1982

An individualized teacher-directed spelling program compared with a computer-based spelling program

Brian Gustafson
Iowa State University

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AN INDIVIDUALIZED TEACHER-DIRECTED SPELLING PROGRAM COMPARED WITH A COMPUTER-BASED SPELLING PROGRAM

Iowa State University PH.D. 1982

An individualized teacher-directed spelling program compared with a computer-based spelling program

by

Brian Gustafson

A Dissertation Submitted to the
Graduate Faculty in Partial Fulfillment of the
Requirements for the Degree of
DOCTOR OF PHILOSOPHY

Department: Professional Studies in Education
Major: Education (Educational Administration)

Approved:

Signature was redacted for privacy.

In Charge of Major Work

Signature was redacted for privacy.

For the Major Department

Signature was redacted for privacy.

For the Graduate College

Iowa State University
Ames, Iowa

1982

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CHAPTER I. INTRODUCTION

Today almost every aspect of our lives is affected or controlled in some fashion by the computer. Billings, banking, payroll, and inventory control are all examples of the many societal functions touched by the usage of computers.

As computer use became widespread, a need to train personnel to operate and maintain computers grew. In the late fifties and early sixties, the first applications of computer technology to instructional settings evolved from this need to train personnel. These first attempts were made by industry. Even though these early efforts were expensive, educators began to realize that the computer had many unique features which could be used to facilitate learning.

During the sixties, the use of computer technology expanded and became less expensive, as did the potential instructional applications. In vestigations were conceived, proposed and conducted. The research findings were promising and some educators voiced the potential for yet another educational revolution, the computer-based learning revolution.

In the late seventies, a more restrained but equally committed position was still being voiced by educators. Bork, almost twenty years after the first educators picked up the banner, is still optimistic.

> While computers are widely talked about as a learning device, the amount of use of computers at the present time for learning could be considered at the level of trivia. Computer use now is a small fraction of other instructional delivery systems. Gradually over the next quarter century the situation will change drastically, until the computer becomes the major delivery system at all levels of education. (8, p. 201)

One may be perplexed by the twenty-year span during which educators have continued to proclaim the coming of the computer. Eisele has suggested that this long delay may be due at least in part to inadequate educational research and development.

> The question is not whether computers can help to perform many appropriate instructional functions but whether they can do so with fidelity to the way they should be performed and whether there are any benefits from their use. Both aspects of the question--that is the one concerning fidelity and the other possible benefits--are in need of considerable research and development. (20, p. 4)

Dence suggested a similar reason for the delayed entrance of the computer into the realm of education. In speaking to the issue of computer-assisted instruction (CAI), she commented:

> CAI is not being used as widely or as effectively as it might be if more educators were familiar with its capabilities. There is a great deal of confusion as to its place in the curriculum. In an effort to utilize CAI effectively, educators have raised questions concerning the conditions under which, and for whom, CAI is effective. These questions remain largely unanswered, although a wealth of research has been conducted to determine the viability of CAI as an instructional tool. Meanwhile, the computer revolution is becoming more pronounced and the use and capabilities of computers in education are increasing daily. Whether or not they will be used effectively depends on the ability to determine whether they can enhance learning. (16, p. 50)

Coupled with insufficient computer-based learning research is the discrepancy between what is known about instructional method and actual classroom practices. In the area of spelling, for example, there is a large body of research pointing out valid teaching techniques which are not being commonly used. Yet, spelling progress is unsatisfactory.

Graham and Miller pointed out that this unacceptable spelling growth may be due to a variety of causes.

> Unsatisfactory spelling progress may be attributed, in part, to inadequate contemporary classroom instruction, poorly designed commercial materials, and the absence of spelling programs based on research findings. (27, p. 1)

Even if research findings were widely disseminated, the complexity of the classroom environment would prevent teachers from implementing many validated instructional methods. With the advent of the microcomputer and microtechnology, it seems appropriate to examine the capabilities of this technology to aid teachers. A computer-based system incorporating recent technological advancements and research-supported spelling instructional techniques was assembled for this purpose.

Statement of the Problem

The purpose of this investigation was to examine the effectiveness of a stand-alone microcomputer-based system designed specifically to deliver an individualized spelling instructional program. The effectiveness of this program and system was examined with regard to student achievement, student retention of mastered words, cost effectiveness in terms of teacher time investments, and the attitudes of both teachers and students toward a computer-assisted individualized spelling program.

Need for the Study

Recent findings reported in the literature have not only established that computer-assisted programs can successfully individualize many curricular areas, but these findings also point to increased achievement, reduced time spent on task mastery, and increased retention (2, p. 31). The majority of reported computer-assisted instruction investigations have been done through the use of large, expensive, off-site

"main frame" computers not easily accessible to regular classrooms.

Spelling research, spanning more than sixty years, has established that certain instructional techniques produce greater spelling achievement and require less instructional time to do it. The research also indicates that these validated instructional techniques have not been widely incorporated into commercial texts nor are they generally used in elementary classrooms.

Present research does not provide information regarding whether or not the employment of inexpensive "stand-alone" computer systems that incorporate some of the research-validated teaching techniques can help students to learn to spell more words correctly and yet reduce the amount of time teachers and students spend in spelling instruction.

Definition of Terms

COMPUTER-ASSISTED-INSTRUCTION--a teaching technique in which the student interacts with instructional stimuli at a computer terminal on a one-to-one basis.

COMPUTER-MANAGED-INSTRUCTION--informational management system designed to support the individualization of spelling.

STAND ALONE MICROCOMPUTER SYSTEM--a microprocessor system that stored and retrieved individual student spelling information on site.

TEACHER--a certificated, full-time regular classroom teacher working with students in this study.

STUDENT--third- or fourth-grade pupil included in the sample.

MAIN-FRAME COMPUTER--a large capacity electronic data processing

unit with permanent data storage.

OFF-SITE COMPUTER SYSTEM--any system in which the computing capabilities were located away from the classroom and were connected to classroom-based terminals via telephone lines.

COMPUTER-BASED INSTRUCTION--a general term including both computer-assisted instruction and computer-managed instruction.

Sources of Data

The nature of this investigation necessitated gathering information from a variety of sources. All students were given pre- and postexperiment achievement measures. They were also given a retention test six weeks after the experiment. All students were also given pre- and post-experiment attitudinal surveys regarding their feeling about spelling and spelling study. In addition, treatment-group students were given a postexperiment computer-based learning attitudinal survey.

Teachers involved with this experiment were asked to log their instructional time investments for control and treatment group spelling activities. They were also asked to complete an attitudinal survey regarding the effectiveness of control and treatment group programs.

Delimitations of the Study

This study was limited to one hundred sixty-three third- and fourth-grade students from a midwestern suburban elementary school. The school in which this investigation was done had a total kindergarten through sixth-grade enrollment of approximately five hundred and fifty students.

This study was also limited to the seven teachers who were the regular classroom teachers assigned to the students involved in this investigation.

Summary

In summary, from the literature it was evident that there is insufficient research reported to encourage or to refute the use of microcomputer-based learning systems. The literature also pointed to the discrepancy between what research suggested should be done in spelling instruction and what is done. The purpose of this study was to examine the effectiveness of a spelling instruction system incorporating some of the research-supported spelling instructional techniques and the technology of microcomputers.

CHAPTER II. REVIEW OF RELATED LITERATURE

The nature of this study necessitated reviewing two broad categories of research, computer-based instruction and spelling instruction. The research literature on computer-based instruction included a wide array of curricular areas as well as learner ages and reported primarily findings related to the use of off-site "main frame" computer applications. Due to the character of the problem being investigated and the nature of computer-based instruction, this review encompassed both the areas of computer-assisted and computer-managed instruction.

In addition to reviewing computer-based instructional research, the problem investigated necessitated reviewing spelling research. This review encompassed both research-validated instructional techniques/procedures and current classroom levels of incorporation of these techniques. Only those validated techniques pertinent to this investigation were included in this review.

Computer-Based Learning (CBL)

In the context of this review of the literature related to computer-based instruction, it is important to differentiate between the concepts of computer-assisted instruction (CAI) and computer-managed instruction (CMI). Some authorities have put forth simple distinctions as do Bozeman and Thomas in their description of CAI.

> C.A.I. is a teaching medium in which a student responds to displays of various kinds presented on a computer terminal (a small television screen or a typewriter-like devise that

> connects to a main computer). A student sits in front of a computer screen that presents questions. When the student provides a correct answer the computer might provide new material and go on to other questions. (10, p. 23)

In distinguishing between computer-assisted instruction (CAI) and computer-managed instruction (CMI), Bozeman and Thomas suggested:

> Although computers help the student learn, this is only half the equation; computers also help the teacher keep track of information regarding student progress. This is known as Computer-Managed Instruction. (10, p. 25)

Fred Splittgerber concurred with Bozeman's and Thomas's description of CAI but goes much further in defining the role of computer-managed instruction. Rather than aiding the teacher as Bozeman and Thomas suggested, he defined CMI as follows:

> In contrast, CMI is defined as an instructional management system utilizing the computer to direct the entire instructional process, including perhaps CAI as well as tradition forms of instruction. . . . (68, p. 20)

Like many complex discriminations, distinguishing between the concepts of CAI and CMI turns out to be a multidimensional problem. Much of the confusion evident in examining expert definitions of CAI and CMI results from the similarity in the external, functional characteristics of the two approaches. Both CAI and CMI use a computer system to guide instruction and both are directed at individualizing instruction.

Robert Fromer with the Control Data Corporation contended that differentiating between CAI and CMI is not a simple either/or question but rather a question of degree in relation to seven dimensions. He suggested that each dimension can be thought of as a continuum upon which an activity falls. His dimensions follow:

(1) Student/Computer Interaction
(2) Programming Languages
(3) Batch vs. Incremental Processing
(4) Real-Time Tolerance
(5) On-Line Requirement
(6) Decision-Making Requirements
(7) Lesson Material Storage
(25, pp. 30-31)

Fromer suggested that the final distinction between CAI and CMI is largely a question of the degree that any computer-based activity falls toward one pole or the other on each dimension. He contended that CAI activities tend to fall toward one end of a continuum and CMI toward the other (25). Thus, it can be seen that separating computer-based activities between the two general categories of CAI and CMI is more a question of degree than a question of what type.

For the purposes of this review, those computer-related activities whose primary function is to deliver student instruction on an interactive basis are considered computer-assisted instruction CAI. Computer-managed instructional CMI activities are considered to be those activities that seek to facilitate the processing of information and to supply this information at appropriate times and places, so that it can be applied directly to instructional decision-making.

Computer-Managed Instruction (CMI)

Most computer-managed instructional activities are predicated on the rationale that it is important to relieve the teacher of various tedious and time-consuming management tasks and so leave him/her with more time to devote to the essence of teaching. The computer is cast

in a supportive role in which it helps to manage, rather than provide, learning opportunities. What the computer does in a CMI system is not complex but does require the speedy, accurate handling and processing of large amounts of information.

Baker has described three themes in American education which have contributed to the development of CMI:

1. Individualization--Educators have demonstrated an intuitive feeling about the existence of means to meet the instructional needs of individual students. Individualization of schooling has been a primary motivation in most CMI development.

2. Behavioral objectives--Student behavior or performance is specified in precise terms as part of the curricular structure. This is usually accompanied by some specification of time, means, and evaluative measures.

3. Educational technology--The impact and progress of technology has been closely scrutinized by educators for instructional potential. The primary focus of attention in recent years has been on computer utilization. (4, p. 118)

Perry and Keyser have suggested some areas where the computer can provide management assistance in instruction:

1. Administer and grade student test

2. Schedule student assignments and testing

3. Provide student with progress reports

4. Sequence students through instruction

5. Provide progress reports to teachers and administrators

6. Compile statistical data

7. Retrieve and analyze stored data on request

8. Make media decisions about instructional strategies, including media selection. (61, p. 173)

The evaluative literature related specifically to CMI is limited. Most references located dealt primarily with descriptions of one particular CMI system or another. Because most computer-based instructional systems are a combination of both CAI and CMI, research in this area is complicated by the difficulty of separating the effects of CAI from the effects of CMI. A further complication occurs in attempting to evaluate the cost-effectiveness of CMI in that there seems to be little agreement regarding a meaningful criteria for such an evaluation.

Bozeman in his paper entitled, "Computer-Managed Instruction: State of the Art," concluded that CMI does have some effect on student achievement.

> The available evaluative data appears to indicate that an increase in student achievement is associated with the implementation and utilization of CMI. (9, p. 132)

He commented further about attitudes toward CMI:

> In general, the available information indicates a favorable or positive attitude toward CMI. This conclusion must be tempered by the fact that often such measures reflect only a certain subset of the district population. Such groups may reflect special characteristics that led to their decision to implement computer-based information systems. Such characteristics may include acceptance of innovations, low anxiety about technological systems, perceived need or assistance in decision making, and administrative support. (9, p. 132)

The pertinent observation regarding CMI research is that this area of computer-based instruction suffers from a lack of a well-designed longitudinal study.

Computer-Assisted Instruction (CAI)

Computer-based programs have been found useful in providing instruction to students. McCulloch in his article on computer-assisted learning systems contended:

> In sum, the main argument for computer-assisted learning is the argument for independent or individual learning of any kind. (55, p. 13)

In the early 1900s, E. L. Thorndike wrote, "Just as personal teaching is precious and can do what books and apparatus cannot, it should be saved for its peculiar work" (75, p. 13). He was saying then what many computer-based instruction enthusiasts are promoting today, that human beings should not be wasted in doing what books, tapes, filmstrips, or a computer can do.

Speaking about computer-based instruction, Perry and Keyser were unequivocal in their stance.

> Computer instruction is a medium designed to promote efficiency in instruction. It (the computer) allows for individualized instruction to occur without compromising the position of the student or the teacher in the instructional process. Computer instruction allows for the effective integration of sensory and motor skills of the students. There is no delivery system for instruction that has the versatility and flexibility of computerized instruction. Computer instruction allows for maximum student interaction with the medium and still recognizes the teacher as an integral part of the instructional process. For many instructional situations, it is necessarily the medium of choice. (61, p. 174)

Other authors have held a more reserved position regarding the usefulness of computer-based instruction. Suppes and Macken suggested in their historical review of CAI research:

> Overly optimistic forecasts have been a common disease of

> the computer industry since its inception. This is especially true of forecasts about new and sophisticated uses of computers. (70, p. 11)

The earliest applications of computer-based instruction during the late 1950s were found in the computer industry itself. These early CAI programs written in fairly complex programming languages were used to train their own personnel in the use of computers. In the early 1960s, Stanford University began a research and development program in CAI that has resulted in some of today's most widely-used classroom applications. Stanford's first efforts were directed toward developing a mathematics course for elementary school-aged students. During the mid and late 1960s, researchers at Stanford expanded their efforts in CAI by switching from teletype machines to video monitors, moving terminals into classrooms, expanding into reading areas and adding university-level computer-assisted instruction.

In the 1960s, another widely-used CAI program was under development at the University of Illinois. This was the PLATO system which today delivers a wide variety of curricular offerings through an interactive system using alphanumerics, graphics and animation.

During the early 1970s, several major CAI projects were developed. The Time-shared, Computer-Controlled, Information Television (TICCIT) system was completed at Brigham Young University providing programs in English and Mathematics for college level students. In the early 1970s, another college-level CAI program titled CARE was developed to provide self-contained teacher training experiences.

