ADI NEWS

VOLUME 8, NUMBER 1 — THE ASSOCIATION FOR DIRECT INSTRUCTION — FALL, 1988

From the Editor:

When one looks carefully at the current reading fad called the "Whole Language Approach" (as we did in our Spring '88 issue of the ADI NEWS), it is easy to be impressed by the stated goals of those espousing the approach and to be completely bewildered by the procedures to follow to achieve the goals. That is because the approach has failed to analyze what needs to be taught, in what sequence, and with what procedures to achieve the stated goals. In this issue, we open with articles dealing with the teaching of reading, with a focus on comprehension. Vicki Snider describes her research on the role of prior knowledge in comprehension. In her introduction, Vicki overviews the big picture of what is required in the many stages of becoming a competent reader, following the model developed by Jeanne Chall of Harvard. We had hoped to have an article written by Dr. Chall in this issue also, but could not get a permissions editor to respond to our request on time. Next, Gersten and Dimino demonstrate some procedures useful in teaching comprehension skills important in understanding dramatic literature. Both of these studies used low-performing students, and as we have learned long ago from Ziggy Engelmann, "If it works with low-performers, it will work with anyone." Each year we are learning more and more about the teaching of reading comprehension skills, but the problem is a complex one, and analysis and testing of component skills will go on for some time to come.

The rest of this issue deals mainly with: (1) some Association business, our Annual Awards and a treasurer's report, and (2) applications of computer-assisted instruction and videodisc instruction using Direct Instruction technology. We have been somewhat surprised at how much is going on in this area. Some of it may open new doors for you.

The DI Conference schedule for the coming year is truly impressive (see inside cover page). Take note and make your plans early.

The Winter and Summer, 1989 issues will be Historical Issues, bringing together some of the best of the past issues of ADI NEWS so that those who have joined us late might see where we have been. We also hope that having the more outstanding articles in three compact 8.5" x 11" volumes will make them more accessible to you as reference material.

We wish you a most happy and successful 1989!

Wes Becker and Staff

Treasurer's Report

by Wes Becker

Table 1 provides a comparison of the financial status of the Association for the past three years. The 87-88 fiscal year was the first year for which we have incurred a loss. This loss was due to our attempt to expand our conference offerings to the Midwest and Southern California. The Milwaukee conference provided the greatest lost, but has now led to a successful conference in the Chicago area this past summer. We are being more careful about new undertakings that do not have strong local support. Our most successful annual conferences are now in Eugene and Salt Lake City.

The handicapped preschool has grown and provided services to more children each year. It amounts to 2/3rds of our budget. Conferences are the next biggest budget item. Income from membership continues to grow at a modest rate. We have some losses from production of the ADI News that are picked up by conference gains in most years.

The increase in administrative expenses over the past three years is due largely to the fact that we are now paying for secretarial, accounting, and other management services that were previously donated by the Engelmann-Becker Corporation. The free services had to be discontinued because the Corporation has not been making a profit for the past two and half years.

We have a strong enough financial base to insure our survival and to allow us to venture into activities that are important to our Association goals. ◆

Table 1. Treasurer's Report for Fiscal Year Ending June 30, 1988 Association for Direct Instruction

	85-86	86-87	87-88
Cash Balances	$41,132	$66,321	$51,783
Gain (Loss) for year	$12,589	$25,189	($14,539)
Income			
Handicapped preschool	$162,417	$217,974	$245,063
Memberships	$11,031	$13,442	$15,297
Booksales	$13,981	$14,318	$11,955
Conferences	$37,004	$106,380	$97,946
Workshops	—	—	$28,351
Other	$21,426	$16,447	$4,700
Total Income	$245,860	$368,561	$403,312
Expenses (Direct)			
Preschool	$166,270	$183,949	$212,326
ADI News and book cost	$9,761	$31,880	$31,646
Conferences	$42,218	$86,540	$104,239
Workshops	—	—	$26,615
Other—e.g., Summer school	$5,043	$7,586	—
Total Direct Expenses	$223,292	$309,955	$374,826
Administrative Expenses	$9,979	$33,417	$43,025
Percent of total expenses	(4.5%)	(10.8%)	(11.5%)
TOTAL EXPENSES	$233,271	$343,372	$417,851

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ADI Annual Awards for Excellence

by Wes Becker

At the Annual Meeting of the Association for Direct Instruction, held in conjunction with the 13th Annual ADI Eugene Conference in August, 1988, awards were made in four areas: Excellence in Teaching, Excellence in Supervision/Teacher Training, Excellence in Administration, and Excellence in the Applications of School Psychology to the needs of children.

Excellence in Teaching

The award for excellence in Teaching was presented by Ziggy Engelmann to Susan Dixon. This is what he said about her contributions to Direct Instruction:

"I know this person from way back when. In fact, I worked with her husband before they were married and her husband was concerned because she wasn't into DI. He didn't know what to do with her. She was a good teacher and a very nice person, but a traditionalist. He didn't know if this was going to impair their relationship.

Well, it turned out that they indeed did get married and with some reluctance she got modestly involved with DI. She taught at a school where we were supervising and she also worked with one of our trainers—a lot. She did a lot of practice after she got into it.

She is sort of an athletic buff. She runs and does things like that. This one person said they run a 10-minute mile. This person would run with them—a ten-minute mile— as though that was her pace. Then, she would run with an 8-minute miler and she would do the same 8 minutes as though that were her regular pace. That is the impression she is capable of giving. She is a very nice, accommodating person.


Susan Dixon

As a teacher I have had the opportunity to see her grow over the years. I have seen her grow from the point that she was mechanical in her presentations and she didn't have all that much pizzazz or management skills. She went from here to Illinois with her husband and she got a job where they were trying to set up a model school with a tough population. The school was in a black area where there was a high turnover. There was a lot of electricity in this school. It had the potential to be a bad situation.

They got a principal in there who wanted to turn things around and she needed a leader. . . a model who was a solid citizen and who really knew how to teach. This person went in a did it.

She's not the type who leads by saying 'Come on guys—Let's get organized here'. No, she does it all by example and all in the same way as when she runs with different people: She's sincere, she's a super model and one hell of a teacher.

Last time I was out there I saw her in her glory. She had a group of not-easy-to-teach kids in the Arithmetic program. She had those guys—it was amazing. She had me take over the group. Afterward, when I compared my pacing with hers and what a klutzy job I did I knew how good she was.

So—she is a model teacher, a super person and for all who have been associated her she has been a star. She is now teaching at North Thurston School District in Washington—Susan Dixon."

Excellence in Supervision/Teacher Training

The award for Excellence in Supervision/Teacher Training was presented by Ziggy to Paul McKinney, who had been one of our conference presenters and the keynote speaker at the Annual Meeting. This is what Ziggy had to say about Paul's contributions:


Paul McKinney

"I kept hearing about this guy. I kept hearing 'you ought to go to this guy's workshops' and 'you ought to see this guy present'. Then, I kept hearing 'you ought to see this guy's program in New York, you really ought to look at what's going on.' Geoff Colvin, who is really into management, went out there to help with some behavior problems. He couldn't do anything for them because the had no behavior problems.

So, I kept hearing about this stuff and I finally got out there and saw the program. I saw some really nice stuff. I saw these kids that had been kicked out of school in the the YMCA because couldn't follow the rules. Here these kids were—proud and smart—they were behind in their academics, not so much because they weren't smart, but because they had missed so much school. They were doing these videodisc programs and I thought there must be something wrong here. I saw 28 kids in a room for 12 and the still frames came on. It said copy the problem and work the answer. It took these kids 5 seconds to do it. I thought this isn't right. I walked around the room and lo—they had copied the problem and worked the answer. They were doing it! Then, I saw him work with some real low performers.

Then, I figured out how this guy works—he is extremely positive. I have never seen him down and I have seen him in situations where you and I would be down. He's up, he's positive, he'll go at it, he works long hours, he works hard, he's one hell of a nice guy and his name is Paul McKinney."

Excellence in Administration

The award for excellence in Administration was presented by Gary Johnson to Joel Davidson. This is what Gary had to say in his presentation:

"For eleven years, Dr. Joel Davidson was Director of Special Education, Washington School District, Phoenix. As director, he recognized the efficacy of Direct Instruction programs with special education populations (LD, EMH, TMH) and in the mid 1970's introduced DI programs in many special settings, starting with *DISTAR Reading I and II* programs, the *DISTAR Language* programs, and the *DISTAR Arithmetic* programs. Other programs were implemented as they became available, including *Reading Mastery III* and *IV*, *Corrective Reading* (Decoding *and* Comprehension Programs), *Spelling Mastery*, *Expressive Writing*, and *Your World of Facts*.

Dr. Davidson also recognized the importance of training in the use of DI materials and brought on staff Mada Kay Morehead, who for many years provided staff development in DI programs along with her other duties as a special education support person.

During the 1985-86 school year, Dr. Davidson supported a pilot of *Reading Mastery* in regular classrooms at Mountain View School. The principal and instructional assistant were sent to the Eugene ADI Conference for training. During fall preservice sessions, selected teachers were trained and then given follow-up training provided by Mariam True of the San Diego Follow Through Program. The program was so well-received that the decision was made to use *Reading Mastery* with all students the following year.

At the beginning of the 1986-87 school year, Dr. Davidson became principal of Mountain View School. He promoted the full-scale implementation of Direct Instruction programs in the building, including all levels of *Reading Mastery, DISTAR Language I, Corrective Reading Decoding* and *Comprehension* programs, *Spelling Mastery, Expressive Writing*, and *Your World of Facts*. All teachers received preservice training. Some teachers were sent to the ADI Conference in Salt Lake City. Dr. Davidson hired a full-time teacher on special assignment to provide initial and ongoing training and to assist with this large implementation. Special Education and Chapter I teachers were given regular classrooms assignments, so that no class had more than 25 students. At each grade level, one classroom was designated "transitional" and was staffed by one certified Special Education teacher and a full-time aide. Students on IEP's and other lower performing or at-risk students received instruction in the transitional classrooms, which had a maximum enrollment of 15 students.

At the beginning of the second year (1987-88), Dr. Davidson arranged for several teachers to attend the ADI Conference in Newport Beach, California, and he also attended sessions there. During the year, he supported expansion of the use of DI programs in other subject areas (spelling, writing).

If these enormous contributions were not enough at Mountain View School, Joel Davidson also replaced the district's "assertive discipline program" with a school-wide classroom management program (Attitudinal Transition Format, or ATF) that involves the use of a point system, peer review, and parent participation. Overall school discipline improved dramatically

He increased the number of trained aides in classrooms while decreasing class sizes.

He opened the first Head Start program on the north side of Phoenix.

He opened one extended-day kindergarten (5 hour) for identified at-risk students.

He started an after-school "homework club" where students have an opportunity to do homework with guidance from a teacher, an aide, and other students.

He started a gardening program, run by a volunteer. Students raised vegetable crops.

He started a woodshop program, the only such program at an elementary school in the district. The teacher teaches a *Reading Mastery* group in the morning, runs the shop program in the afternoon, and runs a hobby club after school.

He arranged for sixth-grade students to fly to Catalina Island to attend a 3-day science institute. Funds for the trip were raised through candy sales, rummage sales, car washes, and other volunteer activities.

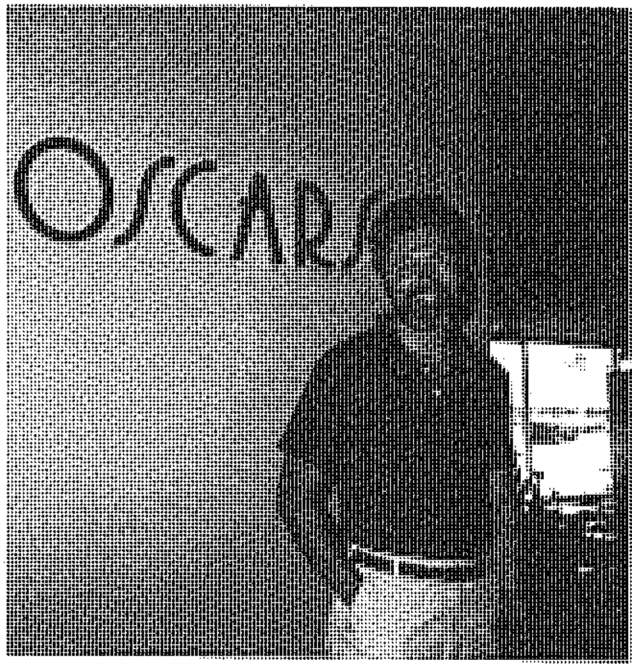
Dr. Joel Davidson is an outstanding candidate for ADI's Administrator of the Year award. He's the best school administrator I've ever worked with."

