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ABSTRACT

This study describes the uses of microcomputers in compensatory education programs funded under Chapter 1 of the Education Consolidation and Improvement Act in Wyoming, and examines the relationship between computer use and student achievement gains. Information was obtained from 42 school districts through a combination of telephone interviews, written questionnaires, and on-site visits. The following summary findings are reported: (1) districts are making active use of computers in Chapter 1 programs; (2) there is little evidence to support large-scale investment in computer-intensive approaches over other Chapter 1 approaches; (3) Chapter 1 teachers would benefit from training in software availability and use; (4) additional computers could be put to effective use in many projects that currently have one computer per class; and (5) the administrative use of computers could be greatly improved. Four case studies describe computer-managed instruction, the use of computers as a supplementary resource, computer assisted instruction (CAI), and the use of computers to drill and practice mathematics. Statistical data are included on three tables and six graphs. An eight-item bibliography, a discussion of the data collection and response, and copies of the telephone interview guide and the survey questionnaire are appended. (FMW)

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The Use of Computers in Chapter 1 Instruction in Wyoming.

THE Northwest Regional Educational Laboratory

PROGRAM REPORT

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THE USE OF COMPUTERS IN CHAPTER 1 INSTRUCTION IN WYOMING

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CONTENTS

EXECUTIVE SUMMARY

1. **Districts are making active instructional use of computers in Chapter 1.**

   The great majority of districts use computers regularly in Chapter 1. If there are projects in which Chapter 1 computers are going unused for weeks at a time, they are a very small minority.

2. **There is little evidence to support large-scale investment in computer-intensive approaches over other Chapter 1 approaches.**

   Wyoming districts making large use of computers achieve gains similar to districts making moderate use. Within one district, gains in an integrated computer-based lab are only slightly higher than gains at other schools. These results are in keeping with the finding of a highly regarded national study (Levin, Glass, and Meister, 1984), that computer assisted instruction is not more cost effective than cross-age tutoring in reading or reduced class size in math.

3. **Chapter 1 teachers would benefit from training in software availability and use.**

   The greatest single need expressed by Chapter 1 teachers regarding their use of computers was for training. In particular, teachers wanted information regarding quality software for use with young students and for teaching comprehension, problem solving and thinking skills. Training on the integration of new software into Chapter 1 instruction through workshops or visits to exemplary projects was widely requested.

4. **Additional computers could be put to effective use in many projects which currently have one computer per class.**

   Most Chapter 1 teachers have regular access to only one computer. While many are satisfied with this arrangement, many others would make more effective use of the resource if they did not have to allocate it among four to six students in a class period.

5. **The administrative use of computers could be greatly improved.**

   Many Chapter 1 teachers and administrators have discovered word processing, but relatively few make use of the record keeping and computational capability of computers. Nearly half the districts have access to Appleworks, but only a few use its database capability or its spreadsheet to store student information or to compute achievement gains. Most districts did not identify a need for assistance in this area, but that may reflect a lack of familiarity with its potential.

INTRODUCTION

Chapter 1 of the Education Consolidation and Improvement Act of 1981 (ECIA) is the largest federally funded elementary and secondary education program. The primary goal of the program is to provide supplemental educational and related services to educationally disadvantaged children who attend public or private schools in low-income areas. In Wyoming, just over 4,000 students in 48 school districts currently receive Chapter 1 services. Sixty-two percent of these students attend elementary schools (through grade 6). At both elementary and secondary levels, instruction is provided in reading, mathematics, and language arts.

Computers are widely used in Chapter 1 instruction nationally. One recent study estimated that 71.6 percent of Chapter 1 elementary school students now make some use of computers in their Chapter 1 instruction (Roberts et al., 1987). In Wyoming, the use of computers in Chapter 1 exceeds the national average.

The use of computers as a means of improving the basic skills of educationally disadvantaged students has been supported by research. A large study of the use of intensive computer assisted instruction (CAI) in the Los Angeles Unified School District in grades 1-6 (Ragosta et al., 1982) demonstrated that students who had regular access to CAI gained more on achievement tests than other students both in the short run and over a period of years. Gains were greater in math than in reading, and did not exceed gains commonly achieved in other Chapter 1 approaches such as peer tutoring. Syntheses of research findings by Visonhaler and Bass (1972), Hartley (1977), Burns and Bozeman (1981), and Kulik, Bangert and Williams (1983) all found that CAI raised achievement. However, such studies have not found that

CAI was any more cost effective than many other competing approaches (Ragosta et al., 1982; Levin et al., 1984).

The purpose of this study is to describe the uses of microcomputers in Chapter 1 in Wyoming and to examine the relationship between computer use and student achievement gains. Three broad questions were posed: What computer hardware and software resources are currently available to Chapter 1 projects in Wyoming? How are computers used instructionally in Chapter 1, and to what effect? To answer these questions, information was obtained from 42 school districts[a] through a combination of telephone interviews, written questionnaires, and on-site visits. Student achievement data were collected through the annual Chapter 1 evaluation and reporting system, and analyzed. Additional information regarding data collection and instrumentation is included in Appendix A.

AVAILABILITY OF COMPUTERS

Finding: While only 28 Wyoming districts (67%) have purchased computers with Chapter 1 funds, nearly every Chapter 1 project makes some instructional use of computers.

Computers are more available to Chapter 1 students in Wyoming than in most other states. Only three Chapter 1 projects in Wyoming reported no use of computers in Chapter 1 instruction. All three were elementary reading projects, and two of these were in districts with other Chapter 1 projects which did use computers in instruction. All remaining projects, including all secondary projects and all math projects, reported making some use of computers.

Only about half the approximately 280 computers used in Chapter 1 instruction were purchased with Chapter 1 funds. Many districts used

[a]Districts were not included if they initiated their Chapter 1 program during the 1986-87 school year.

Chapter 2 or district funds to acquire computers which were made available to Chapter 1 on a regular basis. Table 1 shows the distribution of districts by the funding source for computers used in Chapter 1.

Table 1

Funding Source for Computers Used in Chapter 1

Funding Source	No. of Districts
Only Chapter 1 computers	20
Only District computers	13
District and Chapter 1 computers combined	8
No computers in Chapter 1	1

Many districts apparently have chosen to use non-Chapter 1 funds to acquire computers for Chapter 1 use, either to avoid restrictions on their use by non-Chapter 1 students, or to make more efficient use of existing equipment.

Finding: Apple IIe computers predominate.

Nearly all the computers used in Chapter 1 are Apple IIe computers. Districts also identified Apple II+, Apple IIc, Commodore, and TRS-80 computers in use in Chapter 1 instruction, but these in combination make up fewer than 10% of the computers available. No district reported the use of an IBM or IBM-compatible computer for student instruction.

Table 2

Type of Computers used in Chapter 1 Instruction from all Sources

Type of Computer	Number	Percent
Apple IIe	259	(93%)
Apple II+	5	(2%)
Apple IIc	6	(2%)
Commodore	4	(1%)
TRS-80	6	(2%)

Finding: The most common instructional arrangement is to have one computer in a Chapter 1 classroom in which 2 to 6 students are present at a time.