All of these efforts designed programs around massive off-site

computers connected to classrooms via telephone lines. Even though microcomputers began appearing in homes and classrooms during the late 1970s, little research work has been reported with regard to this type of computer's effectiveness in providing CAI programs.

During this period from the early 1960s to the late 1970s, a body of research was being formed relating to the utility of off-site based CAI. The findings from these studies provide guidance for understanding the conditions under which CAI is effective.

In the area of individualization, CAI provides students with the individualized instruction they may often fail to receive in a large classroom setting (57). A reported advantage was that students were able to participate at each step of the lesson by responding before moving on to new material, therefore maintaining greater amounts of learner involvement and program control (58). In addition, further individualization is promoted by having decisions and branching based on student performance variables such as response pace or the percentage of correct answers.

The importance of immediate and individual feedback is pointed to as an additional advantage of CAI (29, 57). Students receiving feedback demonstrated higher pretest/posttest gain scores than those who did not receive feedback (72). There is, also, greater lesson-material retention when students are given immediate feedback (52).

In comparing achievement levels of students in CAI programs with students in traditional programs, CAI student learning equaled or exceeded the achievements of students receiving traditional forms of

instruction. Magidson found in 1978 that CAI students did as well as their traditionally instructed counterparts in 55 percent of the reported studies and did better than the traditionally instructed groups in 45 percent of the reported studies (58). Suppes and Morningstar found that 74 percent of the students in a Russian class using CAI performed better than the best student in a traditional class (69).

The available research has demonstrated that few researchers bother to investigate retention of learned materials beyond the posttest. Thomas concluded on the basis of available evidence that retention of CAI learners when compared with non-CAI learners is at least equal (73).

Reported research has indicated that students using CAI take less time to learn as much or more than students under traditional instruction (1, 54). Medical science students using CAI took only one-third to one-half as much time to cover a semester's material as did students under traditional instruction (5).

After reviewing more than sixty-five studies and papers reported from 1974 to early 1979 covering a variety of CAI applications, Thomas concluded:

> The studies reviewed paint a positive picture for computer-assisted instruction. In past years proponents hoped to see great achievement gains for CAI courses, spoke of very low costs and high retention, and did not mention time at all. Today, CAI as a medium has "settled down." Achievement gains over other more traditional methods are the norm, but mere equivalence with very good instruction is also attained. Retention is equal to that obtained in traditional instruction. The technology fosters generally favorable attitudes toward computers and often toward the subject being taught. Perhaps the most valuable finding in the long run is that many CAI students gain mastery status in a shortened period of time. Finally, CAI cost appears to be approaching that of conventional instruction, but until standardization of cost

algorithms occurs, comparisons are tentative. (73, p. 111)

In recently reported research pertaining exclusively to elementary-aged students, the findings echo Thomas's conclusions. The Educational Testing Service reported in the 1979 winter bulletin on their five-year longitudinal study being done in cooperation with Los Angeles Unified School District. This study using CAI basic skills materials developed by the Computer Curriculum Corporation in mathematics, reading, and language arts is seeking to answer several questions regarding the use of CAI approaches with elementary-aged students.

Educational Testing Service researchers Marge Ragosta and Paul Holland are evaluating the effects of CAI on compensatory education in grades one through six. Their research is examining (1) if computer-assisted instruction can improve subtest scores measured in standardized achievement tests, (2) what happens when the amount of CAI varies over the school year, (3) whether student achievement can be improved by using computers for two or more years, and (4) what achievement gains are lost after CAI stops.

This experimental-design study involves more than 2500 randomly-assigned students from both Title 1 and non-Title 1 schools. This project will ultimately expose some students to four years of computer-assisted instruction, others to three years of CAI, and some students will receive only more traditional forms of instruction.

After three years, the researchers have reported encouraging preliminary results:

The CAI curriculums have had measurable, positive effects

> on student performance in mathematics and language arts. At this stage there appears to be a consistent, increasing relationship between the amount of time spent on the CAI curriculums and students' performance, especially in mathematics. (14, p. 1)

Demshock and Riedesel, in a United States Office of Education sponsored project, sought to develop a CAI spelling program for sixth-graders. One objective of their work was "to compare a spelling program offered via CAI with a program using conventional procedures" (15, p. 19). They drew the following conclusions from their findings regarding the use of computer assistance in spelling instruction.

> Elementary school pupils at the sixth grade level readily accepted instruction by computer. The children, as might be expected, were excited about being "taught by a computer", but by no means over-awed. In general they looked forward to their turn on the terminal, frequently arriving a few minutes ahead of time or requesting extra time. Teachers reported that they did not have to remind most children that it was time for them to go for the computer session.
>
> The children learned to operate the terminals quickly--by the end of the third session almost all were signing themselves on, making corrections, signing off. (15, pp. 42-43)

Pertaining to individualization of instruction, they found:

> Variations in amount achieved were evident. There is some indication that the low achievers seemed to profit most (as indicated by achievement gain scores) from CAI instruction. This is the group which needs extra teacher time in the classroom--thus teaching spelling to them costs more money. (15, p. 43).

In addition, Demshock and Riedesel concluded:

> A CAI program can individualize instruction. The varying lengths of time it took pupils to complete the program is a strong indication of time saving for some pupils as well as representing one type of individualization of instruction. (15, p. 45)

Dunwell et al., using a computer-assisted instructional course

designed to help students with spelling and grammar called WRITE, examined whether this CAI approach could help fifth-grade students with their spelling. Their findings are based on the results of 42 test and control pairs. They concluded:

> CAI can be effective. The average post-test gain of 14.7 (40.1 to 54.8) for the test group as compared to 7.1 (38.4 to 45.5) for the corresponding control group clearly demonstrates that WRITE was effective. (18, p. 25)

Dunwell et al. also found evidence supporting CAI use in individualizing instruction.

> CAI can be sensitive to individual student needs. The amount of time required to complete the course varied with the degree of need. The five students with the highest pre-test scores required an average of 14 hours and 23 minutes to cover the material, as compared to a mean for the entire group of 22 hours and 30 minutes and a mean of 30 hours and 12 minutes for the five with lowest pre-test scores.

In reviewing a related body of CAI research, but not limited to spelling and/or elementary students, Thomas presented evidence related to the effectiveness of employing computer technology in instruction. Thomas reviewed CAI findings in accordance with achievement, attitude, time savings, cost and retention. Thomas concluded his review of the research on learner achievement as follows:

> The studies reviewed which attempted to evaluate the effectiveness of CAI overwhelmingly support CAI as a viable instructional alternative. At the secondary level the studies have shown higher achievement scores whether measured by teacher-made tests, gain scores on local or standardized tests, or on predicted versus actual scores using regression analysis methods. (73, p. 106)

Even though Thomas reported favorable learner attitudes toward CAI, he

cautioned readers regarding attitudinal research findings.

> Affective change as expressed by attitude is an elusive variable. Instruments are much less precise and the results are often not of a sort which may be interpreted easily. (73, p. 108)

Thomas concluded his review of the attitudinal-related research with the following:

> The few studies which report empirical evidence on student attitude agree that CAI-exposed students have the same or higher levels of good feeling toward their instructional situation than non-exposed students. (73, p. 107)

The developing body of research relating to the effectiveness of CAI supports the use of computers as learning tools. Computer-assisted instruction provides additional opportunities to individualize instruction, produces student achievement level equal to or higher than traditional instructional forms, and requires less learner time to reach task mastery.

Spelling

Spelling accurately is important at all levels of writing. While spelling is neither the most important nor the least important aspect in writing, it is a crucial ingredient. Good spellers commit their thoughts to paper freely. Poor spellers struggle to communicate through the written word.

Spelling mastery presents challenges to both the student and the teacher. As a traditional element in the elementary school curriculum, spelling occupies a considerable portion of the instructional day and

a good measure of each elementary school teacher's energies. Rightly or wrongly, the general public often associates accurate spelling with such personal qualities as neatness, cultivation, and being erudite while incorrect spelling connotes a link with illiteracy.

A quotation from Charles Hoole in 1660 aptly describes the plight of student and teacher alike: ". . . ordinary English spelling, that most troublesome torture of wits" (38, p. 4).

This dilemma has certainly contributed to what Schroeder identified as "one of the most thoroughly investigated areas in the elementary curriculum. It, of course, has also been one of the fundamental subjects in the curriculum" (66, p. 1).

Hanna and others defined spelling as the "process of encoding, or of rendering spoken words into written symbols" (32, p. 264). Brueckner and Bond put forth this definition: "ability to produce in written and oral form the correct letter arrangement of words" (11, p. 346).

Spelling is a variety of integrated skills and as such requires a more complete definition than either of those offered. For the purpose of this review of spelling literature, the investigator has chosen the following definition:

> the ability to recognize, recall, reproduce, or obtain orally or in written form the correct sequence of letters in words. (27, p. 2)

The nature of the problem investigated here necessitated examining some of the research-validated spelling instructional considerations. These considerations were spelling vocabulary (spelling words elected from a pool of most frequently-used words), the presentation of words

in lists rather than in context, the importance of pretesting, the effects of immediate feedback in conjunction with the impact of self-correcting, time allocations, and individualization.

Spelling vocabulary

There has been considerable research done regarding which words should be included in spelling programs. Ernest Horn stated that "the frequency with which words are written by children in a given grade is now generally regarded as the primary principle of the selection of words for that grade" (42, p. 7). Horn also suggested:

> It seems desirable that the words to be taught in any grade should be chosen from among those words that appear in writing done by children in that grade and from words used (frequently) in adult writing, thus insuring both present and future value. (43, p. 1344)

Several researchers have examined the vocabularies used in both children and adult's writing. Studies by Thorndike and Lorge (74), Fitzgerald (21), Dolch (17), E. Horn (39), and Rinsland (64) have all identified frequencies of word usage. T. Horn and Otto (46) suggest that based on these findings a basic spelling vocabulary of between 2,800 and 3,000 high-frequency words would be valuable in both children and adult's writing. Allred recommended a basic vocabulary of 4,000 words (2) (see Appendix A).

> In comparing the 3,000 words used most frequently by children with the 3,000 words used most frequently by adults, the author found an overlap (words used by both children and adults) of approximately 2,000 words. This means that with 4,000 words--those used frequently only by children (about 1,000), only by adults (about 1,000), and by children and adults together (about 2,000), it is possible to identify

> 97 percent of all words used frequently by children and adults in their writing. (2, p. 17)

The findings suggest that to require children to master a basic spelling vocabulary larger than those suggested would be out of concert with more than fifty years of research.

The consistency of vocabularies sampled from different time periods is remarkably stable. Hollingsworth, in 1965, compared the words written in letters to the editor with Horn's 1926 vocabulary listing and found that very few words have come into our vocabulary since 1926 (37).

Words in lists

Three basic approaches are used in teaching students spelling words: (1) spelling only the words presented in a column or list form, (2) writing a sentence including the target word, and (3) writing a paragraph incorporating the spelling word to be learned. Research dating from 1916 regarding which of these approaches is most productive, has supported the list format as the most effective. Ernest Horn stated:

> Research has consistently shown that it is more efficient to study words in lists than in context. Words studied in lists are learned more quickly, remembered longer, and transferred more readily to new contexts. (40, p. 16)

In a study involving 1,100 students in grades three through eight, Hawley and Gallup sought to determine the relative superiority of the list method and the context method (writing spelling words in sentences) in teaching spelling. The principal conclusion to be drawn from this study was that there was no advantage in having children write their spelling words in sentences. Pupils using the list method did

consistently better than those using the sentence method (34).

In another study, McKee sought to compare the relative effectiveness of teaching spelling in a list form with both the sentence form (context) and the paragraph form (context). According to his results, the list format students were equal to or exceeded the performance of the students learning spelling in either the sentence format or the paragraph format (56).

Pretesting

Evidence points to the superiority of the test-study-test method of instruction when compared with the study-test method. As early as 1923, Kingsley found in his two-year experiment with fifth- and eighth-graders that students using the test-study-test method showed better gains than those who used the study-test method (51).

In a study involving more than fifteen hundred students, Gates found that the test-study-test method was better for "bright" students, was better for "average" students, and was better for "slow" students (26). Gates has contended that the test-study-test method might be effectively used with students as young as the second grade (26). Fitzgerald (22) and Horn (43) have suggested that this spelling approach is appropriate at any grade level in which spelling is taught.

Regarding the test-study-test method, Petty stated:

> there is an accumulation of research evidence going back about 40 years which shows the value of the pretest in building positive attitudes in children toward spelling instruction and in resulting high spelling achievement. (62, pp. 86-87)

Feedback and the self-corrected test

The importance of each student receiving prompt feedback regarding the correctness of their spelling is pointed to by some of Thomas Horn's work. Using what is commonly called the self-corrected test approach, a procedure in which the student receives immediate information about the accuracy of his/her attempt, Horn found that the self-corrected test contributed "from 90 percent to 95 percent of the achievement resulting from combined effort of the pronunciation exercise, corrected test and study" (45, p. 285). He also stated: "The corrected test appears to be the most important single factor contributing to achievement in spelling" (45, p. 285).

Allred carried this concept further by suggesting, "The self-corrected test technique works well when conditions exist that permit students to be tested on a word and to correct it immediately afterwards" (2, p. 23).

Time allocations

Approximately fifteen minutes of spelling instruction per day appears to be agreed upon by spelling authorities. These periods of daily instruction are recommended for students from the middle of second grade through the completion of elementary school (63).

In a study done to determine the relationship between spelling achievement and time allotted to spelling, Larson concluded that reducing spelling time from one hundred minutes per week to sixty minutes per week had little adverse effect on achievement (53).

Jarvis reported a study indicating that students did not benefit from extended periods of spelling study. These data revealed that intermediate grade students studying twenty minutes per day achieved at the same level as those studying forty minutes per day (50).

Thomas Horn stated: ". . . time allotted for the study of spelling in excess of 60 minutes a week may be spent more advantageously in other areas" (45, p. 284). Ernest Horn warned against thinking that large amounts of time spent in spelling instruction will produce equally large gains in spelling achievement. He wrote as follows: "What is needed is not more time but spirited, efficient use of instructional procedures" (43, p. 1346). The suggested reasons given for this diminishing return from invested time related to student interest and motivation.

Individualization of spelling instruction

Spelling achievements of individual students in a given elementary grade level are dispersed much the same as they are in other curricular areas. Whole group spelling instruction continues to be an area in which many students meet failure. Horn reported that in general one-fourth of the students in any grade spell as well as the average of the students in the grade above and one-half spell no better than the average of the class below (44).

Manolakes reported the following from his spelling investigation:

> Further, the average child in this suburban sample seemed also able to spell a substantial number of words that have been designated for the level one grade above the present grade placement.
>
> These findings suggest the possibility that large

> numbers of children may be spending a good part of their time in school with instructional activities that they could already successfully complete before they reached the grade level in the instructional sequences. (See Appendix B.) (59, p. 244)

A wide range of spelling achievements is apparent at every grade level. The skills and needs of students are different. Teachers failing to account for individual differences often rely on a hodge-podge of approaches that produce a hodge-podge of results (67).

The importance of individualizing spelling instruction is pointed out by Guiler and Lease. They found that students from all levels of spelling achievement benefited from an individualized spelling approach. They reported that students receiving spelling instruction based on each individual's needs experienced substantially greater gains than students receiving instruction in the conventional group basis (30).