Excellence in School Psychology

The award for Excellence in School Psychology was presented to Mike Vreeland by Leslie Zoref. This is what Leslie had to say in her presentation:

"The person receiving this award is distinguished by the following facts:

- He has actually read *Theory of Instruction all* the way through.
- He knows the middle name and birthday of every DI trainer.



Mike Vreeland

- He knows how many motorcycles Zig owns at any given time.

For those of you who do not know him, I'm describing Mike Vreeland. Mike has been a school psychologist in Kalamazoo, Michigan for eleven years. He has served as a trainer at all nine Kalamazoo (Western Michigan University) Direct Instruction conferences. He has been the coordinator of that conference for three years. He has taught several classes on DI theory, reading, and math at two local colleges.

Mike has boundless enthusiasm for Direct Instruction. He is the leading proponent of DI strategies in the Kalamazoo Public Schools. There, he works with teachers and administrators in both regular and special education on instructional problems. Largely as a result of Mike's doing, the role of School Psychologist has been redefined to focus on instructional interventions rather than IQ scores.

The following example characterizes Mike's dedication to teaching kids well:

His supervisor was getting complaints from other teachers that their school psychologists were not providing them with the same practical services that Mike was giving his teachers. The supervisors solution to this problem was to tell Mike that he couldn't train his teachers during the school day. Mike's response was to provide the needed training *after school.* Mike is dedicated to doing what's best for kids. He is an exceptional school psychologist.

In closing, I might note that this is Mike's fifth trip to the Eugene Conference. My question to Mike is, 'Are you firm yet?'" ◆

Call for 1989 Award Nominations

It is not too early to be thinking of your candidates for the 1989 Excellence Awards. Awards may be made for teaching, supervision, administration, research, and other service areas, such as school psychology. If you have a candidate you wish to noninate, write a letter documenting the contributions made by your candidate. Send your letter to:

Chair, Awards Committee
Association for Direct Instruction
PO Box 10252
Eugene, OR. 97440

The Role of Prior Knowledge in Reading Comprehension—*A Test with LD Adolescents*

by Vicki E. Snider*

Reader's prior knowledge positively influences both the amount and type of information that is recalled (Anderson, Sprio, & Anderson, 1978; Gagne, Bell, Weidemann, & Yarbrough, 1980; Pearson, Hansen & Gordon, 1979; Steffensen, Joag-Dev, & Anderson, 1979). Insufficient prior knowledge or failure to activate prior knowledge when reading can interfere with reading comprehension performance. (Langer, 1984; Pearson, Hansen & Gordon, 1979; Taft & Leslie, 1985). Learning disabled (LD) students may be more likely than average students to have an impoverished knowledge-base as a secondary result of their reading disability (Snider & Tarver, 1987). Therefore, LD students may be at risk for comprehension difficulties related to lack of prior knowledge.

Chall's (1983) five-stage model of reading development provides a useful framework for viewing the acquisition of reading skills throughout the school years. The premise of this research rests upon Chall's stage model. During Stage 1, which typically occurs in first grade, children learn to use letter-sound relationships to decode the printed word. Stage 2, which begins in second and continues through third grade, children gain fluency through practice. In Stage 3, which begins at about fourth grade, children stop "learning to read" and begin "reading to learn." They acquire a rich base of information and vocabulary concepts by reading a wide variety of materials. In high school most students enter Stage 4, in which information from a variety of sources is compared and evaluated. Stage 5 involves synthesis of information and hypothesis formation that is restricted to a specific area of study at an advanced level.

Each stage is dependent on mastery of the previous one. For example, accurate decoding (Stage 1) is prerequisite to fluency (Stage 2). Both accuracy and fluency are necessary for the acquisition of knowledge in Stage 3. Stage 4 builds upon the knowledge acquired in Stage 3. The acquisition of the highly specialized knowledge in Stage 5 is dependent upon the rich base of information acquired in Stages 3 and 4.

The literature provides substantial documentation of LD students' decoding and fluency deficiencies in Stage 1 and 2. LD students seem to experience difficulty with several of the phonological aspects of language which play an important role in the initial acquisition of decoding skills—segmentation, blending, sequencing (Fox & Routh, 1980; Liberman & Shankweiler, 1979; Stanovich, 1982). The ability to decode both rapidly and accurately is a prerequisite to comprehension. It is only when decoding becomes automatic that attention is freed for higher level thinking about the text (LaBerge & Samuels, 1974; Samuels, 1981; Stanovich, 1982). Rapid reading indicates that automatic decoding has been attained.

Stage 4 deficiencies have also been indicated by recent research with learning disabled students. Failure to use metacognitive strategies can interfere with comprehension. The metacognitive processes concern the knowledge and control that a person has over his or her own reading activities. Deficiencies in metacognition, particularly comprehension monitoring, have been observed among young and poor readers (Baker & Brown, 1984; Owings, Peterson, Bransford, Morris, & Stein, 1980). There is some evidence to suggest that LD students are less apt than normal students to monitor their comprehension while reading (Bos & Filip, 1984; Kaufman, 1981). This is not surprising, however, since young and poor readers must divert more attention on decoding than on meaning.

Deficiencies in Stage 3, however, have been largely overlooked. During Stage 3 children acquire much background information and build vocabulary that will facilitate comprehension throughout their lives. An insufficient knowledge-base interferes with reading comprehension because prior knowledge plays a critical role in understanding higher-level concepts. Difficulties with problem solving can often be attributed to an inadequate knowledge base (Glaser, 1984). Students with learning problems often encounter difficulty with content area subjects because they don't have as much background information as their peers (Hansen, 1984; Langer, 1984). Frequently, lack of background information results in a misunderstanding of the text (Nicholson, 1984). Because prior knowledge influences what is understood from tests, two individuals with differing levels of prior knowledge would show differential comprehension of the same text even though they might have comparable reasoning ability (Johnson, 1984). Due to the cumulative effects of the initial decoding problem, LD students are much more likely than average students to lack fundamental information and vocabulary that are necessary for comprehension (Snider & Tarver, 1987).

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Reading comprehension requires an interaction between the text and the knowledge that the reader possesses. The type of information contained in a passage will determine, to some extent, the difficulty of comprehension. Pearson and Johnson (1978) have classified questions as textually explicit, textually implicit, or scriptually implicit, depending on the type of information contained in the passage. Textually explicit questions assess literal comprehension and are the easiest to answer since the information necessary to answer the question is stated in the passage. Textually implicit questions assess inferential comprehension and are more difficult than textually explicit questions. The mean for textually explicit questions is significantly higher than the mean for textually implicit questions for all students, regardless of the amount of prior knowledge (Holmes, 1983; Pearson, Hanson, & Gordon, 1979; Taft & Leslie, 1985). To answer textually implicit questions, the reader must use information stated in the paragraph in order to make an inference. Scriptually implicit questions also assess inferential comprehension; however the scriptually implicit are more difficult than the textually implicit questions because the former require the reader to make an inference based on prior knowledge (e.g., of motives or intentions) (Taft & Leslie, 1985). The scriptually implicit question cannot be answered simply using information in the passage to make an inference; prior knowledge is essential to making an appropriate inference.

Research indicates that students who are low versus high in prior knowledge either do not differ in their ability to answer textually explicit questions (Holmes, 1983) or the differences are small (Taft & Leslie, 1985). However, the difference is greater for textually implicit (Holmes, 1983) and greatest for scriptually implicit questions (Taft & Leslie, 1985). Holmes (1983) has suggested that poor readers' inability to answer inferential questions of the textually implicit type is due to a problem other than lack of prior knowledge. Textually implicit questions should be answerable using the information in the passage to make a deduction or induction.

Research results showing that poor readers' performance on textually implicit questions is inferior to that of good readers has sometimes been inappropriately generalized to learning disabled readers. Many poor readers have lower-than-average IQ's, and thus, might be expected to experience difficulties with making deductions and inductions. Students with learning disabilities, in contrast, are defined as those whose achievement is low despite the fact that their IQ is average. Because the LD student has average intelligence, deductions and inductions may not pose the same problem as they do for poor readers with lower-than-average IQ's. Although IQ is a potentially confounding variable it has seldom been controlled in comparisons of good and poor readers.

Another confounding variable that has too often been ignored in research investigating the reading comprehension problem of students with learning disabilities is level of decoding skill—decoding accuracy and decoding speed or fluency. The net result of this research limitation is that LD students have been reported to be deficient in general comprehension ability, when in fact, their low performance in comprehension tests may have been due to inadequate decoding. When both IQ and decoding ability are controlled, differences between students with low prior knowledge and students with high prior knowledge should be small on textually implicit questions.

This study was conducted in order to investigate reading comprehension performance of junior high school students with learning disabilities. The effects of prior knowledge and type of reading passage were examined. The following research questions were asked:

1. Is there a difference in reading comprehension performance of students who are high in prior knowledge (experimental) and students who are low in prior knowledge (control)?
2. Is there a difference in reading comprehension performance for passages that are textually explicit, textually implicit, and scriptually implicit?
3. Is there an interaction between prior knowledge and type of reading passage?

Methodology

Subjects

The subjects in this study were junior high school students who received parental permission to participate and who met the following criteria:

1. The students had been identified as learning disabled according to state regulations and were participating in a special education resource room program. State guidelines are consistent with federal criteria which require that LD students exhibit a significant discrepancy between ability and school achievement in one or more academic areas. Additionally, the discrepancy between ability and achievement was not primarily the result of a visual, hearing, or motor handicap, mental retardation, emotional disturbance, environmental, cultural, or economic disadvantage.

2. The student had been predetermined to have average intelligence. In order to verify the student's IQ, the most recent Wechsler Intelligence Scale for Children—Revised (WISC-R) Full Scale IQ score was obtained from the student psychological file. Students with IQs below 85 were excluded. The mean IQ of the experimental group was 98 with a range of 85 to 119 and a standard deviation of 9. The mean IQ of the control group was 100 with a range of 87 to 114 and a standard deviation of 8.

3. The student had been predetermined to have sufficient skill in decoding to easily read the passages presented in this study. Adequate decoding was defined as the ability to orally read at a beginning fourth grade level at 120 words per minute with 95% accuracy in word recognition.

4. The student had been predetermined to lack information and vocabulary concepts pertinent to this study. A score of less than 50% on an individually administered curriculum-based test of prior knowledge was the criteria for inclusion.

In this quasi-experimental study, no attempt was made to randomly assign students to condition. During a pilot study, instructed students discussed what they had learned with naive students. This represented a powerful confounding variable, therefore, students for the experimental group were drawn from one school and students for the control group were drawn from two different schools. All the participating schools were similar in terms of socioeconomic status and all were located in the same midwestern city of about 100,000.

In order to assure that the experimental and control groups were equivalent, a *t*-test for independent samples was conducted on potentially confounding variables. As shown in Table 1, there were no significant differences between groups on any variable except reading rate on the test of decoding. This difference in rate was not accompanied by a difference in accuracy and was biased in favor of the control group. It should minimize rather than maximize the outcome. Therefore, the difference was not perceived to be a confounding factor. In addition, no differences in rate were observed during the test of comprehension.

Procedures

Prior to the experimental intervention, a test of decoding ability and a test of prior knowledge were administered to LD students in three schools. Thirteen students from School A, ten from School B, and three from School C met the decoding, prior knowledge, and IQ criteria.

The instructional intervention was provided by the author to 13 LD subjects in School A. Students received 50 minutes of instruction every day for three weeks (13 school days). The resource room teacher who normally taught these students was in the room and assisted by correcting practice exercises and answering questions during independent practice. The 13 students in the control groups received the same amount of instructional time with subject matter typical resource programs. Students read and answered questions about selected passages in *Journeys—A Reading and Literature Program* (Smith & Schultz, 1982), a literature anthology used in the regular language arts program. Students in the control group also received vocabulary instruction drawn from a variety of sources by the regular special education teachers.