The great majority of Wyoming Chapter 1 projects are pull-out projects, in which selected students leave their regular classrooms to receive supplemental instruction in a Chapter 1 room. Approximately 84%[b] of such Chapter 1 classrooms contain at least one computer which is used for student instruction. A single computer in a Chapter 1 classroom in which 2 to 6 students are present for instruction at a time is the most common arrangement.

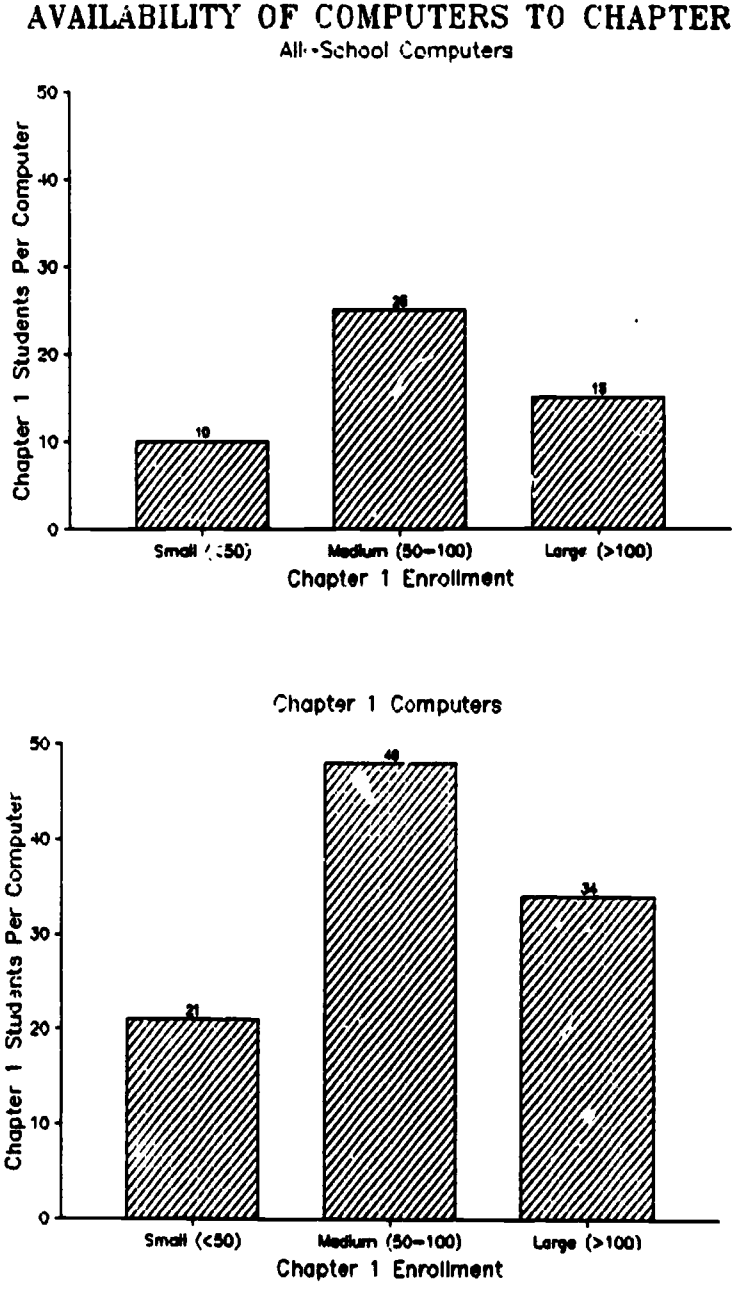
There is an average of one computer for every 4 children in a given Chapter 1 instructional setting in Wyoming. Among projects which use computers, the ratio of students to computer ranges from 1 to 8 at a time.

A few projects[c] provide Chapter 1 instruction in rooms with one computer per child. In three districts,[d] up to six Chapter 1 computers are located together in a Chapter 1 room, and students work at them individually for at least 45 minutes a week. In several others, Chapter 1 students go on a regular basis to the school computer lab for part of their Chapter 1 instruction, or use computers in the school library.

[b]63 of 75 projects for which information is available.
[c]Campbell 1, Cole Elementary in Laramie 1, Lincoln 2, Sheridan 1, Uinta 6.
[d]Campbell 1, Laramie 1, Lincoln 2.

Access to computers varies according to district size, as shown in Figure 1. Small districts with fewer than 50 Chapter 1 students average one computer per ten Chapter 1 students enrolled, when district computers used by Chapter 1 are included. Medium districts (50 to 100 Chapter 1 students) in contrast, average one computer to 25 students.

FIGURE 1



The explanation for these differences is not apparent. Medium-sized districts (those with 50 to 100 Chapter 1 students) have generally been more reluctant to spend Chapter 1 funds on computers; 40% have chosen not to do so, compared to only 19% of small districts and 31% of large districts.

Finding: Only a third of Chapter 1 teachers believe that their students would benefit from additional computers.

Most Chapter 1 teachers have a single computer in their classrooms. Teachers are sharply divided on the question of whether this provides sufficient access to computers for their students. A majority of responding teachers and administrators (63%), including a few with several computers, were satisfied with their current ratio of computers to students. Several explained that the value of the computer for reinforcement and motivation would be reduced if computers were used more often. Many viewed the computer as one of several valuable instructional activities, and intentionally avoided over-using any one.

Thirty seven percent expressed a need for additional computers. Many of these teachers and administrators objected to having students rotate or pair up at the computer for various reasons: sharing interfered with group instruction, sharply limited the amount of time any child could receive CAI, and complicated the planning and pacing of lessons. Many of these teachers indicated that they could make much more effective use of CAI if they had one computer per child.

AVAILABILITY OF SOFTWARE

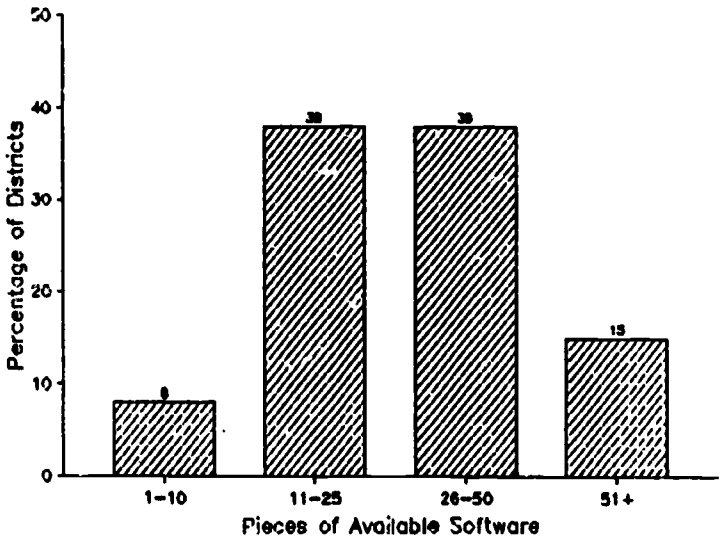
Finding: There is much more variation among Chapter 1 projects in availability of software than in availability of computers.[e]

The combined reading and math software collections readily available to Chapter 1 teachers range from one program (in an elementary reading project which uses computers exclusively for word processing) to more than 200. Typically, a Chapter 1 teacher has about 25 pieces of appropriate software available for Chapter 1 instruction (see Figure 2).