It can be seen that there are sufficient research data to support the widespread classroom usage of a spelling vocabulary drawn from frequently-used words, and that these words should be taught in a list form rather than in context. The importance of pretesting is also amply supported in the findings, as is the significance of providing immediate learner feedback through the use of the self-corrected test procedure. A research conclusion suggesting that between sixty and seventy-five minutes per week spent in spelling instruction is well-supported in the evidence. To maximize the efficiency of learning unfamiliar words, research points out the importance of recognizing individual spelling achievement differences.

Incorporation of research validated techniques

Teachers with varied years of experience will produce an equally varied list of ways to teach elementary spelling. The ways in which spelling is taught ranges from focusing on parts of words (phonemes, syllables, inflectional endings, and affixes) to emphasizing whole language development by including spelling instruction with the other language arts skills. This wide diversity of spelling approaches results from the influences of teacher style, instructional materials, administrative fiat, and the lack of incorporation of pertinent research findings.

Percival Symonds wrote:

> Sometimes it seems as though in spite of all the discoveries made by psychologists in the past two generations that have application to the process of education, in too many places education is still coasting along on traditional rule-of-thumb methods. (71, p. 1)

Spelling is no exception to this observation E. Horn suggested that many of the problems in spelling could be improved through applying what is already known. He stated:

> The evidence is sufficiently complete and convincing to enable schools to teach spelling with substantial professional efficiency. Shortcomings in the teaching of spelling are therefore due not so much to the absence of satisfactory evidence as to the lack of knowledge of existing evidence, to the failure to apply it intelligently, or to erroneous interpretations. (41, p. 6)

As Schroeder suggested, spelling historically has been one of the most frequently investigated elementary school curricular areas. Even though there is a large body of research concerning spelling, many unsolved problems remain (66). Christine and Hollingsworth noted the

large number of studies that have been done in spelling, "yet, many pupils have learned to spell incorrectly" (13, p. 565). Fitzsimmons and Loomer observed that ". . . improvement in spelling programs in the elementary schools does not seem commensurate with the research efforts" (23, p. 1). Petty also contended ". . . that much has been learned but the knowledge has not been used. The problem in spelling really is the application of what is known" (62, p. 79). Horn concurred and stated that ". . . the chief problem today appears to be a more critical and universal application of the evidence available" (43, p. 1350). Campanole also suggested, "If instruction in spelling were planned in a more definite fashion utilizing pertinent research findings, it could be made more meaningful" (12, p. 446).

In a massive research effort, Fitzsimmons and Loomer after reviewing sixty years of spelling research, attempted to determine the level of research awareness and the level of classroom incorporation of research-supported spelling instructional techniques. They surveyed more than twelve hundred Iowa teachers to answer questions such as: "In general terms, is the elementary teacher knowledgeable about research-supported procedures in the teaching of spelling?" (23, p. 2). They also sought to ascertain the following: "Does the teacher, in fact, utilize research-supported techniques in conducting the spelling program in his (sic) classroom?" (23, p. 2).

The Fitzsimmons and Loomer study sought to discover the levels of teacher awareness and the levels of utilization for a variety of spelling procedures. Teachers teaching in grades two through six were asked to

agree, disagree, or be undecided about twenty spelling procedure statements to determine levels of awareness. Ten of these statements were about research-supported spelling procedures, and ten were regarding commonly-used but unsupported spelling procedures. This same sample of teachers was also asked how frequently they used each of the twenty procedures (almost always, frequently, sometimes, infrequently, and almost never). An example of Fitzsimmons and Loomer's technique can be taken from their query regarding presenting words in lists.

> AWARENESS: Presenting words in list form, initially, is a more successful method than presenting spelling words in sentences or paragraph form. (23, p. 27)
>
> UTILIZATIONS: As an elementary teacher I have pupils study their spelling words in a list or column form. (23, p. 27)

After examining teacher responses to the questions of presenting words in list or column form, Fitzsimmons and Loomer found that even though this technique was supported in the research more than forty percent of the teachers disagreed with presenting words in list form. Regarding teacher utilization of this instructional technique, almost one-half of the teachers (46%) said they used it sometimes, infrequently, or almost never (23, p. 25).

Fitzsimmons and Loomer found greater agreement between research evidence and teacher perception in the area of using high-frequency words. The majority of teachers (91%) agreed that spelling words should come from those words most frequently used in child and adult writing. They also found that three-fourths of the teachers employed this technique

in the classroom (23, pp. 28-29).

In spite of the research over the past forty years supporting the value of pretesting prior to study, more than one-half (58.6%) of the teachers disagreed or were undecided about the merit of pretesting. An almost equally large group of teachers (51.8%) indicated that they infrequently or almost never utilized this procedure in their teaching (23, pp. 39-40).

There is ample research evidence pointing out the value of a child correcting his/her spelling as an instructional procedure, but more than forty percent of the teachers responding (42.7%) indicated that they disagreed with this practice, and another twenty-five percent indicated that they were undecided about the practice. A large group (34.5%) indicated that this procedure was almost never or infrequently employed in their classroom (23, pp. 30-31).

Fitzsimmons and Loomer found that slightly more than one-half of the teachers (58.8%) agreed with the research-supported suggestion of limiting spelling instruction to sixty to seventy-five minutes per week. It is interesting to note that nearly three-fourths of the teachers (72.3%) indicated that they almost always applied this procedure to their teaching (23, p. 38).

One of the conclusions Fitzsimmons and Loomer drew from their work in spelling was the disparity between research and practice.

> An important conclusion from this study, and one having significant implication, is that a serious gap appears to exist between the existing research in spelling and its application in the classroom. (23, p. 53)

These investigators suggested the following as a possible explanation for the gap between research findings and classroom practices:

> Perhaps a major factor for a teacher's failing to know this research and to apply it in the classroom is the fact that many publishers of spelling materials have not made results of the field-tested research available to teachers through their spelling series. (23, p. 54)

They have recommended to educators:

> Recognize that tremendous variability exists between the popular spelling series available to schools. These differences are due chiefly to the failure of the publishers to insist that available evidence be followed. (23, p. 57)

Yee and others mirrored this criticism of existing spelling materials. They suggested the following:

> One reason for the lack of theoretical integration has been the avoidance under traditional views and practices of handling individualized spelling instruction and learner data. Such problems have been perpetuated by the traditionally powerful influence of textbooks upon spelling instruction, which causes the purchase and use of millions of spelling workbooks annually. As a result, innovation and concern for improvements in spelling have been inhibited, and developments in spelling have tended to be restricted to simplex group methods and norms. (76, p. 54)

Allred looked to the future of spelling in his recommendations for continued attentions to such areas as spelling reform, application of past research, application of proven steps in spelling study, keeping student interest high and the individualization of spelling instruction (2, p. 41). He has commented on technological aids for spelling instruction:

> Machine aids, especially the tape recorder and computer-assisted teaching, have made important inroads in several instructional areas during the past decade. Their contributions to spelling could be valuable. They have the capacity to store information in unique and potentially effective

> ways. Through their use, students can be motivated, and instruction can be individualized. (2, p. 44)

Summary

From the review of the pertinent literature, it was evident that there was research support for the viability of computer-based learning systems. The reported research was based almost solely on the use of off-site, main-frame computers. No research was located that investigated the viability nor the effectiveness of a microcomputer-driven computer-based learning system.

The spelling literature strongly suggested that certain practices promoted spelling achievement. It was also evident in the literature that even though there was ample research support for these spelling approaches, they are not incorporated into everyday classroom instruction.

This study was developed to examine the feasibility and the practicality of incorporating validated spelling techniques into a microcomputer-driven computer-based learning system.

CHAPTER III. METHODS AND PROCEDURES

This study examined the effectiveness of a computer-based learning system designed specifically to provide individualized spelling instruction. While the primary thrust of this investigation was to determine this system's effectiveness in promoting spelling achievement, the areas of learner and teacher attitude, and the area of teacher instructional time investments were also examined.

Description of the Population

The population for this investigation was the third- and fourth-grade students and teachers from a midwest suburban elementary school. It was deemed desirable to use these students and teachers for the following reasons: (1) the students were old enough to operate the equipment independently; (2) the students were mature enough to handle the paper and pencil tasks associated with this study; and (3) the students' previous spelling instruction had been in two distinctly different but commonly-used programs.

The experimental subjects were from an upper-middle class suburban school district. One hundred sixty-three students and the seven teachers regularly assigned to these students comprised the study population. This study included all the students from the third- and fourth-grades at this attendance center with the exception of one individual. This student participated as did the others, but his data were excluded from the statistical analysis because of his limited experience with the

English language.

The sample students and teachers regularly worked in a multi-age grouped, team teaching setting. All teachers had instructional responsibilities in each curricular area. Every teacher involved in this investigation taught spelling prior to and during the investigation. All students were grouped for spelling instruction in accordance with their individual skill needs.

One team of teachers and their students, prior to this investigation, worked in the Laidlaw Spelling program. These four teachers and ninety-two students used a spelling cycle common to many textbook series: Monday, introduce the words of a particular unit; Tuesday, study the words; Wednesday, pretest the words to determine the words needing more attention; Thursday, study difficult words; and Friday, a final test over the entire unit word list. To provide for individual differences in spelling, students working in the textbooks were placed by their teachers to work in spelling books designed for second- through fifth-grades.

The other three-teacher team worked with seventy-one students in the International Graduate School of Education system for spelling prior to beginning this study. This instructional approach used individually-contracted word-lists and peer partners in a structured-study format encompassing activities such as pronouncing the word, visualizing the word, and writing the word multiple times before testing over the words. Students working in the contracted, word-list program were placed in the sequential word-lists by means of a fall placement test and then each progressed through the lists at individually determined rates. At the

beginning of this study, students in this program were working on word-lists ranging in difficulty from second grade to eighth grade.

The principal differences between the Laidlaw text program and the Internal Graduate School of Education program (contracted-list) were the greater flexibility in the rate at which new words were encountered by students in the contracted-list program and the contracted-list program's concentration on learning unknown words without incorporating nonspelling, language arts skills into spelling activities.

Design of the Study

This study was conducted in an experimental design format. A control group of students working in a teacher-directed individualized spelling program (contracted-list) was compared with a treatment group of students working in a computer-assisted spelling program. Both groups of students worked with the same master word-list (see Appendix C) during an eleven-week period in the spring of 1981.

Immediately preceding the initiation of the experiment, all students were given a spelling placement test to determine the initial placement level for each student in both the control group and the treatment group. All students were also given an attitudinal survey prior to beginning the experiment. This survey examined student attitudes toward spelling and spelling study. The students were assigned to the two groups randomly, controlling for achievement level. If one group received an extra student from one achievement level due to an odd number of students, care was taken to assign the next "extra student" to the

other group. The groups were then randomly assigned to treatment and control groups. Even though it was not controlled, an approximately equal number of students from each of the seven classrooms fell into treatment and control groups.

At the end of the experiment, all students were given a forty-item achievement test covering the words each student had encountered during the investigation. A postexperiment attitude survey pertaining to spelling was also administered at this time.

In preparation for this investigation, the four teachers and ninety-two students who had been working in a commercial textbook series were provided the necessary inservice and materials to enable them to work successfully in the contracted-list spelling approach. This inservice was necessary because all teachers and those students randomly assigned to the control group would use the contracted-list approach during the experiment. The remaining students and teachers were familiar with this instructional approach and were not involved in these activities.

Prior to beginning the experiment, all teachers and treatment-group students were given training in the CAI spelling program. Teachers were provided a manual for operating the system and opportunities to work on the system in both the teacher and student modes. Teachers were also given sample student progress reports and shown how to interpret this information. Treatment-group students were given two training sessions to familiarize them with the use of the equipment and sign-on procedures before beginning the experiment.

Two paraprofessionals were also trained to operate the equipment. The primary responsibility for these people with regard to the spelling system was to monitor operations, supervise student data storage, and to correct equipment problems. Assisting students with spelling problems other than those involving equipment was discouraged.

In addition to these inservice activities, a modification of the word lists for the three teachers and their students already working in the contracted-list approach was made in the fall of 1979. The majority of 792 words available in the computer-assisted system were also found in the contract-word lists. To prevent this study from being a review of previously studied words, the common words were removed from the contract lists and the remaining contract-list words were placed into lists to be used during the period preceding the experiment. Due to the nature of the textbook approach, no attempt was made to modify these word lists.

Treatment-group system procedures

These students worked with a prototype CAI spelling system assembled largely from components of available equipment (off-the-shelf). After receiving student sign-on information, the home computer retrieved from data disks the appropriate student record containing the number of words to present per session, the current state of mastery for each word in the seven hundred ninety-two master-word list and other accounting information. The possible states for each word from the master word-list is represented by the state diagram shown in Figure 1.

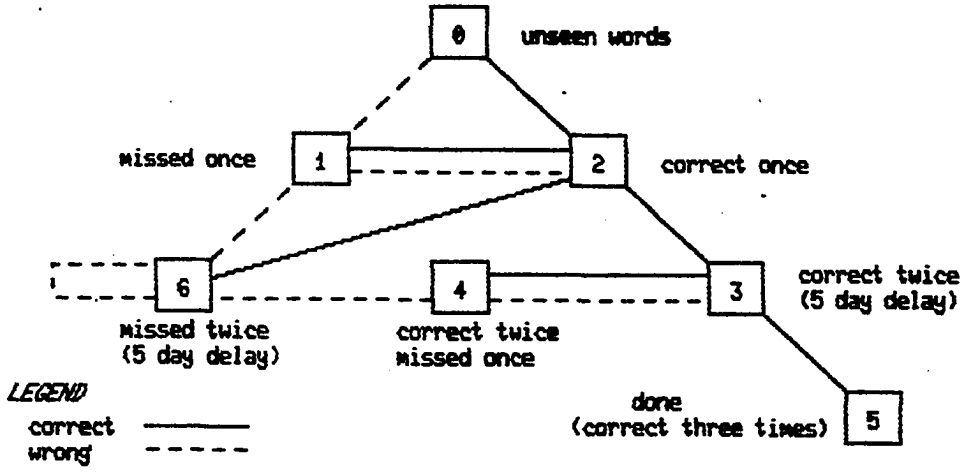


Figure 1. Spelling state diagram

This diagram represented the algorithm created for this investigation and was based upon available research findings in spelling instruction. At the end of each spelling cycle, all master-list words for each student were assigned a state based upon the individual's performance. There were seven possible states to which a word was assigned. State zero contained the words that had not yet been encountered by the student. State one contained the words that had been seen once by the student and had been spelled incorrectly. State two contained words seen once by the student and spelled correctly. State three contained words spelled correctly on two consecutive spelling cycles. Presentation of words in this state was delayed five cycles to check short-term retention. State four contained words spelled correctly twice and then missed on the third exposure. State five contained words spelled correctly two consecutive times and then spelled correctly after a five-cycle delay. Words

reaching this state were considered mastered and not presented to the student again. State six contained words that had been missed two cycles in succession. Words reaching this state were delayed five cycles to inhibit reinforcing incorrect spelling.

A word might have traveled through the algorithm in the following fashion. A word first seen in the last cycle and spelled correctly would be classified in state two. State two words are presented in the following spelling cycle. Should the word be spelled correctly a second time, it would be placed in state three and not seen by the student for five consecutive cycles. Should the word be spelled correctly after the delay, it would be placed in state five and be considered mastered. If the word had been misspelled on the second encounter, it would be placed in state one and presented to the student at the next cycle. Should the individual incorrectly spell the word again, the word would be placed in state six and not presented for the next five cycles.