Materials

Test of decoding ability. Decoding was assessed with the placement test for *Reading Mastery IV* (Engelmann & Hanner, 1983). This test was selected because the passages to be tested were adapted from *Reading Mastery* III and IV. Students demonstrated fluency by orally reading a 200 word passage in 100 seconds with no more that ten errors. This is equivalent to reading at 120 words per minute with 95% accuracy.

Test of prior knowledge. The test of prior knowledge was administered orally to individual students. It was

Table 1. Comparison of Means on Selected Variables Between the Instructed and Uninstructed Groups

	Instructed		Uninstructed		
	Mean	SD	Mean	SD	T-value
Age	14-3	1.06	14-2	1.06	-0.5573
Grade	7.92	.76	8.00	.91	.2335
IQ	98.31	9.02	100.38	7.58	0.6056
Rate	138.38	11.25	145.85	14.03	2.4978*
Errors	3.23	2.20	4.77	1.92	1.8969
Prior Knowledge	7.62	3.38	8.31	2.36	0.6065

*$p<.05$

designed by the experimenter and included 24 open-ended questions about topics that were assessed in the comprehension passages, for example, "What do flies eat?" An open-ended format was selected over a multiple-choice format in order to minimize the risk of guessing and of students learning from the test. The curriculum-based assessment test consisted of 24 items, one question to assess the content of each of the 24 lessons in the instructional intervention. A pilot study was conducted with 16 learning disabled students to determine the suitability of items. Students in the pilot study were given the test of prior knowledge and then asked to complete the test of comprehension. Students' responses and comments were recorded and later the experimenter questioned students about confusing or unusual responses to particular items. As a result of the pilot study, ambiguous test items were eliminated or clarified. For the actual study, the test of prior knowledge was administered by an assistant who was not familiar with the content of the curricula. Answers were recorded verbatim and scored by both the assistant and the experimenter. Percent of agreement was 95%.

Curriculum. Students who were assigned to the experimental group received instruction that drew heavily on the techniques and content of Direct Instruction programs, specifically *Comprehension B* of the *Corrective Reading Program* (Engelmann, et al., 1978) and *Reading Mastery* (Engelmann & Hanner, 1983). Reading material and worksheets were liberally adapted from *Reading Mastery* III and IV. Each lesson taught factual information or vocabulary about topics assessed in the reading passages. One lesson was constructed for each concept that was taught for a total of 24 lessons. Each student received a workbook that included expository passages about a topic and practice exercises. Each lesson consisted of three parts: (a) a structured oral presentation of the information or vocabulary, (b) application of the information as a group, and (c) a written exercise designed to provide independent practice with the newly acquired information. Review was also provided every eight lessons in a Fact Game.

Test of comprehension. Twenty-four sets of passages and questions were constructed to correspond with the topics covered in each of the 24 instructional lessons. Each set consisted of three passages about the same topic and one multiple-choice question. The amount of information in each passage was manipulated in order to make one passage textually explicit, one textually implicit, and one scriptually implicit, and one scriptually implicit. Students completed the test on a computer under the supervision of an adult assistant. The computer randomly selected passages so that all students read eight textually explicit, eight textually implicit, and eight scriptually implicit passages. Responses were stored in a data file on the computer disc.

The passages were primarily short, fictional paragraphs. The passages on the posttest did not directly ask for information that was assessed on the pretest, rather the need for that information was indirect. An example is provided below. The target information in the following example is the fact that a person must return to the water surface slowly to avoid getting the bends. The first paragraph is textually explicit, the second is textually implicit, and the third is scriptually implicit.

1. Darla and Julie were scuba diving 40 meters below the surface. Darla was just about ready to signal Julie that they should go to the surface. Suddenly Julie turned around and pointed to her air hose. Julie was not letting out any bubbles. She was out of air! Darla remembered that their scuba teacher told them. "Remember, don't go up too fast. Take at least two minutes to go up, or you may get the bends."

"I must catch her," Darla thought to herself.

2. Darla and Julie were scuba diving 40 meters below the surface. Darla was just about ready to signal Julie that they should go to the surface. Suddenly, Julie turned around and pointed to her air hose. Julie was not letting out any bubbles. She was out of air! Julie thought about what happened yesterday. Julie had stopped once on the way to the surface. It took her 2 minutes. Darla had stopped twice on the way to the surface. It took her 3 minutes. They both felt fine when they got back to the boat. But Ann went to the surface without stopping. It took her less than 1 minute Ann got the bends

"I must catch her," Darla thought to herself.

3. Darla and Julie were scuba diving 40 meters below the surface. Darla was just about ready to signal Julie that they should to to the surface. Suddenly Julie turned around and pointed to her air hose. Julie was not letting out any bubbles. She was out of air! Julie pointed up and began swimming toward the surface to herself.

"I must catch her," Darla thought to herself.

Question: Why did Darla want to catch Julie?

A. Julie would get tired out.
B. Julie would get the bends.
C. Julie would get lost.
D. Julie would get the shakes.

Results

The design of this study was 2 x 3 between-subject/

within-subject with repeated measures. A split-plot factorial analysis of variance yielded significant differences for both main effects ($P<.01$). The experimental group was able to answer comprehension questions with greater accuracy than the control group and textually explicit questions were the easiest, followed by textually implicit questions. Scriptually implicit questions were the most difficult for all students. (See Table 2). A post hoc analysis of pairwise contrasts using the Scheffe procedure revealed that the difference between textually explicit questions was also significant, however, the difference between textually and scriptually implicit questions was not significant.

Table 2. Mean Effects by Experimental Groups and Type of Passage.

	Types of Passage			
Groups	Textually Explicit	Textually Implicit	Scriptually Implicit	Average
Instructed	7.46	7.15	6.54	7.05
Uninstructed	6.69	5.62	4.62	5.64
Average	7.08	6.38	5.58	

This study isolated prior knowledge from decoding skill and intelligence and thereby demonstrated the effect of prior knowledge alone in reading comprehension. The control group members who were low in prior knowledge had poor comprehension despite fluent decoding and average intelligence. This suggests that when and if adolescent LD students master decoding skills, their reading woes are not behind them.

For students with reading disabilities, Stage 3 is a watershed. Average students enter Stage 3 of their reading development in about 4th grade (Chall, 1983) and spend the next six or more years acquiring the vocabulary and information that will enable them to demonstrate higher-level reading skills. In contrast, LD students remain in Stages 1 and 2, acquiring decoding skills, well into adolescence. Because decoding is not automatic, LD students are unable to read as extensively as their peers during the upper elementary years. Subsequently, they do not acquire the background knowledge that is essential for comprehension of high school texts. For these students, the following educational modifications may be necessary:

1. For LD students who are still struggling with decoding, information and vocabulary concepts must be supplied through non-reading channels. Simply reading a text aloud to LD high school students is not an effective strategy, since it will only benefit those who already have sufficient prior knowledge. Thus, it is important to attempt to ensure that a prior knowledge deficit is remediated as much as possible early in children's school careers, not left unchecked until a student is in high school. Furthermore, reading and content instruction need not be separate. LD students will benefit from an approach to reading instruction that integrates information and vocabulary from a wide variety of subject areas such as science, history and health. Such an integrated instructional approach is sensible, not only because it maximizes the use of precious instructional time, but because it is more interesting to students. Reading Mastery (Engelmann & Hanner, 1983), for example is a bottom-up basal reading program that is rich in science and social studies concepts.
2. School demands in terms of prior knowledge must be continually analyzed. Task analyses of curricula must be conducted to assess what assumptions about information and vocabulary have been made by the text. Based on analyses of the curricula, modifications should be made to accommodate the learner. New information and vocabulary will only become part of the student's repertoire when he or she has at least a partially developed schema for a topic. The resource teacher can be instrumental in assisting content area teachers in modifying curricula.
3. The text can be altered to facilitate reading comprehension. Textually explicit questions highlight factual information and assist in acquisition of new information. They can be used to help students identify important information. Textbooks may need to be modified to include information that can be assessed by textually explicit questions.

Textually implicit questions require the student to use information in the passage in order to make an inference. Students who are fluent decoders should receive practice with textually implicit questions. This allows students to acquire new information and also provides practice in inferential comprehension. The text can be structured to maximize a student's opportunity to use reasoning skills to acquire new information.

Scriptually implicit questions require the student to activate and apply prior knowledge in order to make an inference. Students who possess the required prior knowledge would be encouraged to read passages containing information that is assessed by a scriptually implicit questions. Teachers can assure that students benefit from practice with scriptually implicit questions by preteaching important facts and vocabulary and by helping students to activate prior knowledge prior to reading the passage.

Summary

There are many interrelated factors that affect reading comprehension and make it difficult to isolate and study any single variable. The results of this study suggest that some of these variables may be *hierarchical*. The instructional factors that should be stressed in order to improve comprehension will vary depending on a student's stage of reading development. If a student is not a fluent decoder, then decoding skills must be stressed. If a student is able to decode, but lacks prior knowledge, then exposure to background knowledge and vocabulary must be provided. If the student is a fluent decoder and appears to have adequate prior knowledge, then metacognitive strategies may be appropriate. It is particularly important to consider all stages of reading development when assessing older students because decoding and prior knowledge deficiencies, indicative of deficiencies at earlier stage, may masquerade as metacognitive deficiencies. In order to understand the reading difficulties of LD adolescents, it is necessary to view reading as a continuing process rather than a skill that is mastered when decoding skills are mastered.

The findings of this study are encouraging because they indicate that the information and vocabulary that constitute prior knowledge can be successfully taught. Good instructional design, such as that used in the study, can help LD students cross the bridge from the decoding stages of reading to the higher-level comprehension that is the essence of reading. ◆

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Teaching Literature Analysis to Low-Performers Using Story Grammar and Scaffolded Instruction

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Reading and analyzing good literature enables students to gain a richer perspective on their own life experiences and to enter new and different worlds. Even for students with lower than average performance, these possibilities should be abundant, but they are not (Oakes and Goodlad 1988). For example, the report based on findings of the National Assessment of Educational Progress, *Who Reads Best?*, concluded the "poor readers receive qualitatively different instruction," compared to what good readers receive, and that their teachers are "less likely to emphasize comprehension and critical thinking and more likely to focus on decoding strategies: (Applebee et al. 1988, pp. 5-6). According to the report's authors, these patterns of differential instruction persist in high school.

Here we describe an approach for teaching literary analysis to at-risk secondary students that has been empirically validated in three research studies. The instructional method is based on two seemingly esoteric concepts, *scaffolding* and *story grammar*. It also relies heavily on the body of research on effective teaching principles for low-achieving students (Rosenshine 1986).

Scaffolding is based on the work of the Russian psychologist Vygotsky. It is an instructional process that enables students to solve a problem or achieve a goal they could not accomplish on their own. The teacher concentrates on developing skills that are emerging in the students' repertoire, but that are as yet immature (Palinscar 1986). In scaffolded instruction, the teacher often "thinks aloud," explaining to students in a step-by-step fashion how he or she reached a specific conclusion.

Scaffolded instruction creates a shared language between students and teachers, so that teachers can provide useful, readily understood feedback to students when they need prompts to overcome difficulties (Gersten and Carnine 1986). There is a great deal of dialogue between teacher and students. As soon as possible, the students take over, and the role of the teacher shifts to that of a coach, pushing students to express their thoughts on increasingly complex issues. Gradually, the temporary structure, or "scaffold," is removed, and students perform independently.

In order for teachers to "think aloud" and break down the process of making complex inferences into small steps, come consistent framework or structure must be used. One framework that has been successfully used in reading instruction is call *story grammar*.

Story Grammar

Story grammar evolved from work of cognitive psychologists and anthropologists, who found that, regardless of age or culture, when individuals relate stories they have read or heard, their retellings follow a set pattern. Story grammar refers to this pattern. Children, even as young as age six, demonstrate rudimentary story grammar and use their knowledge of how stories are structured to help them remember important details (Mandler and Johnson 1977).

Various researchers (Stein and Trabasso 1982, Mandler and Johnson 1977, and Thorndyke 1977) have established slightly different story grammar systems, but all are remarkably similar. (In barest form, the main character runs into some kind of problem or conflict and tries to resolve it. After several attempts, he or she resolves, or fails to resolve, the problem.) Story grammar involves the articulation of the character's conflict, a description of attempts to solve the problem, and an analysis of the chain of events that lead to resolution; it also included analysis of how characters react to the events in the story and articulation of the story's theme or themes.