Software is extensively shared in schools. Of the 28 districts which have purchased computers with Chapter 1 funds, six have not purchased any software with Chapter 1 funds. Yet, each of these districts reports having access to at least 20 pieces of software for Chapter 1 use through the district.

Figure 2

SOFTWARE AVAILABILITY



[e]There is no agreed upon metric for measuring the size of software collections in the way the number of books is used to compare libraries. We use "pieces of software" and "programs" to refer to individual commercial diskettes which in fact may contain several instructional activities.

Finding: Software to support math instruction reflects a strong emphasis on computation drill.

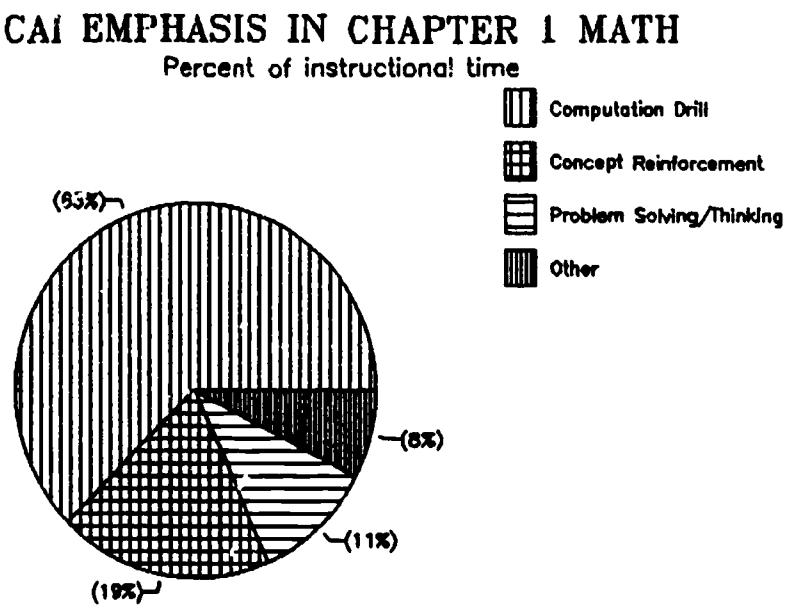
When districts were asked to list frequently used software in math and reading, they tended to give much shorter lists for math, with more overlap across districts. The most widely used programs provided computation drill, often in a game format. The series of drill and practice games produced by DLM, Inc. (Arcademic Skill Builders, with its components, Alien Addition, Alligator Mix, Demolition Division, Minus Mission, Meteor Multiplication, etc.) were identified more often than any other programs.

Several districts used drill and practice programs with additional features such as the use of examples, corrective feedback, record keeping, and adjustment of student progress by mastery. Math Sequences by Milliken was the most frequently mentioned program of this type.

Relatively few programs addressed problem solving. Only three districts identified software packages emphasizing word problems among their most frequently used math software. This reflects both a shortage of quality software in this area and a concentration in Chapter 1 on computational rather than conceptual or problem solving skills. A few districts use software which involves thinking skills such as classification or sequencing tasks outside of a traditional math context. Logo, Micro SOC Thinking Games (American Guidance Service), and Tales of Discovery (Scholastic) were identified as examples of this type.

The emphasis on computational drill and practice was reflected in teachers' descriptions of the types of math objectives which their use of computers supported. Teachers were asked to allocate their use of computer assisted instruction among categories of computation drill, concept reinforcement, problem solving and thinking skills, and other activities (e.g., mastery testing). Results are displayed in Figure 3.

Figure 3



Finding: The use of computers in Chapter 1 reading is much more diverse than in math.

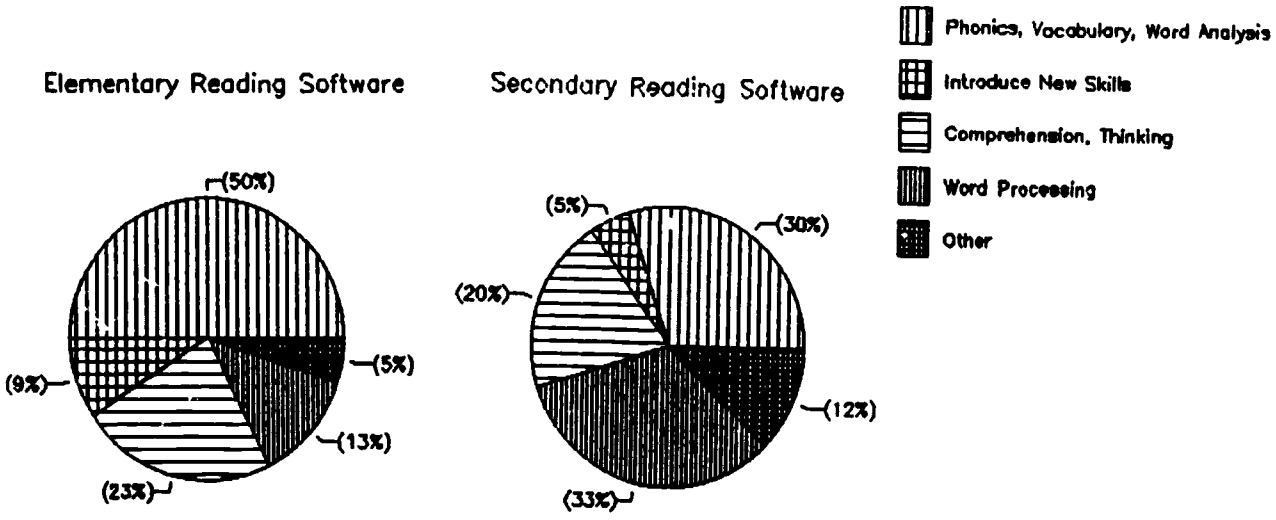
When districts list their favorite reading software, the combined list is far longer in reading than in math (90 programs, compared to 35 in math), with few stand-out favorites.

In the aggregate, software collections are fairly equally balanced between programs that emphasize phonics and word analysis skills (e.g., Word Munchers by MECC, Consonants by Hartley), vocabulary (e.g., Word Attack by Davidson and Assoc.) and comprehension (e.g., Story Tree by Scholastic, Tales of Mystery by Scholastic, Speed Reader II by Davidson).

The distribution of software varies significantly from elementary to secondary programs. In general, secondary programs make much greater use of word processing and involve much less drill of phonics and word analysis skills. The distribution of reading software by skills is shown in Figure 4.

Figure 4

DISTRIBUTION OF READING SOFTWARE



Finding: About half of Chapter 1 teachers and administrators want more software, especially to teach reading comprehension and thinking skills.

About half (47%) of Chapter 1 teachers and administrators want access to more diverse and effective software. Specific needs particularly include reading software to use with beginning readers, and software to teach reading comprehension and other higher order skills.

Five teachers suggested the development of a statewide software library from which districts could borrow. Others recommended an annual statewide "software fair" workshop to demonstrate and share new software among districts.