Treatment-group instructional procedures

Treatment-group students worked on a computer-based spelling system (CBL) during assigned blocks daily. This coincided with the time control-group students worked in the contracted-list program. Students working in the CBL system were required to work during the allotted time slots but used as much or as little time as each required to complete their assigned daily spelling cycle.

Treatment-group students began spelling by entering their name and three digit identification code number into the home computer (Figure 2).

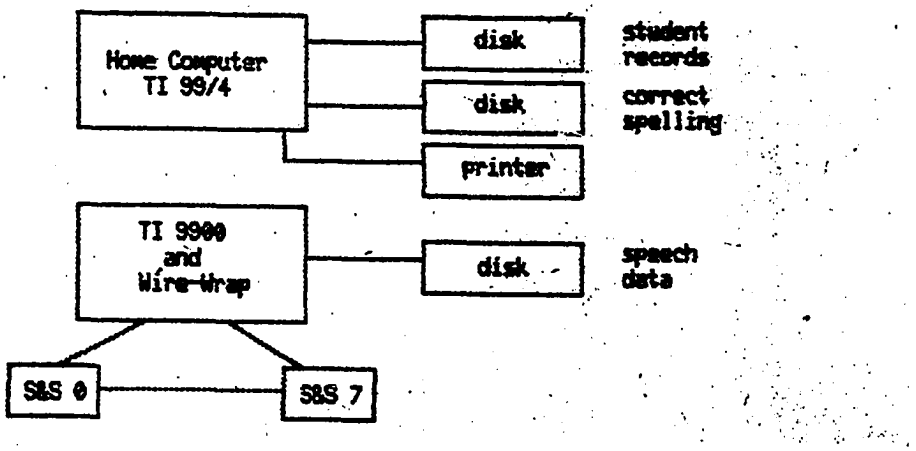


Figure 2. System configuration

After signing on the system, the student was directed via the home computer screen to one of the eight terminals that presented his/her twenty-word spelling cycle. Each terminal connected to the home computer system was a modified "Speak-N-Spell" unit consisting of a keyboard containing operations and alphabet keys, a visual display and a set of headphones. The student went to the designated terminal, put on the headphones and pressed the "go" button to initiate the spelling cycle and was presented the first word. The word was presented verbally to the student who then pressed appropriate letter keys for his/her spelling of the word. As the keys were pressed, the letter was presented verbally and was added to the visual display. By pressing a "repeat" key, the student could have the word pronounced as many times as he/she chose and by using the "erase" key could retype the spelling to their satisfaction. When ready, the student pressed the "enter" key causing his/her spelling

to be checked against the lexicon. If their spelling was correct, they were told it was correct and given the next word in their cycle. If their spelling was incorrect, they were given a second opportunity to spell the word. Should this second spelling attempt be incorrect, the word was spelled correctly for them both verbally and visually. Following each ten-word increment, students were given a tally of the number of words spelled correctly and incorrectly for that increment.

After completing their spelling cycle, each student went to the printer from which they received a listing of all the words encountered in their cycle. Along with a listing of their words, students also received a printed indication of whether they had spelled each word correctly. The correctness of their spellings were conveyed through messages printed next to each word such as "you can spell it!", "work extra hard on this word.", etc. This instructional cycle was repeated daily by each student in the treatment group. During the experiment, no tests or supplementary learning activities were provided to the treatment-group students.

Control-group instructional procedures

The students in the control group were told that the machine could not accommodate all of the students and that their turn on the spelling machine would follow. They were also told that the students had been randomly assigned to the groups.

Each student working in the contracted-list program had a five-day spelling cycle. Each cycle included contracting for specified word lists, structured practice which included a peer partner, and testing.

On the first day of the cycle, the individual contracted with the teacher for the number of word lists they wished to work with during that five-day cycle. The number of lists was governed by the student's interest and the student's performance in the previous cycle.

If a student's performance had been above ninety percent on the last cycle performance, the student could choose to take a greater number of lists, the same number of lists or fewer lists on the upcoming cycle. Any words missed during the preceding cycle were added to the newly contracted words.

If a student's performance had been below ninety percent on any of the lists from the previous cycle, the student was required to take that list or lists again as part of the new cycle. An additional restriction was placed upon these students; they were not permitted to increase the number of lists in the upcoming cycle.

As part of the first day of the cycle activities, each student with his/her spelling partner pronounced the words and concentrated on making a mental picture of the word. During the second day of the cycle, students wrote each of the contracted words three times. During the third day of the cycle, the student practiced spelling the words orally with their spelling partner. During the fourth day of the cycle, the student wrote each of the contracted words in a sentence. During the final day of the cycle, the student was tested over the contracted words. The testing was done in cooperation with spelling partners. Each student pronounced the other student's words as the second student wrote them. The two students then together corrected both students' spelling lists.

After this activity was complete, each student met individually with the teacher at which time the teacher rechecked the test and recorded the missed words and the percentage correct.

Instrumentation and Data Sources

Three types of instruments were used to measure possible experimental differences. They were spelling achievement tests, spelling attitude surveys and a teacher attitude survey. In addition to these three instruments, a teacher time log was devised for teachers to record how their spelling instructional time was allocated.

Two types of spelling achievement tests were created specifically for this experiment. One of these achievement tests was used to place both control and experimental group students on the graduated master-word list. The other type of achievement test was used to assess post-experiment and retention word mastery.

The placement test consisted of seventy-two words randomly selected from the seven hundred ninety-two-word experimental master list (see Appendix D). The seventy-two words were ordered from easiest to most difficult by means of "The New Iowa Spelling Scale" (28). These words were then grouped in eighteen sets of four words each and given a letter designation corresponding to the letter designations (A-R) used in the contracted-list program. The student's preexperiment spelling achievement level was declared to be that of the letter set in which two of the four words were missed. To insure that each individual began the experiment successfully, all students were started with the first word

of the word-list two letter levels below their declared spelling placement level.

The post/retention achievement tests were forty-word tests randomly selected from the words the individual had seen during the experiment. The beginning and ending experiment words were recorded for each individual. The ranges were graphed for the entire sample in ascending ending-word order. The subjects with similar ranges were then divided into testing groups. For each testing group, forty words were randomly selected from the last beginning word to the earliest ending word in the group. In order to maximize the test coverage, twenty-seven separate testing groups were established with group sizes ranging from one to eighteen students. Percent correct on the forty-item test was used as the post- and retention-achievement measure in all analyses.

The spelling attitude survey (see Appendix E) was adapted from a device developed by Demshock and Riedesel (15). It included nineteen items which were designed to measure how well the students liked spelling. This instrument was administered before and after the experiment. A scale score was computed by reversing negative items and then summing the items for each student on both the preexperiment and postexperiment surveys. The scales on these tests had a coefficient alpha reliability of .87 and .88, respectively. One item which was ambiguously worded and did not correlate highly with the other items was excluded from the scale.

Teacher attitude was measured by an opinionnaire (see Appendix F) designed to compare the contracted-list program with the CAI system.

It contained questions about scheduling problems, student behavior and teacher effort. This instrument was developed for the project and was validated by two uninvolved measurement experts.

Throughout the experiment the teachers were asked to record their spelling time on a daily log sheet (see Appendix G). Teachers recorded their time spent with spelling instruction in nine categories. Six of the categories pertained to administration and record keeping, two to student services and one to other tasks. The entries were charged appropriately to treatment-group and control-group activities.

Data Treatment and Analysis

One of the questions investigated in this study was to determine whether students learned to spell words better using the computer-based program than they did in the teacher-managed program. Since there are two issues to this question, the issue of how well the student learned the encountered words and the issue of how well the students retained these spellings, two comparisons were made.

A forty-word spelling test was used to measure student achievement immediately after the experiment (posttest) and again six weeks later (retention-test). Using the percent of correctly spelled words as the comparative basis, the posttest and retention-test scores for each program were computed and analyzed with a t-test procedure.

Another question examined was to determine if there was a change in student attitude toward spelling between the two programs during the course of the experiment. A spelling attitude survey was administered

to each student immediately prior to the experiment and immediately following the experiment.

The spelling attitude survey consisted of nineteen items scored on a five-point Likert scale from strongly agree to strongly disagree. The items were corrected for direction so that the most favorable response was valued at one and the most negative valued at five. To account for omitted data, each student's responses were averaged for the items answered and multiplied by nineteen to produce an "average" spelling attitude. These data were then analyzed by an Analysis of Covariance procedure.

A third question investigated was whether teachers invested more instructional time in one program as compared to the other program. Teachers logged their spelling instructional time daily for each program. A third party observer randomly logged instructional time to verify that the teacher's logs accurately reflected classroom behavior. These data were summarized and analyzed by week and instructional program using a Multiple Analysis of Variance procedure.

Teacher's attitudes regarding the effectiveness of the two spelling programs were also examined. Each teacher responded to a thirteen-item opinionnaire on a five-point Likert-type scale ranging from strongly agree to strongly disagree. Because there were only seven teachers involved in this experiment, no statistical analysis was attempted. A report of how the teachers responded to each opinionnaire item is included in Chapter IV.

Hypotheses to be Tested

1. There is no significant difference in the postexperiment spelling achievement between students working in the computer-based program and those working in the contracted-list program.
2. There is no significant difference in spelling achievement retention between students working in the computer-based program and those working in the contracted-list program.
3. There is no significant interaction between students' postexperiment spelling achievement by ability levels and the type of instructional program.
4. There is no significant interaction between students' spelling retention by ability levels and the type of instructional program.
5. There is no significant difference in student spelling attitude between students working in the computer-based program and those working in the contracted-list program.
6. There is no significant difference in teacher instructional time investment between the computer-based program and the contracted-list program.

Summary

This study was initiated as a result of the investigator's interest in employing currently available technology to facilitate student learning. A review of the literature revealed a need for studies investigating the use of microcomputer-based learning systems that incorporated research-validated instructional techniques.

Data from the areas of achievement, attitude and efficiency were collected from one hundred sixty-three third- and fourth-grade students and seven teachers. These data were analyzed to determine the effectiveness of a computer-based spelling program.

CHAPTER IV. FINDINGS

The purpose of this investigation was to compare the effectiveness of two individualized spelling approaches. One program, contracted-list, was a teacher-managed system in which the teacher contracted with each student for word-lists. The other approach, computer-based, was a computer-managed system in which students encountered words in accordance with a spelling algorithm formulated from existing research. In addition to evaluating the effectiveness of students' word-mastery, this investigation also examined pre- and postexperiment student-spelling attitudes, teacher attitudes, and teacher-time investment.

Within this chapter, the hypothesis will be stated, followed by a discussion of the statistical analyses and a discussion regarding whether there is sufficient evidence to reject the null hypothesis. The data were analyzed using the Statistical Package for the Social Sciences.

For hypotheses comparing computer-based and contracted-list groups, the unequal variance t-test was used. When comparing ability levels, the One-way Analysis of Variance was used. Examinations involving more than two variables employed the Multiple Classification of Analysis of Variance procedure.

Each student was given an achievement test immediately following the completion of the investigation (posttest) and that same test was re-administered to each individual six weeks later as a retention check (retention-test). These achievement tests consisted of forty words randomly selected from the words that each individual encountered during

the experiment. The percentage of words spelled correctly on the post- and retention-tests was the basis for all achievement calculations.

> HYPOTHESIS 1: There is no significant difference in post-experiment spelling achievement between students working in the computer-based program and those working in the contracted-list program.

The initial analysis of the posttest scores revealed a significant difference in the variance between the two groups. There was considerably more variation among the scores of the contracted-list group than there was among the scores of the computer-based group. The contracted-list group's scores ranged from 55 percent correct to 100 percent correct with a standard deviation of .126, whereas the computer-based group's scores ranged from 57.5 percent correct to 100 percent correct with a standard deviation of .084. Because of this difference in standard deviation, the separate t-test formula was used to approximate the t-statistic. Using the two-tailed test, a highly significant difference, $t=2.62$, $p < .01$, was revealed between the two groups. The posttest mean score for the computer-based students was 92 percent correct as compared to the contracted-list students' posttest mean score of 87 percent correct. Students working in the computer-based spelling system scored significantly higher than those working in the contracted-list system. This finding prompted the rejection of the null hypothesis at the .01 alpha significance level. Table 1 represents the findings of this analysis.

Table 1. Separate variance t-test summary comparing mean percent of correctly-spelled words on posttests for computer-based and contracted-list groups

Instructional program	N	Means	SD	df	t-test
Computer-based	78	92	.084	137.62	2.62**
Contracted-list	80	87	.126		

** $p \leq .01$.

HYPOTHESIS 2: There is no significant difference in spelling retention between students working in the computer-based spelling program and those working in the contracted-list spelling program.

As in the case of the posttest scores, the retention-test scores for the two groups failed to pass F-test criteria for equal variance. Again there was significantly more variation among the scores for the contracted-list group subjects than there was for the computer-based group subjects. The range for the contracted-list group was from 40 percent correct to 100 percent correct with a standard deviation of .104 while the range for the computer-based group was from 52.5 percent correct to 100 percent correct with a standard deviation of .082.

The separate t-test analysis revealed a significant difference between the two groups, $t=2.41$, $p < .02$. The students working in the computer-based group achieved a mean score of 93 percent correct while the contracted-list group's mean was 89 percent correct. On the basis of this analysis, the null hypothesis was rejected at the .05 alpha level. Table 2 contains these data.

Table 2. Separate variance t-test summary comparing mean percent of correctly-spelled words on retention-tests for computer-based and contracted-list groups

Instructional program	N	Means	SD	df	t-test
Computer-based	79	93	.082	148.16	2.41*
Contracted-list	79	89	.104		

*$p < .05$.

HYPOTHESIS 3: There is no significant interaction between students' postexperiment spelling achievement by ability levels and the type of instructional program.

In order to test this and the following hypothesis, it was necessary to divide the students into three ability levels. The placement test given at the beginning of the experiment was used to determine level membership. The placement test consisted of seventy-two words randomly selected from the master word list. These words were ordered from easiest to most difficult and then grouped in eighteen subsets. Each subset was given a letter designation (A-R) used in the teacher-managed program. A student missing two or more of the four words in a placement test subset was assigned to the beginning word of the master word list set two levels below the corresponding placement test subset. The dropping of two master word list sets was done to insure that each individual began the experiment successfully. Through this procedure, each student in both treatment and control groups was assigned a beginning word number. A student assigned word number 161 began spelling study with the word, February, the first word of list F1 (see Appendix C). The scores from the two grades were ranked separately and three

approximately equal sized groups were formed for each grade. It was on this basis that the level designations of low, medium, or high spelling ability were made for each grade. Tables 3 and 4 contain the distribution of word levels for the two grades.