Research on Story Grammar

In the 1980's, reading researchers began to wonder whether explicit instruction in story grammar would improve students' comprehension. Singer and Donlan were the first researchers to design an instructional intervention based on story grammar. They worked with average-ability 11th graders using short stories from a high school literature anthology. For one week students were taught five major story grammar elements (character, goal, obstacle, outcome, and theme). While reading, they were instructed to ask themselves questions about each element. For example, for *character*, they might ask themselves, "Is this story going to be about the barber or the officer?" (Singer and Donlan 1982). They were then told to answer each of these questions while reading the story.

The researchers' intent was to structure the students' approach to reading and to focus the students on the key issues and themes in the story. Results indicated that the five-day instructional unit did, in

*To be published in *Educational Leadership* (February 1989) fact, improve students' comprehension of the stories read, at least as measured by multiple-choice test. The only area where no improvement was noted was for the most difficult component of story grammar, articulating the theme of the story.

The next researchers to study story grammar (Carnine & Kinder, 1985; Idol & Croll, 1987) worked with younger students in grades 4 through 6 and targeted low-achieving students (those in Chapter I and special education programs). Their approaches were much more structured and interactive than that taken by Singer and Donlan. Idol and Croll used a visual map of the story grammar elements, while Carnine and Kinder relied on a series of structured verbal interactions based on these questions: (1) "Who is the story about?", (2) "What is he or she trying to do?", (3) "What happens when he or she tries to do it?", and (4) "What happens in the end?" Yet the essentials of the interventions were quite similar. Both sets of researchers used instructional procedures based on effective teaching research (Rosenshine 1986). At the beginning, the teacher modeled and explained how she found the answers to each of the story grammar questions. Within a few days, the students began to answer some of the questions on their own. Day after day, students were presented with a coherent system for analyzing a story (i.e., a scaffold). Gradually, the teacher faded the amount of assistance provided.

In both studies, low-performing students showed significant growth in comprehension on a wide range of measures. These studies demonstrated that story grammar could be combined with research-based teaching techniques to develop a coherent instructional strategy for improving the comprehension of low-performing students.

Research with High School Students

The success of these studies led us to see whether we could improve the abilities of low-performing high school students to understand and analyze literature. The first of two studies conducted (Gurney 1987) was essentially an intensive case study of several learning disabled students, many of whom were reading between three and six years below grade level. The study demonstrated that story grammar intervention significantly improved the comprehension of these students. From this study, we learned that for students at such a low level, it is important to include oral reading of the stories in each lesson. We also found that the students responded quite positively to the consistency of the story grammar strategy.

The next step was a larger scale study (Dimino 1988) conducted with 32 high school freshmen and sophomores in "Basic English," a course for students who could not deal with the rigors of typical high school English. Most, but not all, the students were reading well below grade level; reading scores ranged from 5.2 to 10.1 Prior to the intervention, we gave the students two short stories to read and a series of questions to answer. They answered only about half the questions correctly.

Two teachers participated in this study. Each taught a traditional group and a story grammar group. The students were randomly assigned. Each group received literature instruction for one month. All groups used the same short stories selected from junior and senior high school literature anthologies. All the stories included a problem or conflict.

In the traditional groups, the procedures in the teacher's guide to the literature textbooks were the foundation for each lesson. The teachers introduced each story by defining pertinent vocabulary noted in the teacher's guide and discussing background information to promote interest. Students then read the story. After reading, the group discussed the questions in the teacher's guide. Independent seatwork followed.

In the story grammar groups, instruction focused on the seven story grammar elements shown in Figure 1, a sample student note sheet. During the first few lessons, the teachers explained the story grammar

Figure 1. Sample Story Grammar Notesheet

Story Grammar Notoshoot

Name________________ **Date**________________

Story ________________________________

Main Character:

Character Clues: What is the main character like?

Reactions: How does the main character **react** or **feel** about important events in the story?

Name the **Problems** or **Conflicts.** Circle the main problem.

Attempts: How do the main characters try to solve the problem?

Resolution: How does the main problem get sovled?

Theme: What is the author trying to say?

elements and then demonstrated how to apply them to a series of short stories. Essentially, the teachers "thought aloud." Using the story grammar note sheet, the teachers explained to the students the basis for the decisions made.

During the first lesson, teachers focused on the four easiest, most literal story grammar elements (statement of problem specification of main character, description of attempts, and resolution). Beginning with the second story, the teachers began to introduce more subtle and complex elements (character clues, reactions). The purpose of these early lessons was to illustrate the process of determining the story grammar elements and to demonstrate their internal relationships.

By the third lesson, students began to volunteer information. They did not want the teachers to tell them the main problem, character, or attempts. The teachers solicited responses from the group and recorded the responses on an overhead transparency version of the note sheet. Still, for the more difficult elements—theme, reaction, character clues—the students needed a good deal of guidance from the teachers.

As instruction progressed, students filled out their own note sheets as they read, and the teachers served mainly as facilitators. As students read the stories orally, the teachers stopped at designated points to ask about story grammar elements. The teachers were careful to use consistent language throughout the entire unit. When the teachers stopped the oral reading at specified points, they used the same wording to elicit information on specific story grammar elements.

Students experienced few problems with the literal story grammar elements. Most could readily state who the main character was, specify the major problem, describe the character's attempts to solve it, and tell how the story ended. Therefore, the focus of instruction shifted to the more subtle elements–character clues, reaction, and themes.

At first, the teachers used vivid examples to exemplify the difficult concepts. For example, to demonstrate what a character clue is, the teacher said: "If I walked into the room, threw my books on the desk and said, 'I want you to sit down and keep your mouths shut,' how would you think I felt?" The class then discussed the character clues in that day's story and made inferences about the character's reactions to events in the story.

Determining themes was by far the most difficult aspect of this instruction. The teachers modeled how to generate a theme by reviewing all the story grammar elements on the note sheet and then trying to state the author's intent. Then they indicated that there could be more than one theme for a story, but that any theme provided must be justified by the story grammar elements.

The themes initially generated by the students were either overly concrete or cliches. For example, students read a story about how a father, who was a frustrated athlete, forced his son to become a runner. The story documented the son's resentment. A typical theme offered by students was that "parents shouldn't make their kids run if they don't want to." Students had great difficulty organizing events and reactions and coming up with a statement that captured the underlying meaning of the work. When students did try to be more abstract, they often came up with cliches and morals such as "never tell a lie," and "crime does not pay."

The teachers used three techniques to assist the students in formulating a theme. First, before asking students to determine the theme, the teachers reviewed themes form previous stories to illustrate how the events in the story can be used to develop a *general* statement about what the author was trying to say. Second, the teachers provided a few examples of overly concrete themes, and the group discussed why they would not be appropriate. Third, the teachers provided a series of prompts that helped guide students to a more conceptual level.

As the intervention continued, the students seemed to begin to realize that the study of literature could be exciting. The stories became more than just a series of events to be memorized to pass a test or complete a written assignment. They began to read with an investigative, analytic stance.

An example that illustrates this emerging stance, and the quality of peer interactions, occurred during the discussion of themes for de Maupassant's *The Necklace.* One boy said, "The author was trying to tell us that we should not show off or try to lead people to believe we are rich." His theme hit on a major motif in the story. However, almost immediately, another student said she had a better theme: "The author was telling us that it's better to tell the truth." The student justified her response with the following rationale: "If Mathilda had told the truth to the woman who lent her the diamond necklace, she would not have ruined her life paying for the replacement. More discussion ensued regarding the relative merits of the two themes.

Dimino found that the story grammar students performed significantly better than students in the traditional group on a range of measure. These included answering questions taken from basal texts, answering questions derived from the story grammar elements, and generating written three–to four–sentence summaries of the essential elements of stories read. The effects were maintained over time. Strongest effects were found in the articulation of themes and in the quality of the summaries written.

"The Whole Story"

The research has consistently demonstrated that story grammar instruction can have a positive impact on students' comprehension of literature, particularly for low-performing students. It also serves as a point of departure for spontaneous discussion of more subtle issues. Some caveats are in order, though. First, story grammar applies to many stories, but not all. It is appropriate only for stories with a clear conflict or problem. In each study, finding an appropriate array of stories was a time–consuming task. Individuals interested in using this approach may want to work in teams to select stories.

Second, not all teachers easily adapt to this approach. Some teachers are initially reluctant to "think out loud"; others have problems breaking everything into small steps. We have found that the use of fairly detailed teacher's guides for the first series of lessons helps teachers become comfortable with this teaching style.

These caveats aside, an important advantage of this type of instruction for low-performing students is that comprehension–not accurate oral reading–is always the major goal of instruction. At times in the studies, the teacher read the stories aloud to the students. At other times, students took turns reading, but the teacher never stressed word-attack skills. For many of these students, this experience was a rarity. So often their instruction is limited to specific skills or literal comprehension. Our examination of the accompanying questions from the basal reading anthologies found that almost all were literal and that many focused on small details. If nothing else, story grammar can be used as a system for developing and selecting questions to accompany stories in readers and anthologies.

In addition, story grammar–whether presented as a visual map, a note sheet, or a series of simple questions repeated day-after-day–provides students with a system for analyzing stories that prompts them to work at a deeper conceptual level. As one student poignantly described the experience, "I learned a lot in this class–I didn't used to read the whole story, but now I do." Instruction that doesn't motivate low-performing students to read the "whole story" is doing them a great disservice. ◆

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A Review of Math Tutor

by Ian Spence

From Scholastic Software, 730 Broadway, New York, NY, 10003. Modules available for Addition, Subtraction, Multiplication, Division, Simple Fractions, Complex Fractions, Decimals and Percents, Ratios, Word Problems (Addition & Subtraction), and Word Problems (Multiplication and Division). Cost is $86.95 per module. Each module contains the Teaching Disks and the student Management System and a backup copy of each disk.

Editor's note: Ian Spence's background is in Precision Teaching, Direct Instruction, and computers. He was one of the first to develop computer generated worksheets of Precision Teaching, adapting them for use in arithmetic, morphographic spelling, and decoding. Dr. Spence and his wife, Dr. Aileen Stan-Spence started a learning center (The Learning Incentive) in 1982, in which they used Direct Instruction, Precision Teaching, and computer instruction as their main learning tools. In 1983 Dr. Spence was invited to join Coleco for a year to help build a team to improve the quality of their *Adam* software line. Since then The Learning Incentive has grown to include a day school for learning disabled students (Ben Bronz Academy), and an evening school for learning disabled adults. Dr. Spence has designed and produced two software products: a vocabulary builder, and M-10—a language arts program which develops students' skills in picking out facts, developing a main idea, and looking for errors in grammar.

Math Tutor is a state of the art demonstration of the effect of computers in Direct Instruction. If the *Corrective Math* Series is your cake, *Math Tutor* is the frosting!

Corrective Mathematics comes alive in this computer rendition. This is not surprising, considering it was designed, executed, and field tested by Mike Maloney and his crew at Quinte Learning Center in Ontario, Canada. Quinte Learning Center has successfully utilized Direct Instruction and the Corrective Reading Series for over ten years, and has built a computer component for over six years.

Math Tutor is a beautifully packaged software series which runs on the Apple II family, or on the IBM family of computers. It is a faithful recreation of the presentations from Corrective Math, with the computer adjusting its next step based on the student's answer to questions on the screen. The program begins with a placement test (optional), after which the computer will announce the lesson the student should begin at. The student or teacher can choose to begin at any of the 30 or 40 levels offered. An optional printout is available for the teacher who needs to keep track of a student's progress.

The presentation is skillfully rooted in the Direct Instruction Model. The first presentation screens are unambiguous. A student's response is analyzed, and the next question or statement clarifies the error and allows the student to practice once more. Presentations are made at the student's pace. Student's may take as much time as *they* wish to enter an answer.

The graphics enhance the instruction. A charming little comic strip character (affectionately named Ziggy!) moves around the screen pointing to significant facts. These explanations appear in large, clear letters in a cartoon bubble, and sometimes Ziggy uses a pointer to highlight the answer or arrow. An enlarged cursor guides the student through each step of an involved computation. There is no detour into fancy, intrusive, and time-consuming praise. Ziggy's "talk bubble" only occasionally says "Good Job" or "You're Right", but mostly continues onto the next screen.