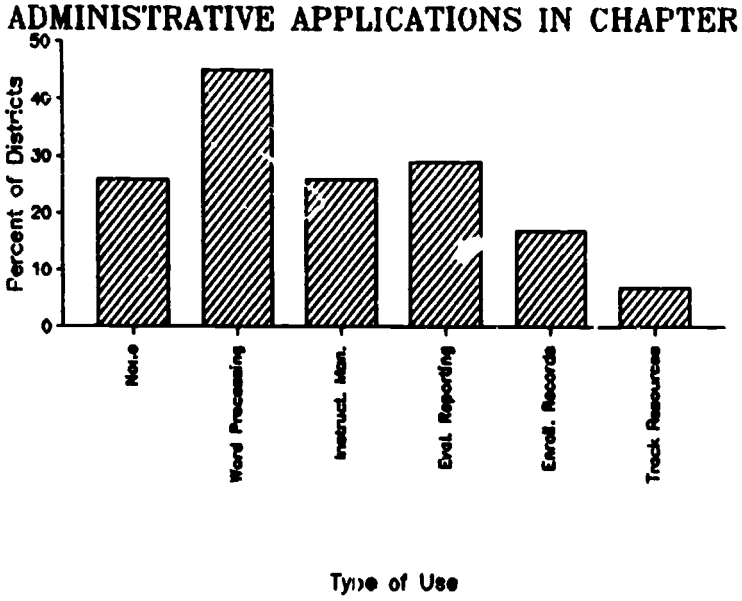
ADMINISTRATIVE USES

Finding: Computers are used less for administrative purposes than for instruction. Fewer than half of districts use computers to store student data.

Most districts (31 of 42) make some administrative use of computers in Chapter 1. In general, however, computers are used much less for administration than for instruction, and no particular administrative application, such as word processing, is undertaken by a majority of districts. No district reported using computers only for administrative purposes in Chapter 1.

The types of administrative uses reported and the proportion of districts applying them are shown in Figure 5. Word processing is the most common administrative application. Teachers mentioned using word processing to write notes to parents, complete progress reports, and to generate worksheets or assignments for students.

Figure 5



Relatively few districts use computers to store student performance information, whether for evaluation reporting purposes (12 out of 42) or instructional monitoring (13 out of 42). Why aren't computers used more for such purposes? Some teachers and administrators identified a need for training in the use of database applications; others maintained that the number of students involved did not justify computerized record keeping.

The type of computer used for administrative applications is overwhelmingly the Apple IIe. No other type of computer was used in more than one district (IBM - 1, MacIntosh - 1, Commodore - 1). Appleworks, used in 20 districts, is by far the single most widely used administrative software package, with PFS File and Report (7 districts) a distant second.

TRENDS IN COMPUTER USE

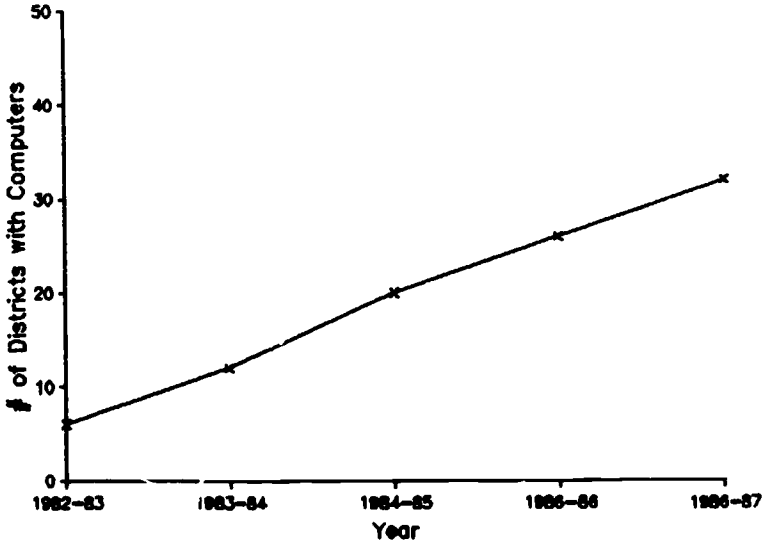
Finding: Most Chapter 1 projects are using computers much more now than they have in the past.

Nearly 75% of districts report that they are using computers more now in Chapter 1 than they did in the recent past. Most of the remaining 25% have reached a stable level of use. Only one district reported a decline in CAI use, and this was only in its reading project, while CAI in math remained unchanged.

Increasing use of CAI is associated with the steady rate in which districts have acquired computers for Chapter 1 over the past five years. Thirty two districts supplied acquisition dates for their computers. The data, shown in Figure 6, show a constant rate of acquisition over a five-year period. Six districts reported acquiring their first computers for Chapter 1 during 1986-87. The fact that nearly all districts now have computers for use in Chapter 1, and the fact that most are satisfied with their ratio of students to computer, suggest that this acquisition rate will soon level off.

Figure 6

COMPUTER ACQUISITION FOR CHAPTER 1



Finding: Districts are gradually broadening their use of computers beyond a focus on drill and practice.

Computers have been used most often to give students practice applying specific skills or concepts that they have been taught previously. Most districts continue to emphasize this use of computers, but several have increased the proportion of time computers are used for other purposes. Of the 32 districts who identified changes in their practices, 25% indicated greater use of word processing and comprehension-oriented software, and less use of drill. Nineteen percent reported large increases in the overall diversity of their computer use. Only one district reported an increase in drill and practice. In addition, several districts (31%) are making more administrative use of computers than they have in the past.

The use of computers with primary grade children is also increasing. Four districts recently extended their use into the first and second grade; many others have used computers at this level for some time. Lack of appropriate software and the lack of student keyboard skills were identified as factors as restricting greater computer use at this level.

Finding: Districts plan to spend less on software in the near future.

Although nearly half of Chapter 1 teachers and administrators feel a need for more software, most districts are not planning any Chapter 1 software purchases in the near future. Facing a declining economic situation, districts plan to share existing software, or to purchase more with non-Chapter 1 funds. Only ten districts intend to acquire new software in the near future.

INTEGRATING COMPUTERS INTO INSTRUCTION

Finding: Most teachers have made significant progress in integrating computer activities smoothly into Chapter 1 instruction.

The integration of microcomputers, like any instructional innovation, has required teachers to acquire a new set of behaviors and skills. When the innovation was first introduced, it was difficult to fit it into existing curriculum and instructional routines. Educators warned that use of computers could disrupt the flow of instruction and contribute to fragmentation of the curriculum.

A large majority of Chapter 1 teachers now appear to have found ways to integrate computers into their instruction smoothly. For a few, this has involved acquiring extensive integrated software systems such as Prescription Learning or less extensive systems such as PAL, Diascriptive Reading, or Milliken Math Sequences, and making this system a major element of their Chapter 1 curriculum.

For a much larger group, successful integration of computers in reading has involved the acquisition of individual software components such as word processing, phonics drill programs, vocabulary builders allowing teacher-entered word lists, story generators, and comprehension exercises. Many teachers are now intimately familiar with such an assortment and can

use software selectively to address specific objectives. Most Chapter 1 teachers now include computer activities as they do other activities in their instructional repertoires: they employ them to provide appropriate practice or clarification for particular objectives, and to maintain variety and interest.

Examples remain of poorly integrated use. In one school, for example, the Chapter 1 teacher takes classes to the school computer lab once or twice a week for a change of pace, often on Fridays. The software employed on these weekly occasions may not fit a particular objective students are working on at that time. Instead, software is selected for its entertainment value, or because the teacher has a new piece of software available. Examples of this type may occur in ten to twenty percent of districts.

Finding: The time individual students spend at the computer ranges from 0 to 125 minutes a week, but averages only 25 minutes a week.