Table 3. Third-grade student preexperiment word level distribution

Spelling ability level	Beginning word level	N	Relative frequency in percent	Cumulative frequency in percent
Low	31	3	4.1	4.1
	36	1	1.4	5.4
	42	2	2.7	8.1
	98	1	1.4	9.5
	122	13	17.6	27.0
	130	6	8.1	35.1
Medium	143	11	14.9	50.0
	156	3	4.1	54.1
	169	1	1.4	55.4
	199	5	6.8	62.2
High	214	8	10.8	73.0
	229	12	16.3	89.2
	244	4	5.4	94.6
	306	1	1.4	95.9
	328	1	1.4	97.3
	459	1	1.4	98.6
	484	1	1.4	100.0
	Total	74		

Table 4. Fourth-grade student preexperiment word level distribution

Spelling ability designation	Beginning word level	N	Relative frequency in percent	Cumulative frequency in percent
	31	2	2.3	2.3
	36	1	1.2	3.5
	42	1	1.2	4.7
Low	60	2	2.3	7.0
	90	3	3.5	10.5
	122	12	14.0	24.4
	143	8	9.3	33.7
	156	1	1.2	34.9
	184	3	3.5	38.4
Medium	199	7	8.2	46.5
	214	14	16.3	62.8
	229	4	4.7	67.4
	244	6	7.0	74.4
	306	1	1.2	75.6
	328	10	11.7	87.2
	348	1	1.2	88.4
High	434	4	4.7	93.0
	459	2	2.3	95.3
	484	2	2.3	97.7
	509	1	1.2	98.8
	535	1	1.2	100.0
	Total	86		

Third-grade students who attained an initial word level between thirty-one and one hundred thirty on the preexperiment placement test were assigned the label "low". Third-grade students in word levels one hundred forty-three to one hundred ninety-seven were assigned the label "medium". Third-grade students in word levels one hundred ninety-nine to four hundred seventy-nine were assigned the label "high".

Fourth-grade students who attained an initial word level between thirty-one and one hundred forty-three on the preexperiment placement test were assigned the label "low". Fourth-grade students in word levels one hundred fifty-six and two hundred twenty-nine were assigned the label "medium". Fourth-grade students in word levels two hundred thirty-four and five hundred four were assigned the label "high".

Since the ability level assignment was made separately for each grade, the analyses of posttest scores by ability and type of instructional program were also done separately for each grade. In each case, the Multiple Classification Analysis of Variance procedure was used. The effects of instructional program, ability level, and the interaction between instructional program and ability level were investigated.

The analyses of the third-grade students' posttest achievement scores revealed no significant interaction between instructional program and ability level $F(2,67)= .381$, $p < .69$. This finding prompted the decision to fail to reject the null hypothesis for the third grade at the alpha .05 level. In addition, the analysis revealed no significant differences due to the ability level $F(2,67)= 1.745$, $p < .18$. However, significant differences were revealed between instructional programs $F(1,67)= 4.259$, $p < .04$. Students who worked in the computer-based program scored significantly higher with a mean of ninety-two percent than did the students who worked in the contracted-list program whose mean was eighty-seven percent. Table 5 presents the analyses of the third-grade posttest scores. Table 6 contains the posttest means scores for grades three and four.

Table 5. Analysis of variance summary for third-grade spelling post-experiment achievement by ability levels and instructional program

Source	df	Mean square	F-value
Spelling ability level	2	.018	1.745
Instructional program	1	.044	4.259*
Two-way interaction between level and program	2	.004	0.381
Residual	67		

*$p < .05$.

Table 6. Posttest mean scores for grades three and four by ability levels

Spelling ability level	Computer-based students			Contracted-list students		
	Means	SD	N	Means	SD	N
Grade 3						
Low	91	.11	17	83	.16	9
Medium	89	.06	8	87	.11	12
High	94	.05	8	90	.08	20
Grade 4						
Low	89	.11	17	83	.21	12
Medium	93	.06	17	86	.12	12
High	96	.05	12	92	.07	16

The analyses of the fourth-grade students' posttest achievement scores revealed no significant interaction between instructional program and ability level $F(2,79)= .119$, $p < .89$. This finding failed to support a rejection of the null hypothesis for fourth grade at the .05 level. Nor did the analyses reveal any significant difference among spelling ability levels $F(2,79)= 2.836$, $p < .07$. However, the analyses did reveal a significant difference between instructional programs, $F(1,79)= 4.706$, $p < .03$. Students in the computer-based group scored higher than students in the contracted-list program with means of ninety-five percent and eighty-eight percent, respectively. A summary of these analyses is contained in Table 7.

Table 7. Analysis of variance summary for fourth-grade spelling post-experiment achievement by ability levels and instructional program

Source	df	Mean square	F-value
Spelling ability level	2	.035	2.836
Instructional program	1	.058	4.706*
Two-way interaction between level and program	2	.001	0.119
Residual	79	.012	

*$p < .05$.

HYPOTHESIS 4: There is no significant interaction between students' spelling retention by ability levels and the type of instructional program.

Each student's ability level for this hypothesis was the same as it was for Hypothesis 3. Ability levels were assigned separately by grade, therefore, retention-test score analyses were done separately. A Multiple Classification Analysis of Variance was used to examine the effects of instructional program, ability level, and the interaction between instructional program and ability levels.

The analysis of the third-grade students' retention-test achievement scores revealed no significant interaction between instructional program and ability level $F(2,67)= .038$, $p < .96$. This finding failed to support a rejection of the null hypothesis for third grade at the .05 alpha level. There was no significant difference revealed among ability levels $F(2,67)= 3.000$, $p < .06$. The analyses did uncover significant differences between the two instructional programs $F(1,67)= 5.006$, $p < .03$. The third-grade students who worked in the computer-based program scored higher with a mean of ninety-two percent than did contracted-list students with a mean of eighty-nine percent. These analyses are presented in Table 8. Table 9 presents the retention-test mean scores for grades three and four by ability levels.

No significant interaction was discovered in the analyses of the fourth-grade retention-test data $F(2,79)= .759$, $p < .47$, nor were the differences in spelling ability levels significant $F(2,79)= 1.561$, $p < .22$. This finding failed to support a rejection of the null hypothesis

Table 8. Analysis of variance summary for third-grade spelling retention achievement by ability levels and instructional group

Source	df	Mean square	F-value
Spelling ability level	2	.035	2.836
Instructional program	1	.058	4.706*
Two-way interaction between level and program	2	.001	0.119
Residual	79	.012	

*$p < .05$.

Table 9. Retention-test mean scores for grades three and four by ability levels

Spelling ability level	Computer-based students			Contracted-list students		
	Means	SD	N	Means	SD	N
Grade 3						
Low	90	.11	17	85	.13	9
Medium	93	.05	8	88	.09	11
High	97	.03	8	91	.07	20
Grade 4						
Low	91	.11	17	89	.17	11
Medium	94	.06	17	86	.10	12
High	96	.05	12	93	.06	16

at the .05 alpha level. However, a significant difference was discovered between instructional programs $F(2,79)= 4.102$, $p < .05$. As in previous analyses, the computer-based group with a mean of ninety-three percent was significantly higher than the contracted-list group whose mean was ninety percent. A summary of these analyses are presented in Table 10.

Table 10. Analysis of variance summary for fourth-grade spelling retention-test achievement by ability levels and instructional program

Source	df	Mean square	F-value
Spelling ability level	2	.014	1.561
Instructional program	1	.037	4.102*
Two-way interaction between level and program	2	.007	0.759
Residual	79	.009	

*$p < .05$.

HYPOTHESIS 5: There is no significant difference in student spelling attitude between students working in the computer-based program and those working in the contracted-list program.

The items in the spelling attitude instrument were corrected for direction so that a 1.0 was the most favorable and a 5.0 was the most negative attitude. The item scores for the items answered were added to produce a score for each student. This score was then divided by the number of items answered and multiplied by eighteen to produce the

attitude score. Since only six students omitted one item and one student omitted two items, this procedure served to produce an estimated score for those students omitting data which could be compared with the remaining students. Item number four did not correlate with the other items and was removed from this analysis. This approach resulted in the possibility of student attitudes ranging from a maximum positive score of eighteen to a maximum negative score of ninety for the instrument as a whole.

The preexperiment spelling attitude mean for all students was 41.72, whereas the postexperiment spelling mean was 37.49. This change in means indicated an improvement in spelling attitude during the experiment. An analysis of covariance, removing preexperiment differences, failed to uncover any significant difference between computer-based and contracted-list group attitudes toward spelling $F(1,147)= .236$, $p < .63$. This finding failed to support a rejection of the null hypothesis at the .05 alpha level. Table 11 presents this analysis.

Table 11. Analysis of covariance summary of student attitudes before and after the experiment for computer-based and contracted-list groups controlling for preexperiment differences

Source	df	Mean square	F-value
Covariate preattitude	1	4599.031	48.715**
Instructional program	1	22.326	.236
Residual	174	94.406	

**$p < .01$.

HYPOTHESIS 6: There is no significant difference in teacher instructional time investment between the computer-based spelling program and the contracted-list spelling program.

Each teacher recorded daily their spelling time by program on log sheets. A third party observer randomly observed and tallied spelling instruction to verify that teachers recorded accurately their classroom behavior. This information was summarized by week and analyzed using a Multiple Analysis of Variance procedure. This analysis examined the average number of minutes teachers devoted to each spelling program during each week of the experiment.

The analysis revealed highly significant differences in the average teacher time investment between the two instructional programs $F(1,84)= 70.308$, $p < .001$. On the average, teachers invested 15.45 minutes per week in the computer-based program and 51.43 minutes per week in the contracted-list program. The weekly total for instructional time investment in both programs combined ranged from a high of 58.64 minutes per teacher during the first week to a low of 26.57 minutes per teacher during the last week of the experiment. No significant interaction between instructional program and weeks was discovered $F(6,84)= .774$, $p < .59$. Based on this analysis the null hypothesis was rejected at the .01 alpha level. A summary of the analysis of variance is shown in Table 12.

An inspection of the mean weekly teacher time investments for the computer-based and contracted-list groups revealed that after the first week the computer-based group's time decreased while the contracted-list group's instructional time remained relatively stable. The average

Table 12. Analysis of variance summary for teacher instructional time investments by instructional program and week

Source	df	Mean square	F-value
Instructional program	1	31716.008	70.308**
Week	6	1786.986	3.961**
Two-way interaction between week and program	6	349.177	0.774
Residual	84	451.104	

** $p < .01$.

weekly teacher instructional time investment for the computer-based group after the first week decreased from a high during week two of 14 minutes to a low in the last week of 3 minutes. During this same period, the contracted-list group's time investment remained relatively constant with 47 minutes invested in week two and 50 minutes invested in the last week of the experiment. The means reported in Table 13 reflect this finding.

Table 13. Mean weekly instructional time investments in minutes for computer-based and contracted-list programs

Week	1	2	3	4	5	6	7
Computer-based	49	14	10	12	14	6	3
Contracted-list	68	47	43	49	47	56	50

Since only seven teachers were involved in this investigation, making statistical inference concerning teacher attitude is questionable. Nevertheless, the examiner wished to describe teacher attitudes on certain aspects of the computer-based system and their perceptions regarding the relative effectiveness of the two spelling programs. Each of the seven teachers responded to a five-point Likert-type scale ranging from strongly agree to strongly disagree on a thirteen-item opinionnaire (see Appendix F). The teachers generally agreed that students could easily operate the computer-based system (item 1), that the system provided adequate information about students (item 5), that the system required less accounting time (item 6), and that the system more easily controlled student progress (item 8). They also felt the student access to the computer-based system was difficult (item 3). Teacher responses to the other opinionnaire items were mixed.

The investigator was concerned that the opinionnaire response did not coincide with informal teacher comments made throughout the experiment. It was decided to interview teachers regarding each item on the opinionnaire. Each teacher was interviewed individually by the investigator. Any ambiguity about the opinionnaire statements was verbally clarified by the investigator. The interview results indicated teachers generally agreed that students operated the computer-based system with ease (item 1), that the computer-based program provided adequate information about student progress (item 5), that less accounting time was required for students working in the computer-based program (item 6), and that the computer-based system provided teachers with more instructional

flexibility (item 7). Interview responses also indicated teachers in general agreed that student progress was more easily controlled in the computer-based program (item 8), that the computer-based students showed more interest in their spelling (item 11), and that the computer-based program was a better individualized system (item 13).

Responses from the interview revealed teachers did not agree that the computer-based program was readily available to students (item 3), that the equipment problems had no effect on student spelling progress (item 4), and that students voiced more apprehension about spelling in the computer-based program.

Teachers voiced divided opinions pertaining to the ease of scheduling students (item 2), the computer-based program's ability to challenge students more effectively than the teacher-managed program (item 9), and the students' assumption of more responsibility for their spelling in the computer-based program (item 12).

Teacher responses to both the opinionnaire and the interview are recorded in Table 14. The written teacher summarizations of their feelings about the computer-based spelling program can be found in the Appendix (see Appendix H).

Upon completing the experiment, it was noted that the contracted-list group students encountered more words than did the computer-based group students. The contracted-list group students saw on the average one hundred fifty-eight words, whereas computer-based group students averaged one hundred forty-six words. Because computer-based group students were limited by schedule and access to the hardware to a daily

Table 14. Tabulation of teacher responses to computer-based spelling program opinionnaire and interview

Item number		Strongly agree	Agree	No opinion	Disagree	Strongly disagree
1. Students found the "S.O.S."[a] system easy to operate.	Opin.[b]	1	6			
	Int.[c]	2	5			
2. Students were easily scheduled to work on the "S.O.S." system.	Opin.		3		4	
	Int.		3		4	
3. The "S.O.S." system was readily accessible for student use.	Opin.			1	5	1
	Int.				5	2
4. The "S.O.S." system equipment problems did not affect student spelling progress.	Opin.		4		2	1
	Int.				5	2
5. The "S.O.S." system provided enough information about individual student spelling progress.	Opin.	2	5			
	Int.	1	5		1	
6. Less teacher accounting time was required for students working on the "S.O.S." system than for those working in the "SLIP"[d] program.	Opin.	5	1		1	
	Int.	5	2			
7. The "S.O.S." system provided for more instructional flexibility than did the "SLIP" program.	Opin.		5		2	
	Int.		7			
8. Individual student spelling progress is more easily controlled in the "S.O.S." system than in the "SLIP" program.	Opin.	1	4	1	1	
	Int.	1	4	1	1	

9.	The "S.O.S." system more effectively challenged individual student spelling abilities than the "SLIP" program.	Opin. Int.		4 5	1	2 2	
10.	Students working in the "S.O.S." system more frequently voiced apprehension about their spelling performance than did students working in the "SLIP" program.	Opin. Int.		2 1		4 5	1
11.	Students working in the "S.O.S." system showed more interest in doing well in spelling that did students working in the "SLIP" program.	Opin. Int.		4 5	1 1	2 1	
12.	Students working in the "S.O.S." system took more personal responsibility for their spelling progress than did students working in the "SLIP" program.	Opin. Int.		3 3	1	4 3	
13.	The "S.O.S." system provides a better individualized spelling program than does the "SLIP" program.	Opin. Int.	2 2	2 4	1	2 1	
14.	Comments:	(See Appendix F.)					

[a]"S.O.S." refers to the computer-based program.

[b]Opin. denotes teacher response to opinionnaire.

[c]Int. denotes teacher interview response.

[d]"SLIP" refers to the teacher-managed program.

twenty-word cycle, a secondary experiment was designed.

This secondary experiment was conducted to determine if student achievement changed in relationship to the number of words in the group's spelling cycle. Forty-four students from the contracted-list group were placed on the computer-based system--twenty-two students on twenty-word cycles per day and twenty-two students on thirty-word cycles per day for a period of five weeks. Each student was tested with an achievement test developed and scored in the same manner as the posttests for the primary experiment.