At Ben Bronz Academy, Math Tutor is used both to augment Direct Instruction, and as a stand alone product. Within the Direct Instruction class, it is dynamite. We review concepts in class, and the students practice in their workbooks. They then have an appointment on the computer, and can start the program unassisted, go to the correct lesson, and review the sequence on the computer. After a half-hour of instruction and reminders, they are generally able to handle all the computer functions themselves and the instruction is so clear that they rarely get stuck on a screen.

Readability is at a 3rd or 4th grade level. We have found that some students who's reading is below this have required help with specific words, but have generally managed to read most of the rest of the script. We have been successful in pairing readers and nonreaders in teams to work together on the computer. For our learning disabled students, *Math Tutor* is an invaluable restatement of each problem and its progression, extra practice, and the motivation which comes from working at your own pace. An excellent set of worksheets accompanies *Math Tutor*, conveniently packaged in a three ring binder.

Math Tutor has an optional management system. If it is used, the computer keeps track of student's placement level, and automatically places him in the appropriate lesson. The teacher can review student progress, or get a printout of results. However the one weakness of the program is that if the student is *placed by the teacher for* practice, a printout is not available, so the teacher must check often on the student to see if he is making progress.

In its simple elegance and faithful execution of Direct Instruction design principles, *Math Tutor* moves the field of computer assisted instruction to its next level which should probably be called computer-interactive instruction. The computer no longer assists, but teaches. We can and sometimes do place a student on

Math Tutor—*Continued*

the computer first to learn new concepts, after which the teacher reviews them in the classroom. With *Math Tutor*, a self motivated, confident student can learn through the computers and the extra practice sheets, and skip Direct Instruction in the classroom.

Math Tutor's stand-alone capability is good news for parents, for whom Scholastic has promised a less expensive home version to be released around December, 1988. Home versions will probably be marketed through retail outlets such as Toys-R-Us,etc. for $21.95 per program.

In our view, this is one of the decades finest pieces of educational software. ◆

More on Software—

Who are these Morning Star People?

by Bob Dixon

Did you see a "Morning Star" booth at one of the ADI conferences last summer, or receive a Morning Star brochure in the mail lately, or see a Morning Star advertisement in an earlier issue of the *ADI News*? If so, you may be wondering, "What's the story on Morning Star?"

I would like to give at least a partial answer to that question here, not so much to satisfy anyone's curiosity, but because I'm quite confident in the potential benefit of Morning Star products to Direct Instruction practitioners.

I first became aware of Morning Star by accident. An SRA representative in Wisconsin took me to visit a special education classroom in the small town of Poynette. It was supposed to be a "PR" visit, in that we couldn't sell anything there because they were already using everything we had to sell. The first thing I noticed was that not only were these folks using a lot of Direct Instruction programs, but they were using them exceptionally well.

At some point, the fellow whose classroom I was visiting, Fred Hofmann, asked me if I wanted to see a computer program on math facts that he and a couple of colleagues had developed in someone's basement. I was a little curious: What would a software program look like that was primarily developed to supplement an on-going, already successful Direct Instruction math program? Would it have some features distin-

Morning Star—*Continued*

guishing it from the plethora of (dippy) existing drill and practice math facts programs?

I didn't really have the time on that visit to examine the program in much detail, but I noticed a couple of features right off the bat. First, the program didn't dive straight into a drill format, but instead, began with a well-designed initial *instructional* sequence that Fred credited to *Direct Instruction Mathematics* (Silbert, Carnine, & Stein, 1981). Next, I made an error on a problem, and noticed what *didn't* happen: I wasn't told, "No, try again," and I wasn't just pushed along to the next problem after a couple more wrong "guesses." Instead, I was given effective instructional feedback; essentially, I was temporarily "rerouted" to the initial instruction, then was required to respond correctly before moving on.

That was about all I had time to see, although Fred told me the program had a management system (a generally good sign) and had, too, some mechanism for placing students at an appropriate level.

Shortly after I returned home, Fred made good on a promise to send me a complimentary set of the Morning Star math facts program (comprised of four diskettes, one each for addition, subtraction, multiplication, and division). I wrote down "review Morning Star stuff" on my list of things to do sometime, but not today, and then more or less forgot about the program until it gave me the opportunity to be a bit of a hero with my wife, Susan. She had a kid named Jeff in her first grade classroom who was heads *above* all the other kids in math, and for various reasons we are all too familiar with, the resources for getting Jeff placed in a math group where he really belonged just weren't there. I took the Morning Star program over to the school, typed Susan's class list into the management system, then got Jeff started with the program. I actually guessed (conservatively) at an initial placement point, but Jeff quickly learned that he could "challenge" levels of the program, and soon, he was working at a level appropriate to his needs.

Susan, whose single classroom computer had heretofore sat idle, was not only impressed that Jeff was working on and learning material that was challenging to him, but that he was able to do so with no intervention by her whatsoever. My observation was that the program had to be quite versatile, because although it was working nicely to help solve a problem with a *high* performer, it had originally been designed—I thought—by special educators for *really not high performers*. That's an old question for Direct Instruction—"Who's it for?"—and I'll never quite understand why the answer seems to allude a fair number of folks. It's for whoever doesn't know what it teaches.

With that thought in mind, Susan decided to try the program with some of her lowest students, those who were making the majority of errors in her lowest *DISTAR* group. They, too, were able to work independently, and to receive valuable reinforcement of the instruction they were receiving in their group, thus making subsequent group instruction smoother. I took these practical classroom results as pretty strong evidence that Fred must have been conscientious in implementing principles from *Direct Instruction Math*, although I had not yet sat down and reviewed the program in any real detail.

Some time later, I received in the mail a brochure from Morning Star on their new spelling programs, comprised of a disk on spelling rules (call "The Rules") and one designed to practice whole words (called "The Partner"). I generalized: Fred had been doing a great job of teaching *Spelling Mastery* and *Corrective Spelling through Morphographs*, and the math facts program was good, so the spelling programs were likely to *at least* be a cut above the many inane sorts of programs I had seen being passed off as "spelling." Several other people I knew had also received the brochure on the Morning Star spelling programs, and some of them wondered whether I might view their release as some sort of invasion of Zig's and my "turf."

In fact, I had a very different reaction. Two of the greatest difficulties of implementing the round pegs of mastery-based instruction (like Direct Instruction) into the square holes of traditional graded classes are accommodating students who enter programs late and students who miss instruction because of absenteeism. I rarely fail to use questions about those implementation issues as an opportunity to point out that *those difficulties simply do not arise in conjunction with ineffective instruction.* I'd be most worried if a kid missed a couple weeks of school and returned to an instructional program without missing a beat. Real worried.

Still, most teachers have to live with these implementation problems in settings that do not allow for them to be solved optimally. I welcomed the release of the Morning Star spelling programs as a possible means of addressing these problems when they arise with *Spelling Mastery*, at a modest cost, both financially and in terms of teacher time. *That* possibility got me to move "review Morning Star" to my list of more immediate tasks.

Originally, I had intended to write a more or less formal review of Morning Star software for the *ADI News*, but more people were asking me about the company than about the software. Generally, when Susan or I have recommended to teachers that they try Morning Star, they have just tried it. There's not much to lose with Morning Star's generous 30 day trial period for the products (the complete products, not demonstration disks). However, I'd like to briefly outline some of the specifics—in addition to classroom tryouts—that account for my support of Morning Star.

In order for us to have an expectation that software will have some sort of *instructional* impact upon students, we would have to see evidence that fundamental instructional design principals prevail over other considerations in the development of the software. We've all seen, I'm sure, examples wherein *Technological* considerations are the predominant–and often only–features of software: high resolution graphics, animations, mucho colors, pretty music, the use of a mouse, etc. The Morning Star programs incorporate the following instructional features:

1. *Good initial instructional sequences*, characterized by a good sequence of examples, a generous set of examples, and where applicable (as in the case of spelling rules), negative examples. For instance, the first sequence in the addition math facts program teaches the fact 2 + 1, 3 + 1, 4 + 1, and 5 + 1, in that order. Each problem is modeled twice (with students engaged, even during the modeling), then the student works each problem twice, in a highly prompted setting.

2. *"Natural" tasks.* In the math programs, students type numerical responses; in the spelling programs, students type words. The programs only occasionally utilize multiple choice tasks, when appropriate. For example the spelling rules lessons ask questions such as, "Does *shop* end cvc?" in the course of a sequence that Engelmann and Carnine refer to as a cognitive routine.

3. *Effective, instructional corrections.* The objective of a correction is to reduce the likelihood of the same type of error occurring in the future. When an error is made on a spelling rule, for instance, the steps in applying the rule are completely reviewed and the student is required to spell the original word correctly before moving on.

4. *Progress through the programs is dependent upon mastery.* The phrase "students progress at their own pace" is ambiguous in computer-based instruction. It often means that decision making is left to the student. In the Morning Star programs, the authors have "premade." critical decisions about what students do next, based upon objective performance criteria. High students, as I suggested above, can reach appropriate performance levels quickly while low students are given all the time and practice they need to master each phase of the programs.

5. The primary advantage of the Morning Star management systems is that *they keep track of student progress.* Teachers *can* intervene in assignments after making initial assignments, but they don't have to, and under most circumstances, wouldn't need to.

In addition to these features, the Morning Star programs all require a high level of student interaction at all phases of instruction, tasks progress from easier (and more prompted) to harder (and unprompted), and student interest is maintained more through success and a variety of meaningful tasks than through gimmicky sorts of technological wizardry (which, I believe, students become "saturated" on quite quickly.)

My enthusiasm for Morning Star is not diminished by the desire I have to see them make some improvements in their products. For example, if a student misspells *judging* as "juging," the correction treats the error as if the final e rule had not been applied correctly. This does not effect the effectiveness of the instruction, but it does reduce the *efficiency* somewhat. I'd like to see somewhat more sophisticated response evaluation in situations like this.

My most extensive criticism of the Morning Star programs is not with the instruction at all–and of course, the instruction is central–but with the management system. I've already passed some of these thoughts along to Morning Star, and to their credit, they are unusually receptive to suggestions and criticism. Also, I understand they are in the process of addressing some of these management system issues even as I write.

Getting the programs set up initially is not difficult, but could be improved. On the positive side, the programs give teachers a great deal of flexibility. But as with any type of computer software, the price of flexibility can be diminished ease of use. I would like to see some changes in the Morning Star management systems that might save some teacher time, and student time as well.

When I "set up" the addition math facts program, the steps were to:

1. Type a student's name.
2. Assign that student to a section (1, 2, or 3).
3. Select a starting level for that student (there are twenty-six levels in each of the four facts programs).
4. Select a maximum time for accepting a student response (fast, normal, or slow).
5. Choose to enable or disable a pictorial graphics option.

Making those selections does not take much time (except that selecting a starting level for a given student ought to be done thoughtfully, using information provided in the teacher's guide). However, those same five steps *must* be repeated for every student I want to add to the system, and then I must repeat the whole process over again for the other programs: subtraction, multiplication, and division. Most teachers aren't going to need to add all students at once, or to all programs at once, but the time it takes is the time it takes, whether done in one sitting or many.

Just to avoid being branded a cheap critic, I am offering an alternative:

1. Select the section first, so that each student added after that automatically belongs to that section.
2. Add a student name, then another, then another, until all names are added. *Then you're done,* if you want to be. Maximum response time could be offered as a "default" setting (presumably normal), as well as the option to enable or disable the graphics option.

So far, that plan seems to neglect selecting a placement level, which of course, would vary from student to student. The easiest change in the Morning Star system that would address this problem is to select a level after selecting a section, but before adding a student. In that way, all level "B" students could at least be added at one time, all level F students, and so on. The most effective and efficient way to handle placement, however, is to make a placement test a part of the computer program, especially an "adaptive" test that could quickly determine the optimal starting point for each student, automatically. Such on-line placement tests would save even more time in the spelling programs, which require more initial settings when adding students to a program.

As long as I'm just writing a wish list, I would also like to see "system utilities" that allow a teacher to create a class list for one program, such as addition, then copy that same list to any of the other Morning Star programs. That option becomes a possibility when student records have default settings and when placement is part of the programs. (In the case of "The Partner" spelling program, a similar utility, allowing a teacher to copy spelling lists to another Partner disk, would also be a big time saver whenever more than one teacher within a building is using the program.)

