
   ____None
   ____Have seen blind people on campus or downtown, etc.
   ____Have met at least one blind person.
   ____Have blind friends or relatives I've spent time with.
   ____Interact with blind people almost daily.

9. The following is a sample of braille. Please write the print equivalent under the sample.

   (A sample of tactual braille was inserted here.)
<table>
<thead>
<tr>
<th>Test Number</th>
<th>CAI Subject Number</th>
<th>TM Subject Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11.</td>
<td>1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11.</td>
</tr>
<tr>
<td>Two</td>
<td>9 14 13 12 11 10 9 8 7 6 5 4 3</td>
<td>9 14 13 12 11 10 9 8 7 6 5 4 3</td>
</tr>
<tr>
<td>Three</td>
<td>0 2 6 2 2 2 2 2 2 2 2 2 2</td>
<td>0 2 6 2 2 2 2 2 2 2 2 2 2</td>
</tr>
<tr>
<td>Four</td>
<td>3 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>3 0 0 0 0 0 0 0 0 0 0 0 0</td>
</tr>
<tr>
<td>Five</td>
<td>3 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>3 0 0 0 0 0 0 0 0 0 0 0 0</td>
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<tr>
<td>Six</td>
<td>3 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>3 0 0 0 0 0 0 0 0 0 0 0 0</td>
</tr>
</tbody>
</table>

Achievement Raw Data — Number of Errors Made

<table>
<thead>
<tr>
<th>Final Exam</th>
<th>Exam</th>
<th>p1</th>
<th>p2</th>
<th>p3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 1</td>
<td>3 0</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
</tr>
<tr>
<td>2 3 2 5 5 4 2 2 2 2 2 2 2 2</td>
<td>3 3 3 3 3 3 3 3 3 3 3 3 3 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 4 3 4 4 3 4 3 4 3 4 3 4 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 3 4 3 4 3 4 3 4 3 4 3 4 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 4 5 4 5 4 5 4 5 4 5 4 5 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 5 6 5 6 5 6 5 6 5 6 5 6 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 6 7 6 7 6 7 6 7 6 7 6 7 6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 7 8 7 8 7 8 7 8 7 8 7 8 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 8 9 8 9 8 9 8 9 8 9 8 9 8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 9 10 9 10 9 10 9 10 9 10 9 10 9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 10 11 10 11 10 11 10 11 10 11 10 11 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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## APPENDIX F

**Student Time Raw Data -- Measured in Minutes**

<table>
<thead>
<tr>
<th>Group</th>
<th>Subject</th>
<th>One</th>
<th>Two</th>
<th>Three</th>
<th>Exam</th>
<th>Four</th>
<th>Five</th>
<th>Six</th>
<th>Final</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI</td>
<td>1</td>
<td>280</td>
<td>145</td>
<td>310</td>
<td>60</td>
<td>195</td>
<td>105</td>
<td>180</td>
<td>60</td>
<td>1335</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>188</td>
<td>223</td>
<td>540</td>
<td>60</td>
<td>240</td>
<td>105</td>
<td>180</td>
<td>60</td>
<td>1596</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>120</td>
<td>230</td>
<td>180</td>
<td>90</td>
<td>165</td>
<td>105</td>
<td>150</td>
<td>90</td>
<td>1130</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>135</td>
<td>200</td>
<td>135</td>
<td>60</td>
<td>155</td>
<td>90</td>
<td>220</td>
<td>60</td>
<td>995</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>150</td>
<td>270</td>
<td>130</td>
<td>60</td>
<td>165</td>
<td>127</td>
<td>230</td>
<td>75</td>
<td>1147</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>205</td>
<td>235</td>
<td>150</td>
<td>85</td>
<td>260</td>
<td>120</td>
<td>145</td>
<td>85</td>
<td>1285</td>
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<td></td>
<td>7</td>
<td>205</td>
<td>160</td>
<td>245</td>
<td>78</td>
<td>120</td>
<td>180</td>
<td>120</td>
<td>80</td>
<td>1188</td>
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<td></td>
<td>8</td>
<td>90</td>
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<td>65</td>
<td>765</td>
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<td></td>
<td>9</td>
<td>180</td>
<td>120</td>
<td>120</td>
<td>70</td>
<td>60</td>
<td>150</td>
<td>210</td>
<td>90</td>
<td>1000</td>
</tr>
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<td>77</td>
<td>111</td>
<td>60</td>
<td>207</td>
<td>89</td>
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<td>75</td>
<td>1009</td>
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<td>90</td>
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<td>70</td>
<td>120</td>
<td>120</td>
<td>150</td>
<td>120</td>
<td>985</td>
</tr>
</tbody>
</table>

| TM    | 1       | 220 | 225 | 300   | 60   | 240  | 245  | 180 | 90    | 1560  |
|       | 2       | 165 | 255 | 360   | 60   | 300  | 300  | 180 | 60    | 1680  |
|       | 3       | 180 | 210 | 240   | 65   | 255  | 270  | 210 | 75    | 1505  |
|       | 4       | 240 | 210 | 240   | 60   | 255  | 270  | 210 | 60    | 1545  |
|       | 5       | 180 | 150 | 360   | 90   | 270  | 240  | 270 | 150   | 1710  |
|       | 6       | 285 | 265 | 265   | 60   | 205  | 180  | 120 | 60    | 1440  |
|       | 7       | 215 | 240 | 245   | 60   | 300  | 240  | 200 | 60    | 1560  |
|       | 8       | 215 | 250 | 270   | 60   | 300  | 270  | 200 | 60    | 1625  |
|       | 9       | 280 | 235 | 240   | 75   | 205  | 240  | 270 | 60    | 1605  |
|       | 10      | 212 | 230 | 275   | 55   | 260  | 255  | 215 | 75    | 1577  |
|       | 11      | 120 | 180 | 175   | 60   | 150  | 135  | 120 | 75    | 1015  |

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### APPENDIX G

Instructor Time Raw Data -- Measured in Minutes

<table>
<thead>
<tr>
<th>Group</th>
<th>Subject</th>
<th>Total Minutes</th>
</tr>
</thead>
<tbody>
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<td>CAI</td>
<td>1</td>
<td>330</td>
</tr>
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<td></td>
<td>2</td>
<td>398</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>420</td>
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<tr>
<td></td>
<td>4</td>
<td>394</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>291</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>404</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>370</td>
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<td>8</td>
<td>418</td>
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<td>9</td>
<td>423</td>
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<td>451</td>
</tr>
<tr>
<td>TM</td>
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<td>114</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>155</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>124</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>103</td>
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<td></td>
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<td>94</td>
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<tr>
<td></td>
<td>11</td>
<td>128</td>
</tr>
</tbody>
</table>
Appendix H

Sample

Certificate of Achievement
CERTIFICATE OF ACHIEVEMENT

Presented to

For successful completion of a six-week introductory

Braille Transcription course at Western Michigan University, Kalamazoo, Michigan

and in recognition of volunteer participation in Special Education research.

Susan V. Ponchillia
Instructor/Researcher

Date
BIBLIOGRAPHY


Bunderson, C. V. Current issues in the United States regarding CAI. Austin, TX: Texas University Computer-Assisted Instruction Laboratory, 1970. (ERIC Document Reproduction Service No. ED 009 046)


Dowsey, M. An investigation into the on-line teaching of programming languages. Programmed Learning and Educational Technology, 1972, 8, 34-47.


Magidson, R. M. One more time: CAI is not dehumanizing. Audiovisual Instruction, 1977, 22 (8), 20-22.


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