> SECONDARY HYPOTHESIS: There is no significant difference in the achievement of students receiving twenty words per cycle and students receiving thirty words per cycle.

The twenty-word group saw on the average almost ninety-three words and the thirty-word group saw an average of one hundred thirty-two words during the secondary experiment. A mean achievement score of 84.7 percent correct was obtained from the students receiving twenty words per session and a mean of 85.8 percent correct was obtained from the thirty-word per session group. A t-test analysis failed to indicate that there was a significant achievement difference between the twenty- and thirty-word per day groups, $t = .262$, $(p < .61)$. On the basis of this analysis, the investigator could not reject the null hypothesis at the .05 alpha level. These data are shown in Table 15.

Table 15. T-test analysis of student achievement for twenty vs. thirty words per daily spelling cycle

Group	N	Means	SD	df	t-test
Twenty words	22	85	.135	43	.262
Thirty words	22	86	.135		

Summary

Analyses of the data in the areas of achievement, attitude, and instructional time were presented in this chapter. Conclusions for each of the six hypotheses were drawn. A discussion of these findings will be conducted in the following chapter.

CHAPTER V. SUMMARY, DISCUSSION AND RECOMMENDATIONS

Summary

The purpose of this investigation was to examine the effectiveness of a computer-based learning system designed specifically to provide individualized spelling instruction. The principal focus of this study was to determine this system's effectiveness in promoting spelling achievement. In addition to examining spelling achievement, the areas of learner and teacher attitude, and the area of teacher instructional time investments were also examined.

This study was conducted in an experimental design format. A control group of students working in a contracted-list, individualized spelling program was compared with a treatment group of students who worked in a computer-based, individualized spelling program. One hundred sixty-three third- and fourth-grade students and their teachers from a midwestern suburban school district comprised the study population. The specific methods for gathering data were discussed in Chapter III. Data analyses were described in Chapter IV.

Findings from the data are as follows:

1) The computer-based students' postexperiment achievement scores were significantly higher than the scores of the students working in the contracted-list program.

2) The computer-based students' retention-test achievement scores were significantly higher than those of students working in the

contracted-list program.

3) There was no interaction between the type of instructional program and ability group. There were not significant differences in the spelling growth rates among the ability groups within each program.

4) The changes in student attitude toward spelling did not differ significantly between the two instructional programs.

5) There was a significant difference in the amount of time teachers invested in the two instructional programs. Teachers used three times more instructional time in the contracted-list program than they did in the computer-based program.

6) The rate at which students encountered unfamiliar words in the computer-based system could be increased at least a third without significantly affecting their posttest achievement scores.

Limitations

There are several limitations that may have had significant impact on the findings of this study. The equipment used in this experiment was designed for other purposes and numerous compromises were necessitated on the part of the developers and the participating students and teachers. Static electricity problems promoted by carpeted floors and unprotected wires caused many electronic malfunctions. Incompatibilities between the Speak & Spell units and the monitoring computers caused students to repeat a ten-word sequence approximately eight to ten percent of the time. Extraneous Speak & Spell buttons inadvertently pressed required students to start their daily cycle over. The Speak & Spell voice

simulation units had to be slowed down making the word pronunciations difficult for students to understand. Storing the students' data required the use of several disks. The use of multiple disks for data storage made it necessary to require students to work on spelling only when their disk was in the system, thus restricting student access. All of these equipment limitations may have masked the potential of a computer-based spelling program.

Both equipment access and instructional schedules combined to limit students working on the computer-based program in the number of words they encountered during their daily cycle. This coupled with the short duration of the experiment may have altered the conclusions of this study.

The spelling algorithm used in the computer-based program was generated from reported spelling research but had not been empirically tested. To fully understand the merits of a computer-based spelling program, several variations of this algorithm should be tested to determine which variation is most effective in maximizing the rates for encountering new words and achievement.

The findings reported in this study were based upon the data collected from third- and fourth-grade students attending a single school in a midwestern, middle class, suburban school district.

Discussion

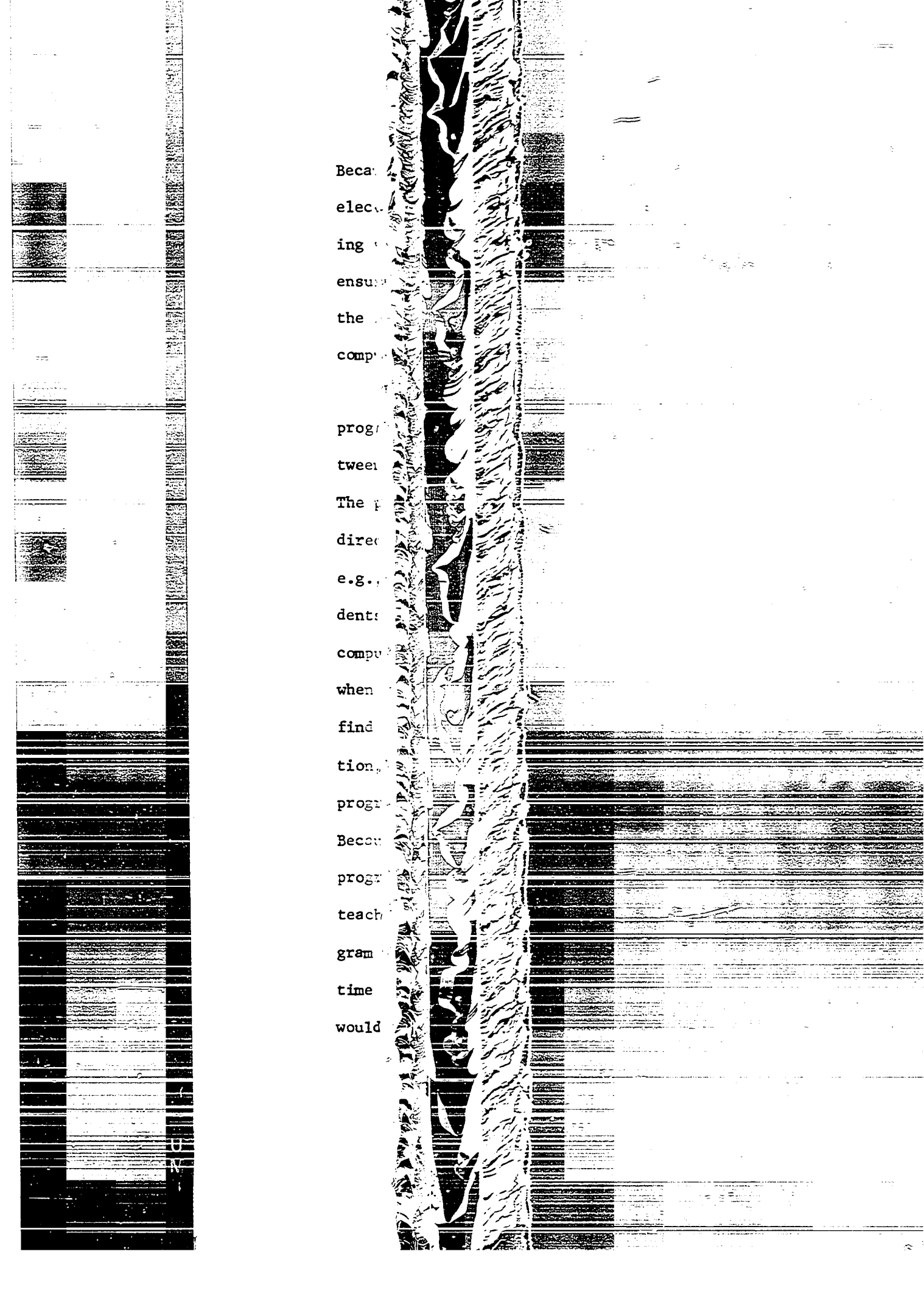
In this study, there were three primary areas of investigation. One concerned the effectiveness of the computer-based program, the second involved the student attitude toward the system, and the third was the

effect of using the computer-based program on teacher work load. In this section, the findings will be discussed within those three areas.

Hypotheses 1, 2, 3 and 4 focused on the effectiveness of the computer-based program. The analyses for Hypotheses 1 and 2 revealed that, when considering only instructional program, the students in the computer-based program scored about three percent better than did the students in the contracted-list program on both the post- and retention tests.

The analyses for Hypotheses 3 and 4, which took into consideration spelling ability and grade level, discovered that the significantly superior performance of the computer-based students when compared with the contracted-list students was relatively consistent across spelling ability levels and grade levels. A comparison of student scores among spelling ability levels approached significance for both grades on both tests. As expected, the lower spelling ability level groups had lower scores.

The high scores of most students on both the post- and retention tests may have obscured the real differences between the two instructional programs under investigation. An inspection of the means for students using the computer-based program revealed scores above eighty-nine percent for all levels on both tests and a mean of ninety-six percent for the "high" spelling ability students on the retention test. Presumably many students "topped-out" the test and their scores were controlled by the ceiling effect. The consistent pattern of students working in the computer-based program scoring higher than the students working in the



contracted-list program may be more indicative of the differences between the programs than that revealed by the analysis.

Hypothesis 5 focused on the students' attitude toward spelling. There was a general improvement in attitudes toward spelling during the experiment. This improvement in attitude toward spelling by students may have been due to the special attention they received during the experiment, producing a Hawthorne Effect. This change in attitude was found in both groups indicating that student attitude toward spelling was not differentially affected by either instructional program.

The preexperiment attitude opinionnaire found no significant differences between the computer-based and contracted-list groups nor was any postexperiment difference noted, but there was a significant difference between the attitudes of students among the ability levels within each group. Low spelling ability students in both treatment and control groups indicated that they liked spelling better than did students in the medium ability and high ability level groups. This same pattern of low ability students indicating more positive attitudes toward spelling was also found on the postexperiment opinionnaire. The investigator could find no explanation for this puzzling finding.

Another aspect of this investigation was to examine the amounts of instructional time required by each of the spelling programs under investigation. Instructional time invested in the two programs was markedly different. The computer-based program required significantly less teacher time than did the contracted-list program. This finding was most evident during weeks two through six of the experiment.

Because of problems associated with start-up procedures and static electricity, teachers spent much more time during the first week helping students working in the computer-based program than they did in the ensuing five weeks. Even with the additional problems associated with the first week, teachers involvement was significantly less with the computer-based program than with the contracted-list program.

The differing ways teachers expended their time in the two spelling programs caused the investigator to speculate that the differences between the two programs may be even greater than this study indicated. The principal time investments in the contracted-list program were directly related to the number of students under that teacher's care, e.g., recording scores, conferencing, contracting with individual students, etc., whereas, the principal time investments related to the computer-based program were more group oriented, e.g., telling students when the system would be available for their use, where students could find print-outs, what to do with print-outs, etc. In this investigation, roughly one-half of each teacher's class was in the computer-based program with the other half of each class in the contracted-list program. Because of the differences in how teachers used their time in the two programs under investigation, it might be conjectured that the time teachers would spend with an entire class in the contracted-list program would be roughly double the times reported in this study, while the time teachers might use for a whole class in the computer-based program would increase but not double.

Teacher opinion regarding the spelling programs under investigation

was an area which the investigator wished to describe. Teacher perceptions were surveyed in two ways--one an opinionnaire and the other an interview. The major difference between the teachers' responses to the opinionnaire and the interview was a greater consolidation of agreement or disagreement on some of the items. These changes may have been due to resolution of ambiguity in some of the opinionnaire items, or they may have resulted from teachers attempting to give the investigator what they perceived was wanted.

Generally, teachers agreed that the computer-based program was a viable spelling approach. They felt that students easily operated the computer system and that students showed a greater interest in their spelling. Teachers also felt the computer-based program supplied adequate student progress information, required less accounting time, freed them to do other instructional tasks, and enabled them to control more easily individual student progress.

Teachers felt that students voiced no remarkable anxiety about learning spelling in the computer-based program, and that the computer-based program was a better individualized spelling program than was the contracted-list spelling program.

On the negative side, teachers indicated that the computer-based program was not readily accessible to students and, also, felt that equipment problems affected the spelling progress of students.

Teachers were divided in their opinions regarding the ease of scheduling students to work on the computer-based program, whether the computer-based program more effectively challenged students, and whether

students were more responsible for their spelling progress in the computer-based program than they were in the contracted-list program.

Upon completing the experiment, it was noted that the contracted-list program students on an average had encountered twelve more new words than had the computer-based students. Because the equipment used in this experiment was designed for other purposes, compromises were necessary. This, coupled with the restrictions of daily instructional schedules, resulted in limiting computer-based program students to twenty-word-per-day cycles. A like limitation was not placed upon the students working in the contracted-list program. This investigator was interested in knowing if computer-based students' achievement would be affected should the number of words encountered in their daily cycle be increased.

To attempt to answer this question, a secondary experiment was designed to examine the achievement differences between students receiving twenty-words-per-daily cycle, as in the original experiment, compared with students receiving thirty-words-per-daily cycle. The forty-four students for this secondary experiment were drawn from the contracted-list group and, therefore, had no previous experience with the computer-based program.

Due to summer vacation, only a postsecondary experiment achievement test was administered to the students in the secondary study. The results from this test indicated that computer-based program students could encounter new spelling words at a rate fifty percent faster than did the computer-based students in the original experiment without

significantly changing their achievement scores. While this secondary experiment did provide valuable evidence, it did not establish what the true upper limit might be for the rate of encountering new words. Nor does it help us understand the relationship between the rate and student time investment.

Recommendations for Further Study

The findings of this investigation are encouraging but have raised and left unanswered far too many questions to conclude the true and full educational value of a computer-based spelling program. This study supports the need for further research to establish more definitively the educational validity of microcomputer-based spelling instruction.

Not only do the findings of this study raise several interesting questions, but they promote speculation regarding where further research might lead. Those interested in doing further research in the area of computer-based spelling might well consider the following:

1) Replicate this experiment with redesigned equipment to determine whether equipment difficulties affected the outcome of this investigation.
2) Replicate this experiment over a longer period of time to determine if students working in the computer-based program maintain their superior performance over students working in the contracted-list program.
3) Replicate this experiment with a different and/or a wider student age span to determine the computer-based program's

effectiveness with other elementary grade levels.

4) Replicate this experiment using student demographics other than grade level and spelling ability used in this investigation, e.g., student learning modality preference (visual, tactile, auditory), student learning style (sequential, random), etc.
5) Investigate the teacher spelling time investment in a "whole" class setting when comparing a computer-based program with a contracted-list program.
6) Investigate the amount of time students invest while working with the computer-based program as compared with other spelling delivery systems.
7) Investigate the effects that different spelling algorithms might have on the number of words students learn, their achievement and retention levels, their attitudes toward spelling, and the amount of time they invest in learning to spell correctly.
8) Investigate the relationship of student attitude toward spelling and spelling ability.

Concluding Statement

In this time of escalating educational costs, larger class sizes, and increased public pressure for accountability, educational decision-makers must seek more effective instructional alternatives that enhance the learning for all who pass through the school system. This investigation provides a window, albeit small, into the assistance that technology may provide for tomorrow's school and home.

The computer, especially the stand-alone microcomputer, clearly opens the door to new instructional strategies for which there is an inadequate research base. Educators must meet the challenge of opportunity if they are to fulfill their charge. That challenge being how best to synthesize our knowledge of learning with technology--present and future--to produce the instructional models that will more adequately meet the needs of all.