The options currently available to teachers in the Morning Star management systems are good ones. My thoughts above would not deprive teachers of making those choices; teachers could still override the default settings and placement (including placement criteria).

Again, I want to clearly emphasize that these relatively minor criticisms do not deter me for a moment from highly recommending Morning Star programs, not only as supplements to Direct Instruction programs, but for use with other programs as well. Many readers, no doubt, use some Direct Instruction programs, but not all. Say, for instance, that you use *Reading Mastery* and *Corrective Reading*, but not *Spelling Mastery* and *DISTAR Arithmetic* (shame on you). You should still take a look at the Morning Star programs. At the risk of further exposing my own prejudices and fanaticism, I'm not the least bit reluctant to suggest that the Morning Star spelling programs, used exclusively as a spelling program are likely to be more effective than a basal organized around weekly word lists and predominated by activities that are independent, or don't relate much to spelling, or both.

Within the two years or so that I have known Fred Hofmann, Morning Star has moved out of the basement and into a well-staffed office in Madison, Wisconsin. The principals in the company, Fred, along with Barry Golden, have so far remained at their posts in the schools, Fred as a teacher and Barry as a curriculum and special education director. Their product development continues, slowly and conscientiously. (I understand they will be releasing a main idea program in January, 1989, based upon *Direct Instruction Reading*, Carnine and Silbert, 1979).

For more information (like prices) on Morning Star products, call 1-800-533-0445 (or in Wisconsin, 608-233-5056) and talk to the nice person that answers, or just send some money to Morning Star Software, Inc., P.O. Box 5364, Madison, WI 53705. ◆

CAI for Math Story Problems—*The Role of Good Instructional Design*

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In recent years, the number of microcomputers being used in special education classrooms has increased dramatically (Hanley, 1984; Mokros & Russell, 1986). As the number has increased, teachers and researchers have asked numerous questions regarding their use. Most research has documented how computers have been implemented in the schools, with less attention paid to the effects of CAI on learning, particularly for mildly handicapped students (Hanley). Although relatively little research has been conducted to answer this question, the use of microcomputers for instruction appears promising (Ellis & Sabornie, 1986). Several studies have concluded that CAI, when used as a supplement to teacher-directed instruction, is more effective in increasing student performance than when CAI is used alone (e. g. Burns & Bozeman, 1981; Chiang, 1978; Forman, 1982; Kulik, Bangert, & Williams, 1983; Lieber & Semmel, 1985).

Since 1982, the authors and their colleagues have investigated a broader range of issues surrounding technology and special education—differential effectiveness for various academic tasks, for different stages of instruction, and for varying levels of involvement on the part of the teacher (Carnine, 1984; Woodward et al.,, 1986). Four recent studies, three of which achieved significant results, demonstrated that CAI could be effective as an instructional medium regardless of the type of CAI (drill and practice, tutorial, simulation), type of academic task (vocabulary, reasoning skills, problem-solving), or degree of involvement of the teacher (from very little to providing instruction before students practiced with the simulation) (Woodward, et al).

In the study which did not achieve significant results (Gleason, 1985), the effectiveness of a CAI tutorial program for teaching math story problems was examined. Although a large number of studies have been conducted in math problem solving, few have yielded information for building effective interventions in this area. The field is in need of a strategy that will work with low achieving students, particularly those with learning disabilities. The specific purpose of the study was to determine whether mildly handicapped students could learn to solve multiplication and division story problems if taught a strategy for choosing the correct operation. A second interest was that of finding out whether a CAI tutorial by itself could effectively teach this complex skill.

In the Gleason study (1985), twenty-six middle school students from special education resource rooms who could not solve multiplication and division story problems were randomly assigned to two treatment conditions, either a direct instruction CAI program or a highly regarded commercial CAI program that used a guided discovery approach. Results indicated no significant difference between performance of the two groups and no significant difference between pretest and posttest for either of the groups. As a consequence of these findings, we set out to revise the direct instruction strategy. We believe that the results were not due to the failure of the computer as a medium, but to our failure to analyze sufficiently skills required. Collins and Carnine (1988) have documented how a theory-based revision process can significantly improve the quality of a CAI program. Thus, we set out to try again with a better analysis.

The newly designed strategy was tested in Boriero's 1987 dissertation which is summerized below. Two modes of presentation were compared—teacher-assisted instruction and computer-assisted instruction. We were interested in examining whether a CAI tutorial could teach word-problem-analysis skills to mildly handicapped students and how that instruction would compare to the instruction that an expert teacher could provide. Gleason's 1985 study had indicated that the *novelty* of learning from a computer was not sufficient to bring about significant student learning.

Method

A pretest-posttest design with random assignment of subjects to treatment groups was used to compare computer-assisted instruction with teacher-directed instruction to teach multiplication and division math story problems to middle school mildly handicapped students. The same curriculum was used for both conditions. The only difference between the two instructional approaches was the medium used to communicate instruction to the students.

Subjects

Several criterion-referenced screening tests on math story problems and computation skills were given to 47 mildly handicapped middle school students (6th, 7th, and 8th graders) from five special education resource classrooms in five schools in a middle-sized school district in the Northwest. Of the 47, only 19 students were eligible for the study. All had received some previous instruction in solving math story problems, but were performing at approximately a fourth grade level. Their overall math ability was below average as indicated by a median percentile rank score of 12 on the the Metropolitan Achievement Test for Total Math Ability (Durost, Bixler, Wrightstone, Prescott, & Balow, 1971). Subjects were Caucasian from middle to low income families.

The 19 students were randomly assigned to two experimental groups. No significant differences were found between the groups on story problem screening test scores or sex distribution. Mean scores on the screening test were 5.1 and 4.9 ($t\,(19) = .23; p = .41$) One group consisted of 7 boys and 3 girls; the other group was 4 boys and 5 girls.

Curriculum Design

Two sets of materials were used in this study: (1) Computer Assisted Story Problems (CASP) (Gleason, Carnine, & Moore, 1986), and (2) Teacher Directed Story Problems (TDSP) (Gleason, Carnine, Moore, & Boriero, 1986). Both curricula taught multiplication and division story problems. The instructional method and design used in the CASP and TDSP programs was based on the model articulated in *Theory of Instruction* (Engelmann & Carnine, 1982). The method requires direct teaching of a clearly-specified, explicit strategy. When instructing the students, the teacher demonstrates each step in the strategy, then prompts students to perform the steps in the strategy. As students acquire the new skill, the teacher assesses student progress and prompts are gradually faded until students achieve independence. During the various stages of instruction, great attention is given to the selection and sequencing of examples; students receive numerous opportunities to respond; and immediate corrections are provided if students make errors. Corrections are based on previously-taught rules or on steps in the strategy. In the CASP version of the program, the computer provided the same demonstrations, prompts, opportunities to respond, carefully-selected examples, and corrections for student errors.

In designing the two programs, every effort was made to control for instructional method so that the only difference in treatment conditions would be the medium of instruction. Every lesson in the TDSP program was scripted to insure that the teacher would be using the same words and examples as the computer program. The wording for corrections was also included in both versions.

The computer program was able to replicate teacher functions in that it presented lessons, provided corrections, provided extra practice, and provided feedback. The teacher, however, could perform several functions the computer could not. The teacher could modify lessons to meet the students' needs by asking questions and determining whether students should have more or less structure than provided in a specific lesson. Students in the TSP group were also able to ask the teacher questions and have them answered. The teacher presented instruction by reading to the students; the students in the CAI group had to read the information themselves. In addition, the teacher used eye contact, voice intonation, and facial expressions. However, the purpose of this study was not to see if a computer could replicate the functions of a teacher, but rather *to determine whether a CAI program designed to use the same instructional method as the teacher could successfully teach students multiplication and division story problems.*

Procedures

Students in both groups were instructed in groups of 2 to 5 students for 30 minutes daily for 18 days or until the program was completed. Students completed one or more lessons per day. Each of the program lessons began by providing instruction on a new skill.

Computer-Assisted Instruction. Students in this group were seated at desks in a classroom and provided with their own computer keyboard and monitor. Specific training on how to use the computer was given by trained monitors during the first two lessons so that students would successfully respond to the information presented via computer. Training included: (a) carefully reading information presented on the screen, (b) following instructions given for particular items, (c) responding to items presented on the screen by punching the appropriate key or writing on worksheets, and (d) reading and responding to corrections presented for incorrect answers on the screen and worksheets.

A typical CAI instructional session proceeded in the following manner: The monitor distributed worksheets and booted up disks for the students. For each new skill, a set of directions, a demonstration, then prompts and questions were presented on the screen. The story problems appeared either on screen or on their worksheets. Students responded to the questions on the screen either by punching the correct key on the keyboard or by writing the correct response on their worksheets. The correct answer for a particular item was always presented on screen so students could check for correct responses. Students also typed their answers into the computer and the computer provided corrections when necessary. During the instructional session, the monitor walked around the group and occasionally reinforced students with points and/or verbal praise for staying on task. The monitor did not help students with instruction or corrections.

Teacher-Directed Instruction. One of the authors served as the teacher for this group. Her role for the TDSP group was to instruct students on the strategy for solving multiplication and division story problems, using the scripted lessons described earlier. As was the case for the CASP group, the teacher used a point system and verbal praise for the TDSP group. A typical TDSP lesson proceeded as follows: Worksheets corresponding to that day's lesson were given to the group. The teacher used scripts and overhead transparencies. Each lesson included the same demonstrations, examples, corrections, etc, that were used in the CASP lessons. Students gave responses to questions either orally or on worksheets. If students made incorrect responses, the teacher corrected by immediately telling the correct answer and repeating the question or problem. Students were shown the correct answers on the teacher's overhead and instructed to cross out their incorrect answer and write the correct answer in the space provided.

Measures

Three tests were designed: a pretest, a posttest, and a transfer test. Time on task was also measured. The pretest was a 15-item criterion-referenced test designed to measure student performance on multiplication and division story problems, basic multiplication and division computation, and addition and subtraction story problems. The test included four addition, five subtraction, four multiplication, and two division story problems.

The posttest consisted of two parts. The first part was a 10-item criterion-referenced test very similar to the pretest. It contained two addition, two subtraction, four multiplication, and two division story problems. The second part included six multiplication and division story problems. Students were instructed to draw pictures representing each story problem, then find the answers.

The transfer test also consisted of two parts. The first part contained eight story problems from the Metropolitan Achievement Test. These problems were different from the criterion-referenced problems in the following ways: (1) the semantic and/or syntactic structure of the word problems differed greatly from those used in the instructional programs; (2) the problems contained irrelevant information or distractors; (3) the problems required students to perform more than one operation (i.e., multiplication and then subtraction).

The second part of the transfer test consisted of five dialogues representing multiplication and division story problem situations recorded on a tape recorder and presented to the students orally. In this example, Diane called out to Mark. "Hi Mark. I have six bags. Let's fill them with candy." Mark replied, "OK, Diane, I'll put two pieces of candy into each bag." Diane then asked, "So, how many pieces of candy do we have altogether?" Students were instructed to listen care-

Table 1. Means, Standard Deviations, and Mean Percent Correct on Tests for Solving Story Problems.

		Pretest			Posttest			Picture Posttest			TransferTest			Oral Transfer Test		
Group	N	M	SD	Mean Percent Correct	M	SD	Mean Percent Correct	M	SD	Mean Percent Correct	M	SD	Mean Percent Correct	M	SD	Mean Percent Correct
TDSP	10	5.1	1.60	51%	9.3	1.10	93%	5.4	0.69	90%	4.4	2.60	55%	4.8	0.40	96%
CASP	9	4.9	2.40	49%	9.1	0.93	91%	5.6	0.73	93%	3.8	2.50	48%	5.0	0.00	100%

fully to each problem, draw a picture representing what they had heard, then solve the problem.

Representative samples of the time students spent actively engaged in working were collected for both CASP and TDSP groups. These data were collected by trained observers on eight randomly selected days across the duration of the study. Interobserver reliability was 89%.