Even in schools with six computers in a single Chapter 1 room and a computer-centered instructional approach, students spend less than half their Chapter 1 time on computer activities. Concerns regarding computer burnout, software limitations, and the need for direct instruction and other activities appears to dictate a maximum of about 125 minutes a week.

Such arrangements remain very rare. More typically, a small group of students take turns at a single computer. Each student gets 15 to 25 minutes at the computer, and usually waits until the following week for another turn. In some classes, each student uses the same software to address a group objective. In others, instruction is more individualized, and software is selected according to the individual child's need.

To convey the diversity in instructional uses of computers, four abbreviated case studies follow. In each, the instructional role of computers is

described in the context of other Chapter 1 instruction, and evidence of effectiveness is reviewed.

CASE STUDY #1: COMPUTER-MANAGED INSTRUCTION

The Chapter 1 Lab at Porter Elementary School (not the real name) provides an example of intensive use of computer-managed instruction in Chapter 1.

Porter has one of the highest concentrations of children from low socio-economic backgrounds in Wyoming. 65% of the 350 students receive free lunch. More than a hundred qualify each year for Chapter 1.

In the past, Porter has had three full-time Chapter 1 teachers. When one teacher left in the spring of 1986, the school invested $58,000 in a computer-managed instruction lab and did not replace the teacher.

The lab includes six Apple IIe computers equipped with color monitors and sound boards and two Dukane filmstrip cassette players for student instruction, an IBM XT computer and laser disk player for testing and monitoring student progress, and a video cassette recorder and monitor with tapes for staff development. Instructional materials include more than 500 pieces of software, several filmstrip cassette units, and a supply of student workbooks, with rights to duplicate materials within the school. All software and equipment are kept in one Chapter 1 classroom.

The Chapter 1 lab follows a diagnostic prescriptive approach to supplementary reading and math instruction for students in grades K through 4. In the fall, Chapter 1 students take a diagnostic multiple choice test supplied with the lab. Students mark their answers on paper, and a Chapter 1 teacher transfers student responses by hand to an IBM XT computer. Scoring software prints out a chart for each child showing which skills were mastered and which require additional instruction. The teacher selects three of the initial skill areas needing instruction, and the computer prints a pre-set prescription of activities to address each one.

Prescriptions typically include four types of activities: computer activities (generally drill and practice), tutorial sessions with a teacher, work book exercises, and use of filmstrip cassette stories. Students spend an average of about 75 minutes of the 165 minutes per week they are in Chapter 1 working at the computer. When a student finishes the tasks pertaining to one skill, he or she takes a 5-item mastery test at the computer using software stored on the laser disk. If the skill is mastered, the teacher updates the student's file, and a new prescription is printed.

Students meet in classes of 8 to 18 students for an average of 35 minutes per day. Instruction is highly individualized, in the sense that students spend most of their time working alone rather than in groups, and on diverse activities and objectives. Students working on reading and students studying math work side by side. On occasion, students work together or with the teacher in pairs or in groups of 3. Prescriptions are individualized according to test results, but not according to student temperament, learning styles, or interests. Since every child's prescription includes computer activities and there are 6 computers for more than 6 students, the computers are used almost continuously.

The actual reading that occurs in the lab is generally limited to instructions, individual words, and short passages used in comprehension exercises for those students who progress to the comprehension-level objectives. From time to time, students listen to stories on tape cassettes with accompanying text and illustrations on filmstrip. The Chapter 1 teachers report that students do not read stories or poems as part of the lab, and there is no discussion of text. No reading of extended passages apart from filmstrips was observed. Teachers report that students do read aloud individually on occasion.

There is no overt coordination of the lab with the regular classroom, except that the sequence of skills in student prescriptions follows the same sequence as skills taught in the basal reader. Chapter 1 teachers do not meet regularly with classroom teachers, although some classroom teachers visit the lab on their own initiative to keep abreast of their students' progress. The test-generated prescriptions dictate the instructional activities, and are not ordinarily shared with classroom teachers. On the other hand, the computer activities are presumably well integrated with the workbook, filmstrip, and tutorial sessions focusing on a particular skill.

Computers are used as a reward as well as for instruction. When students finish an activity successfully, they are often allowed to play non-instructional games such as "Galaxy" or "Karate" on the computer for the remainder of the period. One day a week is devoted largely to game activities for a change of pace.

Evidence of Effectiveness

The company which marketed the lab did not supply any formal evidence of the effectiveness of their system. To assess its effectiveness at Porter, student normal curve equivalent gains at Porter for students in grade 1-4 were compared to gains at other District A Chapter 1 schools.

The comparison, shown in Table 3, indicates that Porter Chapter 1 students on average gained slightly more than Chapter 1 students in other District A schools, whether gains are measured from fall of 1986 to spring of 1987 or from the spring of 1986 to the spring of 1987. However, neither difference is large enough to be statistically significant. These data suggest that the program at Porter results in real gains in reading test scores, and is at least as effective as other approaches currently employed.

Table 3

Comparison of Achievement Gains in Grades 1-4 for Porter and other Chapter 1 Schools

Average Achievement Gains from October, 1986 to April, 1987

	N	Pre	Post	Gain
Porter	36	22.2	42.9	20.7
Others	164	17.1	35.5	18.6

Average Achievement Gains from April, 1986 to April, 1987

	N	Pre	Post	Gain
Porter	39	37.5	41.0	3.5
Others	75	31.0	33.6	2.6

Discussion

The individualized computer managed approach used a Porter has several positive features. The system provides an extensive, integrated set of instructional resources, coded by objective. Computer use is integrated smoothly into other Chapter 1 instructional activities by educational plans generated for each child from diagnostic test results. Student progress is monitored systematically, and students work on a skill until it is mastered.

The approach raises potential concerns of cost and instructional balance. In most Chapter 1 schools, $4,000 for software represents a large investment. To invest several times that amount for Chapter 1 alone is not cost effective unless the student-teacher ratio is increased substantially over a period of years.

In reading, the approach focuses upon the drill and practice of individual skills. Extended reading, writing, and discussion are largely absent, yet these activities are essential to a comprehensive reading program. It is important that the regular classroom provide a compensating emphasis in those areas, and that some way be found to coordinate classroom and Chapter 1 instruction from month to month.

CASE STUDY #2: COMPUTER AS SUPPLEMENTARY RESOURCE

District B serves several elementary schools in Chapter 1. Chapter 1 provides supplemental reading instruction in grades 1-6. The district provides an example of an effective Chapter 1 project which makes selective use of computers as one of several supplementary resources to vary instructional fare.

Three elementary schools were visited in the course of this study. An average of 22% of their students receive free and reduced lunch. Twenty percent are from minority backgrounds, predominately Hispanic. The regular classroom reading program at District B is based upon a basal reader series, augmented by Distar, a phonics-based approach, in grades 1 and 2.

The computer is one of several resources employed by teachers in an eclectic program which varies from school to school. Each Chapter 1 classroom has one computer for an average class size of 4. In one school, the Chapter 1 teacher takes her class to the school computer lab once a week for additional computer use. In other schools, students use the Chapter 1 computer one at a time in rotation once or twice a week. Most students spend an average of 20 to 25 minutes with the computer per week.