Educators must work closely with technologists in designing educational models that incorporate both learning theory and technology. Unlike the print publishers with their more intimate knowledge of schools, technologists are removed from the educational process. The educator and the technologist, together, must resolve practical but difficult issues such as determining the learner's role, the teacher's role; what amounts and types of feedback does each need; can instructional models incorporating technology be cost effective; and what types of preservice and inservice programs must be developed to adequately prepare teachers for these role shifts? Failure to meet this challenge will be an opportunity lost.

SELECTED BIBLIOGRAPHY

1. Allen, J. R. "Current Trends in Computer-Assisted Instruction." Computer in the Humanities, 7 (1972), 47-55.

2. Allred, Ruel A. Spelling: The Application of Research Findings. Washington, D.C.: The National Education Association, 1977.

3. Baker, F. B. "Computer-Based Instructional Management Systems: A First Look." Review of Educational Research, 41 (1971), 51-70.

4. Baker, F. B. Computer-Managed Instruction: Theory and Practice. Englewood Cliffs, N.J.: Educational Technology Publication, 1978.

5. Bitzer, D. L. and D. Alpert. "Advances in Computer-Based Education." Science, 167 (1970), 1582-1590.

6. Blanchard, Sr. M. Gervase. "An Experimental Comparison of the Test-Study Method of Teaching Spelling in the Eighth Grade." Unpublished master's thesis. Fordham University, New York, 1944.

7. Borg, Walter and M. Gall. Educational Research. 3rd ed. New York: Longman, Inc., 1979.

8. Bork, A. "Stand-Alone Computer Systems - Our Educational Future." Journal of Educational Technology Systems, 7(3) (1978-79), 201-207.

9. Bozeman, William C. "Computer-Managed Instruction: State of the Art." Association for Educational Data Systems, 12(3) (Spring 1979), 117-137.

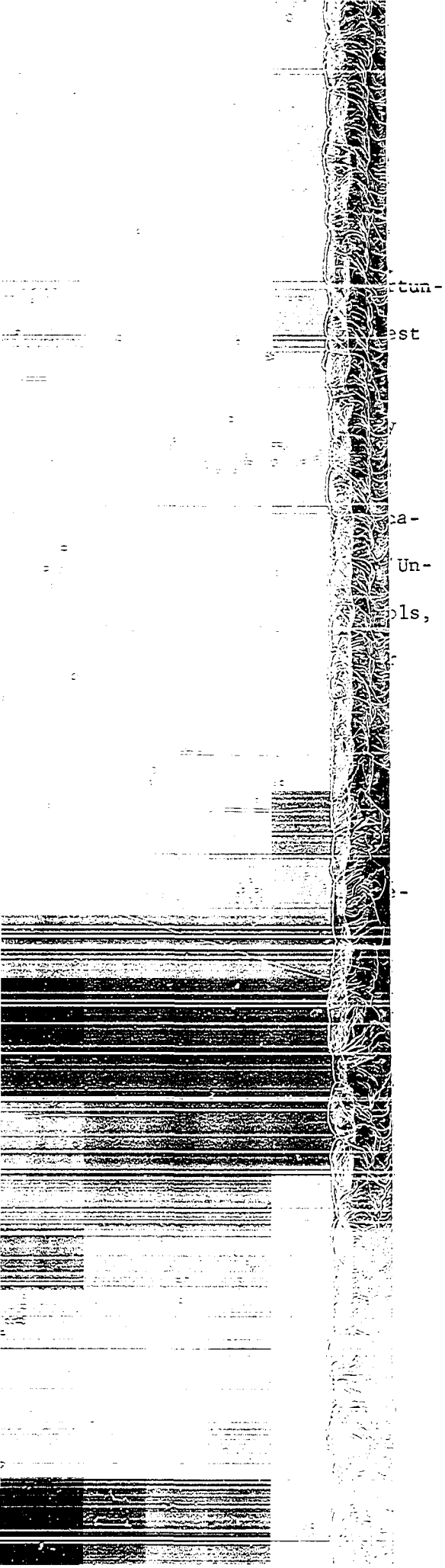
10. Bozeman, William C. and David B. Thomas. "Computers can Manage, and Assist with Instruction." Executive Educator, 2(3) (March 1980), 23-25.

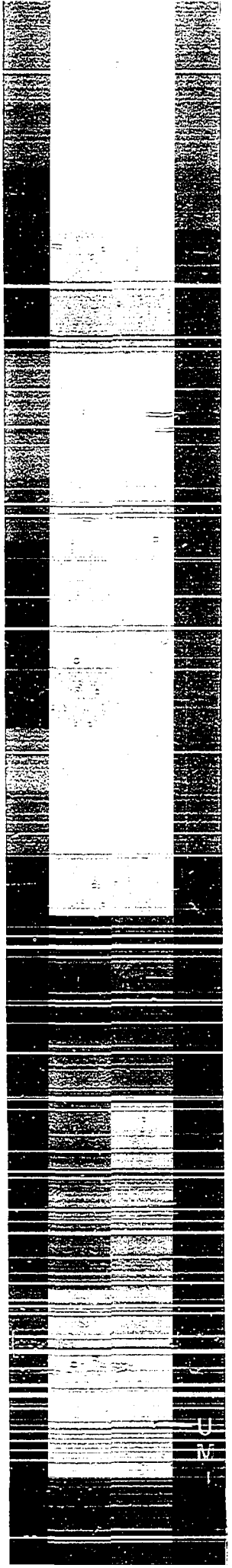
11. Brueckner, L. and G. Bond. Diagnosis and Treatment of Learning Difficulties. New York: Appleton-Century-Croft, 1955.

12. Campanole, Eugene A. "Survey of Methods in the Teaching of Spelling." Elementary English, 39 (May 1962), 446-455.

13. Christine, Roy O. and Paul M. Hollingsworth. "An Experiment in Spelling." Education, 86 (May 1966), 565-567.

14. Churchill, Mary, ed. "Computers are Fun, But can They Teach?" Educational Testing Service Developments, 15(4) (Winter 1979), 1-2.





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15. Demshock, George and Alan Riedesel. "Use of Computer-Assisted Instruction to Teach Spelling to Sixth Graders, Final Report." Pennsylvania State University, University Park, Computer-Assisted Instruction Lab., 1968.

16. Dence, Marie. "Toward Defining the Role of CAI: A Review." Educational Technology, 20(11) (November 1980), 50-4.

17. Dolch, Edward W. Better Spelling. Champaign, Illinois: The Garrad Press, 1960.

18. Dunwell, Stephen and others. "Report on WRITE: A Computer-Assisted Instruction Course in Written English Usage." Shared Educational Computer System Inc., 50 Market Street, Poughkeepsie, New York, 1972.

19. Edwards, J. and others. "How Effective is CAI? A Review of the Research." Educational Leadership, 33 (1975), 147-153.

20. Eisele, James E. "A Case for Computers in Instruction." Journal of Research and Development in Education, 14(1) (1980), 1-8.

21. Fitzgerald, James A. "Words Misspelled Most Frequently by Children of the Fourth, Fifth, and Sixth Grade Levels in Life Outside the School." Journal of Educational Research, 26 (November 1932), 213-218.

22. Fitzgerald, James A. "Research in Spelling and Handwriting." Review of Educational Research, 22 (April 1952), 89-95.

23. Fitzsimmons, Robert J. and Bradley Loomer. Improved Spelling Through Scientific Investigation. Des Moines: Iowa State Department of Public Instruction, 1974.

24. Fletcher, J. D. "Modeling the Learner in Computer-Assisted Instruction." Journal of Computer-Based Instruction, 1 (1975), 118-126.

25. Fromer, Robert. "Distinctions Between CAI and CMI Systems." Educational Technology, 12(5) (May 1972), 30-31.

26. Gates, Arthur t. "An Experimental Comparison of the Study-Test and Test-Study Methods in Spelling." The Journal of Educational Psychology, 22 (January 1931), 1-19.

27. Graham, Steve and Lamoine Miller. "Spelling Research and Practice: A Unified Approach." Focus on Exceptional Children, 12(2) (October 1979), 1-16.

28. Greene, Harry A. The New Iowa Spelling Scale. Iowa City: Division of Continuing Education, University of Iowa, 1954. (Revised 1977, Bradley Loomer.)

29. Grimm, F. M. "Computer Simulations as a Teaching Tool in Community College." American Biology Teacher, 40(6) (1978), 362-64.

30. Guiler, W. and G. Lease. "An Experimental Study of Methods of Instruction in Spelling." Elementary School Journal, 42 (1942), 234-238.

31. Hanna, Paul. "The Teaching of Spelling." National Elementary Principal, 45 (November 1965), 57-59.

32. Hanna, P., R. Hodges, and J. Hanna. Spelling: Structure and Strategies. New York: Houghton-Mifflin, 1971.

33. Hanna, Paul and J. Moore. "Spelling from the Spoken Word to the Written Symbol." Elementary School Journal, 53 (February 1953), 329-337.

34. Hawley, W. E. and J. Gallup. "The List Versus the Sentence Method of Teaching Spelling." Journal of Educational Research, 5 (1922), 306-310.

35. Henderson, Edmund H. and James W. Beers, eds. Developmental and Cognitive Aspects of Learning to Spell: A Reflection of Word Knowledge. Neward, Delaware: International Reading Association, 1971.

36. Hibler, G. H. "The Test-Study Versus the Study-Test Method of Teaching Spelling in Grade Two: Study I." Unpublished master's thesis. University of Texas, Austin, 1957.

37. Hollingsworth, E. "Spelling Lists--Outdated?" Elementary English, 42 (February 1965), 151 passim.

38. Hoole, Charles. A New Discovery of the Old Art of Teaching Schoole (1660). Boston: Scolar Press, 1973.

39. Horn, Ernest. A Basic Vocabulary of 10,000 Words Most Commonly Used in Writing. Iowa City: College of Education, University of Iowa, 1926.

40. Horn, Ernest. "The Validity and Reliability of Adult Vocabulary Lists." The Elementary English Review, 16 (1939), 129-134 passim.

41. Horn, Ernest. "Research in Spelling." The Elementary English Review, 21 (January 1944), 6-13.

42. Horn, Ernest. Teaching Spelling. Washington, D.C.: American Educational Research Association, 1954.

43. Horn, Ernest. "Spelling." Encyclopedia of Educational Research. 3rd ed. New York: Macmillan, 1960.

44. Horn, Ernest. Teaching Spelling: What Research Says to the Teacher. Department of Classroom Teachers, American Education Research Association of the National Education Association, Washington, D.C., November, 1967.

45. Horn, Thomas D. "The Effect of the Corrected Test on Learning to Spell." Elementary School Journal, 47 (January 1947), 277-285.

46. Horn, Thomas and Henry J. Otto. Spelling Instruction: A Curriculum Wide Approach. Austin: Bureau of Laboratory School, University of Texas, 1954.

47. Horn, Thomas. "Spelling." Encyclopedia of Educational Research. 4th ed. New York: Macmillan, 1969.

48. Hunter, Beverly and others. Learning Alternatives in U.S. Education: Where Student and Computer Meet. Princeton, New Jersey: Educational Technology Publications, 1975.

49. Jamison, D., P. Suppes, and S. Wells. "Effectiveness of Alternative Instructional Media." Review of Educational Research 44 (1974), 1-67.

50. Jarvis, Oscar T. "How Much Time for Spelling?" Instructor, 73 (September 1963), 59-60.

51. Kingsley, J. H. "The Test-Study Method Versus Study-Test Method in Spelling." Elementary School Journal, 24 (1923), 126-129.

52. Kulhavy, W. K. "Feedback and Response Confidence." Journal of Educational Psychology, 69(5) (1976), 522-528.

53. Larson, I. M. "Time Allotment in the Teaching of Spelling." Unpublished master's thesis. University of Iowa, Iowa City, 1945.

54. Lewellen, L. "Computers in the Classroom." Journal of Educational Data Process, 8 (1971), 33-38.

55. McCulloch, D. W. "The Uses of a Computer-Assisted Learning System, in Principle and Practice." Educational Technology, 20 (June 1980), 12-15.

56. McKee, Paul. "Teaching and Testing Spelling by Column and Context Forms." Unpublished doctoral dissertation. University of Iowa, Iowa City, 1924.

57. Magidson, E. M. "One More Time: CAI is not Dehumanizing." Audio-visual Instruction, 22 (August 1977), 20-21.

58. Magidson, E. M. "Trends in Computer-Assisted Instruction." Educational Technology, 18(4) (1978), 5-63.

59. Manolakes, George. "The Teaching of Spelling: A Pilot Study." Elementary English, 52 (February 1975), 243-247.

60. Montgomery, M. A. "The Test-Study Method Versus the Study-Test Method of Teaching Spelling in Grade Two: Study II." Unpublished master's thesis. University of Texas, Austin, 1957.

61. Perry, Tom and Ed Keyser. "The Computer as an Instructional Medium." The Clearing House, 53 (December 1979), 172-174.

62. Petty, Walter. "The Teaching of Spelling." Bulletin of the School of Education, Bloomington: Indiana University, 45(6) (November 1969), 79-98.

63. Ragan, William B. Modern Elementary Curriculum. New York: Holt, 1966.

64. Rinsland, Henry D. A Basic Vocabulary of Elementary School Children. New York: Macmillan, 1945.

65. Rushby, John. Computers in the Teaching Process. New York: Halsted Press, 1979.

66. Schroeder, Howard H. "An Analysis of the Visual and Auditory Perceptions in Spelling Instruction." Unpublished doctoral dissertation. University of Iowa, Iowa City, 1968.

67. Shell, L. "B+ in Composition: C- in Spelling." Language Arts, 52 (September 1975), 239-257.

68. Splittgerber, Fred L. "Computer-Based Instruction: A Revolution in the Making?" Educational Technology, 19 (January 1979), 20-27.

69. Suppes, P. and M. Morningstar. "Computer-Assisted Instruction." Science, 66 (1969), 343-350.

70. Suppes, Patrick and Elizabeth Macken. "The Historical Path from Research and Development to Operational Use of CAI." Educational Technology, 18 (April 1978), 9-12.

71. Symonds, P. M. What Education has to Learn from Psychology. 3rd ed. New York: Teachers College Press, Teachers College, Columbia University, 1968.

72. Tait, K., J. R. Hartley, and R. C. Anderson. "Feedback Procedures in Computer-Assisted Arithmetic Instruction." Journal of Educational Psychology, 43(2) (1974), 161-171.

73. Thomas, David. "The Effectiveness of Computer-Assisted Instruction in Secondary Schools." Association of Educational Data Systems Journal, 12(3) (Spring 1979), 103-116.

74. Thorndike, Edward L. and Irving Lorge. The Teacher's Word Book of 30,000 Words. New York: Columbia University, 1944.

75. Thorndike, E. L. Education. New York: Macmillan, 1912. Cited by D. W. McCullouch, "The Uses of a Computer-Assisted Learning System, in Principle and Practice." Educational Technology, 20 (June 1980), 13.

76. Yee, Albert H., Jay H. Shores, and Frank Baker. "The Development of a Comprehensive Computer-Managed Spelling Program." Educational Technology, 13(12) (December 1973), 52-56.

ACKNOWLEDGMENTS

The writer is indebted to a number of people for the guidance and encouragement they offered during the course of his graduate work and especially this investigation.

To Dr. Ross Engel for his perspicacious guidance throughout my graduate program and his support in the writing of this study.