Results

Table 1 presents the descriptive statistics for the pretest, both parts of the posttest, and both parts of the transfer test. The mean percent accuracy on the written posttest, 93% for the TDSP group and 91% for the CASP group, was not significantly different for the two groups. A 2 X 2 ANOVA performed on pretest/posttest scores on written problems showed a significant effect for time, $p < .0001$. The 2 X 2 ANOVA yielded no other significant effects. A moderate correlation ($r = .44$) was found between pretest and posttest scores. The mean percent accuracy for the picture posttest items was 90% for the TDI group and 93% for the CAI group, again a nonsignificant difference.

Percents were computed for written pretest and posttest items to compare changes in identifying the correct operation for addition and subtraction versus multiplication and division word problems. On an average, 87% of the subjects selected the correct operation for pretest addition and subtraction items. The percentage correct on posttest addition and subtraction operations was 100%. In comparison, subjects selected on average the correct multiplication and division operations on 47% of the pretest items. However, the percentage correct operation selection increased to 86% on the posttest items.

Percents were also computed for written pretest and posttest items to compare changes in producing the correct numerical answer to addition and subtraction versus multiplication and division problems. On the pretest, subjects had an average of 82% correct numerical responses to addition and subtraction problems. For the posttest, the percent correct, 88%, was just slightly higher. For multiplication and division pretest items, subjects scored an average of 38% correct. The posttest percent correct was a little higher, 56%.

The mean percent accuracy on the first part of the transfer test was 55% for the TDSP group and 48% for the CAI group, yielding no significant difference. For the oral transfer items, the results again yielded no significant difference. The TDSP group had a mean percent accuracy of 96%, while the CASP group's accuracy was 100%. Data collected for the percentage of student time on-task for teacher and computer groups was 92.4% and 95.7%, respectively.

Discussion

Generally, software powerful enough to act nearly like a human tutor has not been available (Carlson & Silverman, 1986; Carnine, 1984). In fact, Carlson and Silverman, among others, warned that to ensure effective instruction, the initial instruction of new skills or knowledge should be delivered by the teacher, especially for a complex skill or one that is important to later learning (e.g., solving story problems). After conducting the first study (Gleason, 1985), we thought so, too. Gleason surmised that perhaps, for a skill such as solving story problems, students needed to receive teacher-directed models before using the computer for additional practice opportunities. A software program typically cannot provide what a teacher usually handles (Carlson & Silverman).

The software program that was used in the first study was revised and field-tested extensively. Every aspect of the instructional design was attended to and reworked, then used to establish the two programs used in the second study (CASP and TDSP). Using those two programs, as well as extending the instructional time from 11 to 18 days, led to superior performance by the two groups in the second study (91% and 93%) compared to the two groups in the first study (53% and 41% on posttest). In addition, the students in the second study made significant gains in learning from the pretest to the posttest.

Results from the two studies indicate that when CAI is properly designed, the computer can be an effective instructional medium for mildly handicapped students. In addition, when the instruction is properly designed, it is irrelevant whether the medium of instruction was a teacher or a computer. Clark (1985) and Salomon and Gardner (1986) have indicated no surprise with such results. Both have stated that when all else is held constant except the medium of instruction, not much effect will be observed. Clark explains that "... there simply are no unique contributions to learning that can unambiguously be traced back to the construct 'computer'" (p. 140). Differences will be found only when unique and necessary attributes of the teacher's or the computer's method interact with student learning (Clark; Salomon & Gardner). Apparently, in the second study, any unique and necessary attributes of either the teacher or the computer tutorial were washed out in favor of the attributes common to both.

Findings from the written posttest demonstrated that students learned the strategy for finding the correct operation, but not whether they conceptualized the processes that underlie math word problems. The picture posttest was given to determine if students had a conceptual understanding. The results were very encouraging. Basically, the scores on those tests showed that students in both groups understood the concepts underlying story problems. In both groups, students accurately represented word problems by drawing them, then solving for the answers (CASP group, 93%; TDSP group, 90%).

In addition to determining whether students could successfully use the strategy and demonstrate conceptual understanding of word problems, the study investigated the transfer of these skills to problems of different types. The transfer test, as previously described, consisted of two parts, a simulation and a written test on items from a standardized test. In general, the findings from the two-part transfer test showed that students were very successful in transfering skills to simulation problems (CASP group, 100%; TDSP group, 96%), *but not successful in transfering skills to the standardized test items* (CASP group, 48%; TDSP group, 55%).

Before instruction, the students were unable to work problems representative of a fourth-fifth grade standardized test; e.g., "A monkey ate two bunches of bananas. There were five bananas in each bunch. How many bananas did it eat?" After instruction, students were able to determine the correct operation from problems of this type. The transfer items were not taken from a fourth-fifth grade standardized test, but rather from seventh-eighth grade tests. These standardized test items were much more difficult in terms of vocabulary, length, key words, and structure than the written transfer problems. Several studies have reported that linguistic variables such as vocabulary and syntax account for differences in problem difficulty and in varied learner outcomes (e.g., Jerman & Mirman, 1974; Linville, 1976; Wheeler & McNutt, 1983).

Occasionally, the standardized test questions required students to carry out more than one operation. For example: "Five jet airplanes landed at the airport yesterday. Each carried 51 passengers. A total of 106 people got off. How many passengers continued on to other airports?" Transfer to these more difficult problems would actually have been surprising. Transfer needs to be taught and included as one of the instructional stages (Horner, Bellamy, & Colvin, 1985; Rincover & Koegel, 1975; Wahler & Fox, 1981).

In contrast to the poor transfer to more difficult items was the transfer to a simulated setting. Those problems were of the same difficulty level as those used in training. Consequently, the students were able to apply what they had learned in the context of more "real life" events. This finding is encouraging because of the well founded concern about transfer outside the school. The current finding is only suggestive, however, because the transfer did not actually take place outside of schools, but was merely simulated.

A final result was the measurement of on-task data. Both groups appeared to be sufficiently engaged (92.4% and 95.7%) and achieving at a high enough success level that on-task behavior would partially account for the high achievement level of the students in both groups (Fisher, et al, 1980). MacArthur, Haynes, and Malouf (1986) cautioned that academically engaged time might be a variable that influences whether CAI results in greater achievement than teacher-assisted instruction. In the present study, engagement was very high in both settings.

The results of these studies support earlier conclusions (Woodward, Carnine, & Collins, 1988): Teachers and students benefit from a careful analysis of instructional content and use of sound instructional design principles to establish programs that successfully teach mildly handicapped students. Specifically, the present study shows that when an instructional program is carefully designed, students with learning disabilities can learn to solve math story problems via computer as well as from a teacher. An obvious advantage of using a computerized tutorial is that the teacher's time will be freed to analyze data, make decisions about what will be taught next, even teach other students. There is little danger that the teacher will be replaced by computer-assisted instruction, but there is much work to be done in exploring the relationship of teachers and computers. Hopefully, we will do this by leaving behind the worn question — "Is the computer more effective than the teacher?". Taking Torgeson's (1986) advice, that regardless of whether CAI or TDI is being examined, good instructional design must receive attention in order to achieve educationally significant results. ◆

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A Research Review—

Low-Cost Computer Networking for the Teacher

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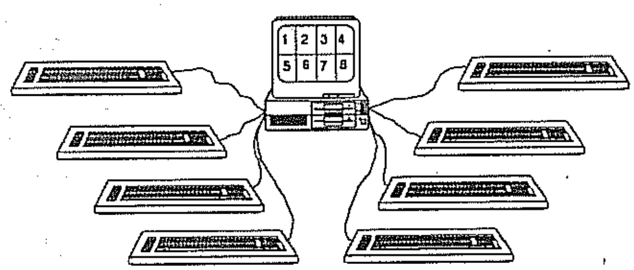
Although the ratio of students to computers is declining, access is still a major concern. One obvious response to this need is to buy more computers. An additional tactic is to analyze how computers are used, to identify alternative ways of increasing access. For example, computers in special education are used primarily for drill and practice. An alternative way of providing drill and practice is to network as many as 16 keyboards to a single computer. The screen is set up as a grid with a cell for each student. The student's name, problem number, answer and feedback are displayed sequentially in the cell. As many as 16 students now have access to one IBM or IBM compatible computer (see Figure 1).

Figure 1. Teacher Net 8-user system.



This low-cost networking system has many additional applications which turn a computer into a classroom assistant for teachers. This article briefly describes those applications and the research conducted on them.

The Practice Assistant

This application allows students to work at their own pace through textbook assignments or teacher-created assignments. Students enter the item number, their answer, and then receive feedback (if the teacher has selected the feedback option).

In one study (Moore, Carnine, Stepnoski, & Woodward, 1987), 14 learning disabled middle-school students entered their answers to math-fact review and operation-review assignments. Thirteen randomly assigned students were in the comparison group. The study ran for 15 minutes a day for 13 consecutive school days. Scoring the responses of students who used The Practice Assistant took an average of 4 minutes a day; scoring the papers of the comparison students took an average of 70 minutes a day.

Another study (also reported by Moore et. al., 1987) used a single subject reversal design with seven remedial elementary students. For the first 15 minutes students worked both new and review math problems. The teacher then spent 3 minutes with them scoring responses and providing corrective feedback. During the conventional instruction treatment, the teacher spent the first part of the 3 minutes reading answers to the problems as the students checked their answers. The time required to read the answers to the students left only 23% of the time for corrective feedback. With The Practice Assistant however, 71% of the time was spent giving corrective feedback. In addition, when students entered their answers on The Practice Assistant, the teacher had a diagnostic summary which served as a base for her corrective feedback.

When new skills were presented with The Practice Assistant, student scores were higher than with conventional instruction. When reviewing familiar skills, performance didn't differ for The Practice Assistant and for conventional instruction. This parallels the findings from the first study (Moore, et al., 1987) where Teacher Net saved substantial amounts of time for the teacher, but didn't differentially improve student performance on familiar material. These two studies show that The Practice Assistant helps teachers save time, increase the time they spend teaching, and improve student learning. The research on the next application demonstrates another way in which Teacher Net can contribute to improved student learning.

The Lecture Assistant

With The Lecture Assistant, the teacher intersperses questions throughout her presentation. After a question, the students enter their answers. In this application, only the teacher views the screen. It displays the average percent correct for all students on that item, each student's individual response, whether it is correct, and the cumulative percent of correct responses for each student, up to that point in the lesson. Using this information, the teacher decides whether more explanation, examples or practice items are needed. After adjusting instruction accordingly, the teacher can check on the students by having them answer more questions. The teacher can then repeat the cycle: explain, ask questions, adjust instruction, ask more questions. The advantage of The Lecture Assistant is that the teacher has immediate, fairly complete information on how well students are understanding the explanations and demonstrations.

Research on The Lecture Assistant involved 30 learning disabled junior high school students (Woodward, Carnine, Gersten, Moore & Golden, 1987), who were randomly assigned to The Lecture Assistant or conventional instruction. Students in both treatments worked 35 minutes a day for three weeks. Instruction was provided from the same reading program. They were taught three reading comprehension strategies—two familiar and one new. Two posttests were devised, one for the familiar strategies and one for the new strategy.

Scores on the posttest for the new strategy were significantly higher for students in The Lecture Assistant treatment (51% versus 38%). The Lecture Assistant students also had a significantly higher rate of academic engagement (89% versus 52%). Finally, 78% of The Lecture Assistant student enjoyed the instruction (over half of whom identified the quality of instruction the main factor); only 25% of the comparison students enjoyed the instruction, and less than an eighth of them mentioned quality of instruction as the main fact.

The Grading Assistant

In addition to saving time and supporting instruction, the Teacher Net hardware system has other features that are attractive to teachers. Electronic grade books give teachers reports and calculate grades very rapidly. Electronic gradebooks also allow easy changes in grade level cut offs, deletions of scores and alterations of the relative weights of different categories of scores. The major draw back of electronic gradebooks is the time required to key in the individual scores.

The Grading Assistant accepts scores electronically from The Practice Assistant. Teachers neither score students responses nor calculate grades in the gradebook. (Scores can also be entered manually into The Grading Assistant, to accomodate assignments, such as essays, where answers cannot be scored by The Practice Assistant.)

Research by Hayden, Wheeler & Carnine, (1987) found that while the greatest time savings came from The Practice Assistant, passing scores to The Grading Assistant took about 10 extra seconds for each assignment. then, the full flexibility of the electronic gradebook was available. The teacher used The Grading Assistant to monitor student progress toward IEP objectives, to communicate student progress to parents, and to provide students frequent feedback about their grades.