Several activities are employed in Chapter 1 classes; many involve special equipment. Children read stories aloud or silently and discuss them, fill out worksheets on word analysis skills, listen to taped stories using Hoffman filmstrip-cassette machines, and answer questions at Charlie the Robot, another learning machine. One school uses a Controlled Reader, a machine to control reading speed and eye movement, once a week. In at least one school, children read literally hundreds of story books at home as part of an ongoing Chapter 1 competition. While teachers describe their program as phonics-based, extended reading and comprehension activities are very much in evidence.

In this context, computers serve much the same function as worksheets. They are used to give practice and reinforcement in specific skill areas that have been previously taught in direct group instruction. Their advantage over worksheets is that they provide immediate feedback, encourage students to work at a higher rate of speed, and bring an enjoyable variety.

Student enthusiasm for the computers was unmistakable. During our observation, each child who was given an opportunity to use the computer expressed overt delight. Several mentioned they wished they could use it more often in class.

Software collections were modest, typically with 15 to 20 programs to choose from. All employed excellent color graphics in interactive formats to provide practice with skills including letter recognition, word analysis, comprehension skills, and visual memory.

Effectiveness

Achievement gains for District B were among the highest in the state both in 1985-86 and 1986-87. IN 1986-87, fall-spring achievement gains averaged 17.5 NCEs across grades 2-6 for 58 students tested, compared to a statewide average of 10.5 NCEs. Annual (spring-spring) gains for students remaining in the program for two consecutive years averaged 10.5 NCEs (from 37.2 to 47.7) for the 26 students with available data, compared to a state average of less than 1*.

Discussion:

Teaching machines have come and gone in remedial reading programs since the early 1960s. In many instances, districts purchased them as the latest hot item when they came out, found that the claims made for them were unrealistic, and abandoned them a few years later. The eclectic approach employed in District B has provided a flexible instructional environment in which new devices and techniques have been absorbed and retained without making a dramatic change in the operation of the program. Teachers have continued to search for new activities and techniques without discarding old ones. Here, computers represent one more tool that has been added to the repertoire without any dramatic change in overall instruction.

There is no single formally articulated Chapter 1 program in District B which integrates student activities in a specified sequence. The absence of a formal sequence does not mean that activities are poorly integrated; it means only that each teacher must have a solid grasp of principles of reading instruction, extensive familiarity with the instructional resources available, monitor student progress regularly through a variety of means, and adjust the pacing and selection of activities accordingly. Such an approach relies directly on teacher expertise, and may pose problems for beginning teachers.

The fact that Chapter 1 students in District B regularly exhibit among the highest achievement gains in the state, both fall to spring and sustained over a two year period, argues that the program currently works well.

*Based on 1985-86 data.

CASE STUDY #3: REGULAR CAI GOVERNED BY CLASSROOM INSTRUCTION

District C is an example of intensive use of computer instruction in Chapter 1 which is guided by the regular classroom curriculum.

Chapter 1 operates in several elementary schools in District C, in both reading and math. Three schools were visited in the course of the study. The percent of students at these schools receiving free or reduced lunch ranged from 13% to 19%.

Computers are an integral part of Chapter 1 instruction. Each Chapter 1 school has 6 computers housed together in one section of the Chapter 1 instructional area, and an extensive software collection of 25 to 50 software packages purchased by the district, with most of these containing several activities. The computers and software are managed by an aide.

Chapter 1 instruction is directed by the pace of regular classroom instruction, and by formal diagnosis of skill deficiencies. The importance of these sources of direction varies from school to school. At one elementary, Chapter 1 is viewed as a direct supplement to the regular curriculum without an independent instructional direction of its own. The focus of Chapter 1 instruction is determined by the topics being addressed in the classroom. Classroom teachers provide weekly plans identifying the skills and topics for particular Chapter 1 students to work on. Diagnostic testing plays a minor role. At a second elementary, instruction is also directed by regular communication with classroom teachers, but Chapter 1 also conducts its own diagnostic testing of the skills identified in the Systematic Approach to Reading Improvement (SARI), and emphasizes deficient areas in instruction.

Students spend from a third to a half of their Chapter 1 time (or from 65 to 100 minutes a week), using computers. Classes range from 1 to 10 students, and most of the time there is a computer available for each child. Instructional activities are largely divided between tutorial instruction provided by a teacher, and computer activities managed by an aide.

In a typical example, a classroom teacher may determine that a child needs additional instruction on reading vowel sounds. In Chapter 1, a teacher will tutor the child on particular vowels, and prepare a cassette tape for the child to use with the Hartley Vowel software program. The child may then spend a few sessions in the computer area under the supervision of an aide practicing matching vowels on the computer monitor with the sounds on the tape.

The use of computers was limited by the need for varied instructional activities, and by available software. Teachers and aides agreed that students "burned out" on the computer if they used it too long or too often. For first and second grade students, sessions were kept under 30 minutes and were not held daily. For older students, 30 minute sessions every other day, or 20 minute sessions on consecutive days appeared to maintain interest. Aides found that action programs, such as games, held interest much more effectively than routine drill programs. Software was particularly limited for first and second grade students with small reading vocabularies.

Aides and teachers were generally satisfied with their ability to integrate computer and tutorial instruction under the direction of the classroom curriculum. This was made possible by the size of their software collection, the intimate familiarity of aides with the content and objectives of each piece of software, and the fact that many programs allowed teachers to enter their own vocabulary, stories, or spelling words, often with accompanying tape cassettes controlled by the software.

Effectiveness

Chapter 1 students were tested in reading and math with the Iowa Test of Basic Skills in the fall of 1986 and in the spring of 1987. Students showed moderate gains in both subjects (6.9 NCEs in reading, 3.4 NCEs in math) for the three schools observed. Because the district changed to a newly normed test in 1986, annual gains could not be determined. In reading, the students in the primary grades gained considerably more than for older students.

Discussion

In many respects, the use of computers in Chapter 1 in District C is exemplary. A computer is usually available for each child. The software collection is large, and systematically linked to specific reading and math objectives. Care has gone into the selection of software, to address a wide range of objectives, and many programs allow teacher modification. Computers are used regularly, but not to the extent that students lose interest. The use of computers is directly coordinated with the regular reading and math program.

With these characteristics, why aren't achievement gains higher, especially in the higher grades? In reading, the explanation may lie with the match between the instructional emphasis of the program and the Iowa Test of Basic Skills (ITBS). Unlike most standardized reading tests, the ITBS includes only reading comprehension in its reading score. Any gains students make in vocabulary or word analysis which are not reflected in improved comprehension are not measured by the reading score. It is possible that the combined classroom and Chapter 1 instruction contribute more directly to improved comprehension in the earlier grades, or Chapter 1 instruction in the higher grades may emphasize word analysis and vocabulary. In math, an analysis of subtest gains might reveal substantial gains in some areas and offsetting weaknesses in others. With this information, the district could selectively strengthen its instructional emphasis in Chapter 1.

CASE STUDY #4: DRILL AND PRACTICE IN HIGH SCHOOL MATH

District D makes extensive use of computers in its highly successful secondary math program.

District D serves three secondary schools in Chapter 1 reading and math. The district is rural and predominantly white; students on free or reduced lunches range from 13% to 21% at the three schools. The Chapter 1 program has received national recognition for its reading project. The math project at the high school is described here, however, because it makes greater use of computers and has demonstrated remarkable achievement gains.