To Dr. Rex Thomas for his generosity in the planning of this study and interpretation of the data.

To Dr. Anton Netusil for his advice during the data analysis phase.

To the children and teachers for their willing participation in this study.

The Iowa State University Committee on the Use of Human Subjects in Research reviewed this project and concluded that the rights and welfare of the human subjects were adequately protected, that the risks were outweighed by the potential benefits and expected value of the knowledge sought, that the confidentiality of data was assured and that informed consent was obtained by appropriate procedures.

A final thank you to all who offered encouragement during this study.

APPENDIX A. TABLES OF FREQUENCIES OF WORD USAGE IN CHILDREN'S AND ADULTS' WRITING

The two studies generally accepted as the best sources regarding the written vocabularies of both children and adults are those done by Horn (39) and Rinsland (64). These studies when examined together reveal a considerable overlap among the most frequently used words of children and adults. These studies also suggest that the words included in the first one thousand words for both children or adults are used considerably more often than are the words in succeeding one thousand word groupings. Tables A.1 and A.2 reflect the decline word usage as the frequency pool increases from one thousand to two thousand and to three thousand words. The first one thousand words is forty-four times as often as those found in the third one thousand words in both children's and adults' writing.

Table A.1. Frequency of word usage: Children (64)

Number of words	Percent usage	Percent gain in use per 1000 words
10	25	--
100	60	--
1000	89	89
2000	95	6
3000	97	2

Table A.2. Frequency of word usage: Adults (39)

Number of words	Percent usage	Percent gain in use per 1000 words
100	58.8	--
1000	89.6	89.6
2000	95.4	5.8
3000	97.7	2.3

APPENDIX B. MEAN PERCENTAGE CORRECT ON SPELLING LISTS AT GRADE LEVEL AND ONE GRADE LEVEL ABOVE GRADE PLACEMENT PRIOR TO INSTRUCTION

Table B.1. Mean percentage correct on spelling lists at grade level and one grade level above grade placement prior to instruction (59)

Grade	N	At grade level	One grade above
2	386	75.07	50.97
3	465	74.48	64.47
4	495	72.06	64.00
5	494	78.23	70.34
6	489	78.55	65.42
Total	2,329	75.65	63.58

APPENDIX C. SPELLING MASTER WORD-LIST

LIST A 1	LIST A 2	LIST A 3	LIST A 4
am	we	at	the
you	us	are	of
an	who	go	do
for	and	yes	far
it	as	to	get

LIST A 5	LIST A 6	LIST A 7	LIST B 1
ten	run	now	use
why	they	on	our
is	this	in	out
all	or	not	one
come	same	put	any
			saw

LIST B 2	LIST B 3	LIST B 4	LIST C 1
give	from	has	red
name	his	look	men
that	with	fear	where
went	man	fast	kind
when	want	bell	well
will	how	live	little

LIST C 2	LIST C 3	LIST C 4	LIST C 5
some	find	keep	shed
think	tell	just	mouse
help	seen	down	germ
hope	these	six	brick
stay	many	mother	here
back	each	star	away

LIST D 1	LIST D 2	LIST D 3	LIST D 4
first	cold	high	clean
over	thank	after	wheel
under	ago	there	score
five	toy	make	gown
bed	also	their	hoped
call	until	house	earn
bring	sit	hot	air
again	four	much	bath

LIST D 5	LIST E 1	LIST E 2	LIST E 3
year	cut	small	steps
would	won	snow	ill
third	stop	into	yard
which	sun	never	tall
store	flag	hurt	bread
old	face	ask	roll
fly	draw	must	wood
dry	about	father	dirt
	black	morning	card
	found	hair	bird
	three	always	strong
	right	because	try
	days	know	turn

LIST F 1	LIST G 1	LIST H 1	LIST H 2
February	sea	dried	opening
may	open	cries	cloud
paint	hospital	due	dream
swimming	rain	true	dresses
dress	only	kick	climb
study	amuse	silver	scout
vacation	brush	tied	enjoyed
green	chest	clothing	join
stout	ranch	lunch	nurse
barge	enter	short	shore
copy	steel	cash	wrist
enjoy	cheer	shine	written
rubber	snowy	together	castle
its	plane	what	charge
mail	rifle	point	chopped

LIST I 1	LIST J 1	LIST J 2	LIST J 3
choice	glass	cattle	gentle
cheering	smell	twice	giant
shout	yellow	products	magic
slide	jolly	camel	jet
pound	king	carried	jump
arrow	silk	could	junk
hello	act	produce	write
suppose	packet	goat	cool
balloon	ache	stage	cook
penny	jacket	cage	foot
funny	crack	ginger	blew
supper	socks	age	group
class	neck	given	few
spell	sack	begged	blue
cross	kept	jungle	storm
	correct	juggle	corner
	cannot	huge	north
	calendar	strange	cover
	clay	orange	doctor
	scared	large	desert

LIST J 4	LIST L 1	LIST L 2	LIST M 1
covered	site	enormous	medicine
drink	beet	curious	dentist
torch	allow	cause	noise
happier	crawled	crutch	pitcher
brag	two	creature	ceiling
divided	too	drying	quarter
entered	order	director	whisper
studies	hurried	haunt	worry
oranges	beat	charging	grocery
hoping	match	avoid	escape
happily	eight	justice	engineer
guessing	ninety	losing	million
itch	seven	operate	wreck
dressed	accurate	accident	enemy
bound	sympathy	destroy	grateful
bigger	remedy	terrible	circle
biggest	positive	soap	whistle
finally	museum	scratch	valuable
babies	immense	parade	exciting
sight	alert	magazine	borrow

LIST M 2	LIST N 1	LIST N 2	LIST O 1
yolk	spoil	fatality	disturb
customer	plain	knives	dropped
envied	mouth	defense	edit
entrance	nerve	brake	energy
climbing	peaceful	gracious	general
arrive	spear	double	injured
briefly	smack	crash	paused
musical	novel	taught	poetry
quietly	problem	tennis	portion
sound	rough	officers	ounce
scold	signal	couch	realize
husband	snore	college	revenge
church	spare	steak	telegram
tailor	unite	safety	theme
insult	wisdom	chart	transfer
nickel	pole	acre	terribly
smile	relative	count	spoiled
toast	reasons	switch	wreckage
catch	pickles	cruel	steer
needle	phrase	collar	several
	operator	argue	beehive
	judgment	bragging	those
	immortal	claim	concert
	crewel	contrast	stooped
	feeble	delivery	tumble

LIST P 1	LIST P 2	LIST P 3	LIST Q 1
fried	manual	flash	erase
sensible	model	claimed	absolute
cord	mystery	earliest	actually
copied	omitting	deposits	announce
offer	poverty	cabinet	article
lift	purchase	channel	audience
nine	register	clock	boundary
clown	religion	sweet	existed
clear	renewal	film	extreme
pitch	research	lawyer	fierce
activity	rivalry	sorry	foreign
annual	salaries	waist	grammar
applied	severely	desk	ignore
assemble	splendid	royal	instinct
assist	supreme	robin	majestic
budget	surround	puzzle	military
cancel	vacancy	icy	occupy
carnival	vigorous	planned	physical
excess	visible	riddle	premium
failure	thirst	churn	society
furnace	scenery	jail	urgent
horrible	scarf	autumn	thorough
imagine	rarely	warrior	specific
justify	prisoner	steal	scarcely
liquid	organize	kite	official

LIST Q 2	LIST R 1	LIST Z 1	LIST Z 2
numerous	original	aloud	isle
liable	apology	avoiding	it's
murmur	campaign	avoided	heir
moist	courtesy	baste	hare
issuing	debtor	based	hopes
initial	receipt	avoids	frying
impact	routine	bale	existing
faults	virtuous	bail	erased
finance	peculiar	cane	ewe
exceed	pageant	cheers	erasing
generous	descend	charges	erases
civil	eligible	charged	films
confirm	condemn	cheered	filming
conceal	geometry	chopping	filmed
democrat	ignoring	chop	fry
distinct	icicles	bragged	fries
doubtful	appetite	break	colleges
applying	athletic	brags	counsel
agency	aquarium	bred	council
chin	acquire	bore	copies
loan	aisle	boar	copied
smoke	alerts	absences	copying
attitude	alerting	ignores	cite
surveyed	alerted	ignored	claims
possible	arrival	imagined	claiming

LIST Z 3

churches
chord
chops
crawl
crawls
crawling
covers
covering
edits
editing
enjoys
enjoying
enters
entering
daze
denying
die
dew
edited
dries
dye
dressing
peer
pier

LIST Z 4

pausing
pauses
pause
orders
ordering
opens
ordered
no
noun
offers
offering
offered
opened
role
roar
rite
rein
quantity
possess
pursued
planning
plan
pigeon
plunge
plans

LIST Z 5

poll
policies
smiling
son
sorrow
scare
scheming
scene
scowl
shawl
shape
seems
seams
sealing
shop
smart
sleep
skylight
skinned
lone
light
lifts
lifting
lifted
mortgage

LIST Z 6

monthly
near
mourning
male
urn
urging
vein
vane
tide
they're
waste
we're
tumbles
tumbled
trifle
urge
tumbling
tale
tail
summon
suite
studying
stair
stare
stake

LIST Z 7

stooping
stoop
studied
stoops
strength
strain
theories
worrying
worries
worried
worm
yoke
yell
yawn

APPENDIX D. SPELLING PLACEMENT TEST

S. O. S. PLACEMENT TEST

A.

he
if
off

B.

say
most
said

C.

ball
from
party

D.

door
fire
goes

E.

head
city
playing
sat

F.

rabbit
dogs
shall

G.

club
either
brief
eyes

H.

foods
lad
bowl
cake

I.

sugar
soil
gift
pleasant

J.

surprise
board
person
certain

K.

branches
sadness
slaves
pajamas

L.

Maine
democracy
Washington
North Dakota

M.

friendship
unfriendly
fisherman
public

N.

gobble
speech
painting
carpenter

O.

batch
miner
coconut
vessel

P.

maple
agreeable
rooster
waffle
arise

Q.

dusty
hummed
slices
singer
unfold

R.

prescribed
spider
tendency
colonial
sick

APPENDIX E. STUDENT SPELLING ATTITUDE SURVEY

S.O.S PROJECT

Student Name_____ 104

Student Number _____

Teacher _____

	1 STRONGLY AGREE	2 AGREE	3 DON'T KNOW	4 DISAGREE	5 STRONGLY DISAGREE
1. I have always liked spelling.					
2. I would rather do any other school subject than do spelling.					
3. Spelling is easy for me.					
4. I like spelling but I like other subjects just as well.					
5. Trying to spell correctly makes me nervous.					
6. I don't feel sure of myself in spelling.					
7. I feel good about spelling.					
8. My mind goes blank and I am unable to think clearly when spelling.					
9. When I hear the word spelling, I have a feeling of dislike.					
10. Spelling is fun.					
11. Spelling makes me feel like I'm lost in a jungle and can't find my way out.					
12. I am afraid of spelling.					
13. I like spelling better than any other subject.					
14. When I know the word I enjoy spelling.					
15. I don't think it is important to spell well.					
16. I dread spelling.					
17. I feel spelling is an important subject.					
18. Being good in spelling makes me feel satisfied.					
19. I am not satisfied with what I'm learning in spelling.					

APPENDIX F. TEACHER SPELLING OPINIONNAIRE

S.O.S. PROJECT

Please record your reaction to the following statements on the scale provided. "S.O.S." refers to the computer-assisted spelling program and "SLIP" refers to the teacher-managed spelling program.

	STRONGLY AGREE	AGREE	NO OPINION	DISAGREE	STRONGLY DISAGREE
1. The students found the "S.O.S." system easy to operate.					
2. Students were easily scheduled to work on the "S.O.S" system.					
3. The "S.O.S." system was readily accessible for student use.					
4. The "S.O.S." system equipment problems did not affect student spelling progress.					
5. The "S.O.S." system provided enough information about individual student spelling progress.					
6. Less teacher accounting time was required for students working on the "S.O.S." system than for those working in the "Slip" program.					
7. The "S.O.S." system provided for more instructional flexibility than did the "Slip" program.					
8. Individual student spelling progress is more easily controlled in the "S.O.S." system than in the "Slip" program.					
9. The "S.O.S." system more effectively challenged individual student spelling abilities than the "Slip" program.					
10. Students working in the "S.O.S." system more frequently voiced apprehension about their spelling performance than did students working in the "Slip" program.					

	STRONGLY DISAGREE	AGREE	NO OPINION	DISAGREE	STRONGLY DISAGREE
11. Students working in the "S.O.S." system showed more interest in doing well in spelling than did students working in the "Slip" program.					
12. Students working in the "S.O.S." system took more personal responsibility for their spelling progress than did students working in the "Slip" program.					
13. The "S.O.S." system provides a better individualized spelling program than does the "Slip" program.					

14. Comments:

_____

_____

_____

_____

_____

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_____

APPENDIX G. SPELLING INSTRUCTION TIME LOG

S.O.S. Project Time Log

Teacher _____

Week of _____

	Mon.	Tues.	Wed.	Thurs.	Frid.	Remarks
1. Recording commitments	IGSE / SOS	IGSE / SOS	IGSE / SOS	ISSE / SOS	IGSE / SOS	
2. Evaluation of corrected student tests						
3. Recording of scores and misspelled words						
4. Check study pages (both assigned and missed)						
5. Spelling partners (reassign, fill-in, etc.)						
6. Materials management (organizing, order, equip)						
7. General instructions						
8. Answering questions						
Other tasks (please specify)						

APPENIX H. TEACHER WRITTEN COMMENTS REGARDING THE COMPUTER-BASED SPELLING PROGRAM

TEACHER WRITTEN COMMENTS

Teacher 1.

With better machine reliability a program like this (computer-based spelling program) should be a big help for both kids and teachers. Kids were enthusiastic and I particularly liked knowing they were working at capacity.

Teacher 2.

S.O.S. spelling system (computer-based spelling program), though different than my usual spelling methods, allowed children to move quickly through their words. Others who learned less quickly were offered my "old" methods of study on their more difficult words. I like the system. It offers a child independence, personal responsibility, and a challenge. The children were enthusiastic.

Teacher 3.

It (computer-based spelling program) freed me as a teacher to spend more time working with students who needed help and prepare teaching materials. It was rewarding to see students' enthusiasm for spelling.

Teacher 4.

The S.O.S. program (computer-based spelling program) allowed more time to be spent with individual students. The spelling became more productive due to the fact that I wasn't spending all of the period to check tests, record tests and commitments, etc. The students seem to take more of an interest in spelling. It wasn't necessary to spend as much time keeping students on task.

Teacher 5.

When the computer was working properly it was very effective. There wasn't any teacher records involved so it made it easier on us. Kids were motivated to use the S. O. S. computer, giving a productive learning atmosphere.

Teacher 6.

More individualization;
Better pacing of students;
Gave me more time to work with students;
Less record keeping (paper work);
Great!

Teacher 7.

I noticed that I had a feeling of being unsure about how much actual studying was happening by individual students. Did they continue to miss several words because of level of difficulty or because no effort was put forth? I did have a feeling of being able to say each child was working at the right level for them if progress was shown on each list. This program could be a real asset if many bugs were worked out --it got to be a time-user instead of a time-saver. Students definitely responded well and enthusiastically as opposed to the traditional spelling workbook situation.