At high school, Chapter 1 math is offered to students in grades 9 and 10 in a small Chapter 1 classroom equipped with six Apple computers. No class has more than 6 students, so there is always at least one computer per student

Instruction is individualized. Students are given a diagnostic test, the Diagnostic Math Inventory (DMI) in the fall, and the results are used to develop an individual prescription for each student. A textbook forms the core of instruction with students beginning at different points depending on their DMI results. The text includes exercises which retain items from previous units, so that skills continue to be reinforced long after they are taught.

Computers are used primarily for computational practice. In this respect, their function is similar to worksheets, but students reportedly find them more motivating and complete problems much faster. Occasionally, computers are used to clarify and reinforce a concept that has just been introduced.

In a typical class, students spend the first half of the period completing individual assignments from the textbook. During this time, the teacher instructs individually or in pairs. As soon as work from the text is completed, students are allowed to begin a pre-assigned computer activity Although computer work is usually computation drill, students prefer it to the seatwork, and so are motivated to finish the seatwork quickly.

Software is limited at the high school. Levels C and D of SRA's Computer Drill and Instruction in Mathematics form the core of the collection, along with SRA Math Strategies to address problem solving skills. There is a recognized need for more variety in software, particularly in concept development and problem solving. The match between the textbook and the software is imperfect, and there are several topics in the text which are not directly reinforced at the computer. Nonetheless, the computers are as well integrated into the instructional program as the software will allow.

Effectiveness

The impact of Chapter 1 on student achievement in District D is determined by testing students once a year in the spring with the Comprehensive Test of Basic Skills (CTBS) and computing the annual gain from one year to the next. This approach usually results in smaller obtained gains than the more common method of measuring growth from fall to spring, but is less susceptible to bias (Keesling, 1984). In light of this, average gains in math achievement for Chapter 1 students in District D are truly impressive, averaging 7.8 NCEs from 1986 to 1987 for 49 students in grades 7-10, compared to a national average of only 2.1 NCEs.*

Discussion

The Chapter 1 math program at the high school incorporates several elements which are often associated in research with improved achievement: very small class size, tutorial instruction, continuous practice and reinforcement of skills, and an apparently high percentage of time engaged in learning. The use of computers in the class probably contributes to student engaged time, particularly time spent in the reinforcement of computational skills, and allows the instructor to work individually with other students. The automatic recycling of previously learned concepts and skills is a significant feature, one that is often missing in mastery approaches.

The lack of focus on problem solving skills in the high school project is typical of Chapter 1 math projects. Plans are already underway to include more objectives involving problem solving and thinking skills in the future. Sharing software within the district (a neighboring high school in the same district has an extensive, well organized collection) will strengthen this aspect.

It is not clear whether other districts can achieve the results in District D by adopting its approach. Students' average pretest achievement, at the 28th percentile, is typical for Chapter 1. However, the community is comparatively homogeneous, stable, and supportive of education. In addition, the per-pupil cost of the high school project is high when the investment in computers is considered. The ratio of computers to students (1:1) and students to teachers (3:1 per class) would not be realistic in many districts with large numbers of eligible children.

*Based upon 1984-85 data supplied by the U.S. Department of Education.

EFFECTIVENESS

Finding: There is no reliable relationship between amount of computer use and amount of achievement gain when existing district data are compared across districts.

If computers are a powerful instructional tool and are used effectively, then other things being equal, it is reasonable to expect that Chapter 1 projects that make greater use of computers should obtain greater achievement gains than projects that make less use. The association between achievement gain and computer use was examined using multiple regression. Average minutes of weekly computer use per pupil were estimated for each project by grade level using data supplied by districts. Pretest and grade level were also employed as predictors to control for project differences. Fall-spring achievement gain was predicted from minutes of computer use, grade, and average pretest score. Separate analyses were performed for reading (N=144) and math (N=56).

The number of minutes of computer use was not significantly associated with gain in either reading or math (see Table 4). In reading, grade and pretest were inversely related to gain (i.e., higher gains were associated with early grades and low fall pretest scores). Minutes of computer use showed a weak positive association with gain, too small to be statistically reliable. In math, there was no association at all.

Table 4

Multiple Regression

Predictor	Standard Coefficient (Beta)	T	p
READING (R=.36)			
Minutes of Computer Use	.11	1.43	.16
Grade	-.21	-2.68	.01*
Pretest	-.29	-3.66	.00*
MATH (R=.35)			
Minutes of Computer Use	-.09	-.71	.48
Grade	-.18	-1.34	.19
Pretest	-.23	-1.69	.10

This analysis has several limitations. The project attributes it examines explain only 12% of the variance in project gains. Differences in gains may be associated with several additional attributes, including testing practices, test validity, student differences, teacher effectiveness, and the effectiveness of the regular educational program. The current study could not control for differences in projects in these areas. Controlled studies within districts, or time-series analyses comparing changes in gains before and after computer use are needed. Nonetheless, it is not at all apparent that extensive use of computers is in itself a means to raise Chapter 1 gains. On average, projects in which students use computers fewer than 20 minutes a week show gains approximately equal to those of projects using computers more than 70 minutes a week. The comparison within a single district of high-use and lower-use schools (Case Study #1) also failed to find a significant difference.

*Significant at $p < .01$

Finding: Teachers overwhelmingly support the value of computers in Chapter 1 instruction.

Ninety five percent of the Chapter 1 teachers and administrators contacted believe computers to be valuable instructional tools in Chapter 1. While teachers are unsure whether the use of computers directly affects measured achievement gains, they have no doubt that it affects student attitudes and motivation. Ninety three percent of teachers reported that computers improve student attitudes towards Chapter 1 instruction. Many associated them with improved enthusiasm, attendance, and time on task. Student enthusiasm was obvious in the ten Chapter 1 classrooms visited by the authors.

A large proportion of teachers (77%) indicated that students progress more quickly when computers are used to teach at least some tasks, such as memorizing and retaining vocabulary words and math computation facts. Only one teacher reported having collected evidence to support such a belief, however.

SUMMARY AND RECOMMENDATIONS

1. **Districts are making active instructional use of computers in Chapter 1.**

   The great majority of districts use computers regularly in Chapter 1. If there are projects in which Chapter 1 computers are going unused for weeks at a time, they are a very small minority.

2. **There is little evidence to support large-scale investment in computer-intensive approaches over other Chapter 1 approaches.**

   Wyoming districts making large use of computers achieve gains similar to districts making moderate use. Within one district, gains in an integrated computer-based lab are only slightly higher than gains at other schools. These results are in keeping with the finding of a highly regarded national study (Levin, Glass, and Meister, 1984), that computer assisted instruction is not more cost effective than cross-age tutoring in reading or reduced class size in math.

3. **Chapter 1 teachers would benefit from training in software availability and use.**

   The greatest single need expressed by Chapter 1 teachers regarding their use of computers was for training. In particular, teachers wanted information regarding quality software for use with young students and for teaching comprehension, problem solving and thinking skills. Training on the integration of new software into Chapter 1 instruction through workshops or visits to exemplary projects was widely requested.

4. **Additional computers could be put to effective use in many projects which currently have one computer per class.**

Most Chapter 1 teachers have regular access to only one computer. While many are satisfied with this arrangement, many others would make more effective use of the resource if they did not have to allocate it among four to six students in a class period.

5. **The administrative use of computers could be greatly improved.**

Many Chapter 1 teachers and administrators have discovered word processing, but relatively few make use of the record keeping and computational capability of computers. Nearly half the districts have access to Appleworks, but only a few use its database capability or its spreadsheet to store student information or to compute achievement gains. Most districts did not identify a need for assistance in this area, but that may reflect a lack of familiarity with its potential.

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APPENDIX A

DATA COLLECTION AND RESPONSE

Forty four Wyoming school districts operated continuing Chapter 1 projects during the 1986-87 school year. Information regarding the uses of computers in Chapter 1 was obtained from 42 of these districts through a combination of telephone interviews, written questionnaires, and on-site visits.

Telephone interviews were conducted with Chapter 1 teachers or contact persons at the 27 districts who purchased computers with Chapter 1 funds, using an interview protocol included in this appendix.

On-site visits were conducted in four districts. Districts were selected for on-site visits because they had relatively large inventories of Chapter 1 computers and/or had demonstrated unusual achievement gains. One full day was spent in each district. Interviews were conducted with the Chapter 1 contact person and up to three Chapter 1 teachers. A minimum of three hours was devoted to classroom observation, and informal interviews were conducted with students concerning their use of computers in Chapter 1.

Questionnaires were sent to the remaining 17 districts concerning the use of district computers in Chapter 1 instruction (included in this appendix). 15 districts responded.

Telephone Interview Guide

Computers in Wyoming Chapter 1

Purposes of study: (a) To describe how computers are used in Chapter 1, and (b) to identify exemplary practices and describe them.

District:_____

Contact Person:_____Phone Number:_____

Date of Call_____

1. Overview of Chapter 1 Program

   Grades Served:_____

   # of Schools Served:_____

   Subjects Served:_____

   _____

   _____

   # of Students (unduplicated count - approx.):_____

2. According to state department inventories, (#_____) computers are used in Chapter 1. Correct?

   Where are computers located? (e.g., 1 in each classroom, and 1 in my office)

3. What kind of computers are they? (e.g., one Apple II+ and 1 Apple IIe)

4. Are computers used for <u>administrative</u> purposes? (e.g., to store student data, for word processing?) Describe uses

   Which computer(s)?

   Does it (they) have extra memory? (e.g., 128K?)

   What software do you use for administrative purposes?
   (e.g., Appleworks, PFS)

5. Whom should I talk with to learn about the instructional uses of microcomputers in the district?
   (<u>Call teacher</u>_____) if likely to get better information).

6. Instructional uses in math: Instr. uses - reading/language arts

a. Where is computer?

b. How many children per computer in period?

c. Who gets to use?

d. How do you decide when to use?

e. How many different software programs do you have (estimate)?

f. Up to 5 examples of most frequently used software (Name, publisher, type of use)

Summarize extent of use

a. Primary instructional tool

b. regular supplement to instruction

c. occasional supplement to instruction

Summarize what determines particular child's use

a. regularly scheduled. Each child uses for certain types of reinforcement, or other purpose.

b. individual need. Children who need extra drill on particular topic may use as part of instruction on that topic. (Teacher assigns).

c. reward. Child uses when finished with other work, or other reward basis.

d. Child determines. Child may choose on a given topic whether to work on computer or engage in other activity.

Summarize what types of activities computer provides

a. drill and practice (of what?)

b. learn or develop new concepts

c. reasoning, thinking skills

d. word processing

e. other – identify (diagnosis and monitoring testing)

Summarize how computers are integrated into other instruction in subject.
Example: Teacher presents new vocabulary words in class. Children then drill meanings using a Vocabulary Builder program, in which teacher can enter own words, definitions. Then children use Bank Street Writer to write a story using the words. Teacher corrects, students edit on word processor.

If teacher is interviewed:

How long have you had a computer?

Do you use computer more than in past, or less?

How is your use changing? (type)

How valuable is the computer as a learning tool for you?

Why? (What evidence do you have that it is effective?)

a. Kids like it.

b. Notice more progress

c. Higher gains

Would you like more computers? (Why?)

Do you have enough software?

Trend: purchasing more? less? sharing with others?

What would make your instructional uses of computers more effective?

(More computers, different software [what?], different capabilities, longer period, more training, etc.?)

COMPUTER USE IN WYOMING CHAPTER 1 PROJECTS

QUESTIONNAIRE

District:_____

Chapter Coordinator:_____

1. Overview of Chapter 1 Program

Grades served:_____ Number of schools served:_____

Subjects served: (check all that apply)

_____Reading _____Language Arts _____Math

Approximate number of students (unduplicated count):_____

Do you make any instructional or managerial use of microcomputers in Chapter 1 (including computers purchased with regular district funds)?

_____Yes _____No (if no, you need not answer any further questions)

2. Computer hardware information.

How many computers are available for use by Chapter 1 students (as part of their Chapter 1 instruction)?_____

Where are these computers located?

_____computer lab _____Chapter 1 classroom

_____regular classroom _____other (please describe)

What kind of computers are they?

How many, if any, were purchased with Chapter 1 funds? _____

3. Software uses: management

How are computers used for administrative purposes in Chapter 1? (check all applicable responses)

_____Word processing (e.g., notes to parents, reports re. student progress, etc.)

_____General record-keeping (e.g., student information such as names, addresses, etc.)

_____Diagnosis (e.g., listing of instructional objectives of program)

_____Prescription (e.g., listing of materials available to complement instructional objectives such as computer software, A-V materials, workbooks, etc.)

_____Monitoring of student progress (e.g., recording student mastery of objectives, test scores, etc.)

_____Program evaluation (student pre- and posttest scores, gain computation, etc.)

_____Other: please describe:_____

_____

What software do you use for these purposes?

_____Appleworks _____PFS _____Other(identify)

4. Software uses: instructional

How frequently is the computer used in Chapter 1 instruction?

_____Very often (4-5 times per week per student)

_____Regularly (1-2 times per week per student)

_____Occasionally (1-2 times per month per student)

What determines which children get to use the computer? Please rank each of the applicable responses below.

_____Regular, rotated schedule

_____Individual need for drill on specific topics

_____Reward for work (or efforts) well done

_____Other (please explain)

Approximately what percentage of the children's time on the computer is spent in each of the following activities?

_____% drill and practice

_____% learning or developing (i.e., expanding upon) new concepts

_____% reasoning/thinking skills (e.g., inferential comprehension)

_____% word processing

_____% other (please identify)
100%

Please list two or three examples of software, for both reading and mathematics, that you believe to be very good and would recommend to other Chapter 1 teachers. For each example, please describe their primary functions according to the list above (drill, word processing, etc.).

5. Value of computers in instruction

How would you evaluate the use of computers in Chapter 1? (check all that apply)

_____students appear to make higher pre-post test score gains

_____students appear to make better or faster progress on their daily work

_____students appear to have better attitudes towards school, Chapter 1, reading, math, etc.

What would make your instructional uses of computers more effective? (check all that apply)

_____having additional computers owned by Chapter 1

_____having more and/or better software

_____having more training re. what types of software are available for programs such as Chapter 1, and what works best

_____having more training re. how to integrate computer-assisted instruction into the instructional curriculum

_____other (please describe)