The Testing Assistant

Administering and scoring tests is another time-consuming activity for teachers. This is particularly true for adaptive level tests, in which students only take the items that match their skill level. In effect, the test becomes individualized, with different students taking different items. Such testing can identify skill deficits rather precisely, without requiring students to respond to too many easy items and too many hard items. These advantages are offset by the requirement that the test by given individually.

However, The Testing Assistant administers adaptive level tests to as many as 16 students at one time. Each student's cell displays the item number the student is to complete next.

Fourteen remedial and learning disabled students were given a mathematics adaptive level test, either by the teacher or with The Testing Assistant (Moore, et al., 1987). The teacher took 5 minutes to set up The Testing Assistant for the seven students. The teacher took 140 minutes to administer the test to the other seven students. Analyzing and summarizing the results with The Testing Assistant took the teacher 5 minutes; with conventional procedures, the teacher needed 66 minutes for the other seven students. Overall conventional teacher administration and analysis took an average of 27 minutes per student; with The Testing Assistant, the teacher took an average of about 3 minutes per student.

Fractions Math Lab

The applications of The Teacher Net system have supported the teacher in a variety of ways—gathering information about student understanding, scoring responses, giving feedback, calculating grades, and administering tests. With the Fraction Math Lab, students work from a self-paced instructional text and the teacher gives assistance during guided practice, which is managed by the Teacher Net system. After reading an explanation with several examples, students work several practice problems. The students then enter their answers to test items. If they miss 2 or 3 of the test items, they are instructed to ask the teacher for help. Thus, the students turn to the teacher for support if they fail to learn through the explanation and practice problems in the self-instructional text.

Hayden, Wheeler & Carnine (1988) used a single-subject reversal design to study the effects of the Math Lab on the bahavior of a sixth grade math teacher with 16 students. When the Math Lab was not in use, the teacher had to score the students' responses to the test items as well as respond to requests for help. When the Math Lab was in use, the teacher only had to respond to requests for help. With the Math Lab the percent of academically-oriented interactions between the teacher and students was twice as great as during conventional instruction. By taking over the clerical tasks for the teacher, the Math Lab program allowed the teacher to spend much more time teaching.

The Teaching Assistant

The final application may be the most novel. The Teaching Assistant has an unusually easy-to-use authoring language for creating CAI that is then delivered to a group of up to eight students. Incorrect and late responses are tallied. When the students that make up a group do not make the minimal number of correct responses (at a level set by the teacher), the CAI program treats the response as an error and implements any correction or branching specified in the program. although students go through the program as a group, the management system records correct and incorrect responses for each individual student.

The Teaching Assistant can also be used to create and deliver computer assisted video instruction (CAVI). While the melding of interactive instruction and dynamic video makes CAVI an attractive instructional delivery system, the combination also exacerbates the problem of access. School districts would need to purchase an interface and industrial-grade videodisc player or videotape player as well as a computer. the Teaching Assistant is one way to make CAVI more cost efficient, by teaching eight students at a time, rather than one.

A potential disadvantage of a group-based instructional system is a loss in teaching effectiveness. Noell and Carnine (1987) compared the instructional effectiveness and efficiency of group-delivered CAVI with conventional CAVI, delivered to one student at a time.

The CAVI lesson covered basic facts about blood (i.e., type of blood cells, composition and role of plasma, the clotting process, etc.) The exact same lesson was used for both CAVI treatments (group-and individual-based CAVI) with the exception that feedback statement were changed to reflect the presence of a group rather than an individual (e.g., "Most of you have chosen the correct answer," instead of "You have chosen the correct answer.")

The subjects, 33 high school resource room students, were randomly assigned to The Teaching Assistant CAVI or to conventional CAVI. Scores on a posttest did not differ significantly for the two groups, suggesting minimal detrimental effects for the much more cost effective group format. An unexpected finding was the scope and nature of the interactions among the students in the group treatment. These interactions grew out of the criterion of performance the group had to meet to continue the program and avoid a correction and recycling. At times students would help those who were making mistakes. At other times they would verbally assault students who made frequent mistakes.

Conclusion

The article has described six applications and seven research studies on a rather unorthodox use of computers in education. The studies serve the narrow purpose of evaluating the efficiency and effectiveness of this particular approach to helping teachers harness computer technology to meet some of their professional needs. A broader purpose is to prod educators into considering other, possible equally unorthodox, ways to use computers. The view of computers as a productivity tool is commonplace in other fields. Educators might benefit from taking advantage of computers in this way as well. ◆

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Instruction on Ratios and Proportions—
Active Teaching with Basal Text vs. Videodisc

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Results from four National Assessment of Educational Progress in mathematics (Rothman, 1988; Carpenter, Corbitt, Kepner, Lindquist, & Reys, 1981) have shown that mathematical word problems are one of the most difficult problem types for students of all ages and ability levels to solve. The problem is severe enough that the National Council for Teachers in Mathematics (NCTM) listed problem solving as its number one priority in its Agenda for Action for the 1980's.

The four national assessments have shown that many students were unable to perform the tasks necessary for solving complex word problems: generating equations, determining what information was needed to solve the problem, appropriately sequencing and performing all necessary steps, and checking their answers for reasonableness. Students tended to make assumptions and subsequently perform the required operation(s) based solely on the numbers involved (e.g., the operation for a problem with the numbers 56 and 7 was assumed to be division).

Word problems that involve ratios and proportions are examples of complex, multi-step problems. Word problems involving proportions encompass many different types of problems commonly found both in textbooks and in real life. Problems can involve increases, decreases, discounts, percents, measurement conversion, basic ratios, rate, etc. Yet there is evidence suggesting that as many as half of the secondary school and college-age students have failed to acquire a working understanding of the proportionality scheme (Wollman & Lawson, 1978). Wollman and Lawson (1978) note that proportions are the most ubiquitous mathematical concept in any introductory science course. Physics, chemistry, and biology employ many concepts that are essentially proportions. The logic of ratios and proportions are also assumed in much of algebra.

The deficiencies in performance on word problems, are probably related to the fact that basal math textbooks present relatively few word problems (Kameenui, Griffin, & Hytner, 1985; Nibbelink, Stockdale, Hoover, & Mangru, 1987); and when they do, rarely, if at all, are word problems taught as a separate skill (Carpenter, Corbitt, Kepner, Lindquist, & Reys, 1980). Typically, the two to four word problems that appear at the end of a chapter or instructional unit incorporate only the specific computational skill, for example multiplication, that was covered in the just-completed unit (Picus, Sachse, & Smith, 1983). As Carpenter and his colleagues (1981) note; "...once students realize that all problems can be solved by multiplication, many of them stop analyzing the problems with any care and may even stop reading them." (p. 11-12).

Research on the effective teaching of mathematics has identified several curriculum design principles that positively affect students abilities to learn to solve word problems. One of the most important of these is the teaching of an explicit strategy with clear demonstrations. Carnine, Engelmann, Hofmeister, and Kelly (1987) found that high school remedial students who learned explicit strategies performed significantly higher on a posttest involving all four problem types than those students who were not taught explicit strategies. Kameenui, Carnine, Darch, and Stein (1986) also found that low-performing first-grade students who were taught subtraction using an explicit strategy with clear demonstrations performed significantly better on posttests than did a similar group of students who were taught subtraction using discussions about pictures depicting subtraction. Other researchers (e.g., Herrington, 1980; Lerch & Hamilton, 1966) have found similar results.

Another principle is to provide practice with a wide range of examples so that students can learn how to discriminate between similar problem types that require different strategies, as well as different problem types with which the strategy can be used (Carnine et al., 1987; Suydam, 1984).

These and other related curriculum design principles have been evaluated in comparisons with traditional instruction in word problems (e.g., Darch, Carnine & Gersten, 1984). However the Darch et al. (1984) intervention applied principles of curriculum design and of *Active Teaching* (Good, Grouws & Ebmeier, 1983). The comparison treatment incorporated neither set of principles.

The purpose of the present study was to eliminate Active Teaching as a potential confound by making it an integral part of both the experimental and the comparison groups. The experimental treatment was

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based on Active Teaching and empirically validated curriculum design principles. The comparison treatment was based on Active Teaching and basal curriculum design principles.

Method

Subjects

Ninth-, tenth-, and eleventh-grade students from three math classes in a local area high-school participated in this study. The 29 students were from two equivalent basic math classes for low-performing students, one a morning class and one an afternoon class. Six students were from a math resource room and had current Individual Education Plans (IEP's) for math. These six students were combined with the 9 students in the morning basic math class, resulting in 15 students in the morning basic math class, and 14 students in the afternoon basic math class.

Prior to the start of the study, all students were screened for mastery of necessary preskills. Qualifying students were then administered the math portion of the Metropolitan Achievement Test, Level Advanced I, Form JS. Percentile scores on this test ranged from 6 to 60. Students in each class were then matched based on the screening and standardized measures, and randomly assigned to one of the two treatment groups, the Active Teaching with Emperically-Validated curriculum design group (ATCD) or the Active Taching with Basals group (ATB). This resulted in four instructional groups, with a total of 16 students in the ATB group and 13 students in the ATCD group.

The teachers were graduate students in education or special education at the University of Oregon, all of whom were certified. All teachers had previous teaching experience and were trained in the specific requirements of the two curricula. To minimize possible teacher effects, *each teacher taught each condition for half the study.*

Procedures

Screening tests were administered to the students one to two months before the start of the study. Just prior to the start of the study, students were administered a criterion-referenced pretest. During the study, instruction was presented each school day for the full 50-minute period, except when a change in the school schedule cut short the class period. Immediately following the completion of the study, students completed a posttest and an attitude questionnaire. On the questionnaire, the researcher first read each question out loud to the group and explained it to ensure student comprehension. Students then responded individually in writing to that question. At this time teachers also responded to a Teacher Questionnaire. Two weeks after completion of the study, all students were administered a criterion-referenced maintenance test.

Measures

Preskills testing. Prior to the implementation of the ratios curriculum, an 18-item criterion-referenced screening test was administered to all students. Only students who scored at least 70% on these preskills were considered eligible for participation in the study. Students also completed a multiplication facts timed test. Students were given two minutes to complete 60 multiplication facts. All students were able to accurately complete the facts within the allotted time.

Pretest. A 10-item pretest developed by the researcher was administered to all students just prior to implementation of the instruction. The test contained a sampling of all problem types found on the posttest and maintenance test. Students scored from 0% to 20% correct, with a mean of 9%. Based on these results, it was assumed that no student had sufficient skills in solving ratio and proportion problems to warrant excluding them from the study.

Criterion-referenced test of achievement. A 21-item criterion-referenced test (CRT) was designed to assess student mastery of specific skills taught in the two curricula. Two parallel forms of the test were developed, Form A and Form B. Form A served as the posttest and was administered to all the students immediately after they had completed the instructional unit. Form B was used as a maintenance test and was administered to all the students ten school days after completion of the instructional units. Before the start of the study, both forms of the test were administered to two pre-algebra classes with 26 students in grades 9 through 11 to assess internal consistency reliability. Coefficient alpha reliability was .86 for Form A and .83 for Form B.

Time on-task. Independent observers collected classroom data for 14 days in the ATCD classrooms and 13 days in the ATB classrooms. Observers collected data on rates of student on-task behavior and the level of appropriate implementation of the two curricula. Reliability checks for on-task behavior were conducted on five occasions for the ATCD group and on six occasions for the ATB group. Inter-observer reliability averaged 91% for the ATCD groups and 92% for the ATB groups.

Students' attending behavior was divided into three possible categories: On-task, Off-task, and Other.

Behavior in the Other category included transition times when a student might be waiting for the teacher to begin instruction, to receive material, or for other students to finish their work after they had already finished. During these transition times, a student was not considered to be Off-task.

Fidelity of implementation. Degree of implementation was assessed to ensure proper implementation of treatments. Any gross deviations were brought to the researcher's attention and remedied immediately. During each observation the observer completed a curriculum implementation checklist. Two forms of the checklist were used, one for the ATCD group and one for the ATB group.

Student success rate. Students in both groups completed daily independent work in class. On a few occasions, students completed independent work as homework. This occurred either when a student was absent or when an individual student was unable to complete the seatwork in the time allotted during the class period. Thus, the completion rate for students in both groups was close to 100%. To obtain a measure of on-going student success with the material, the mean percent correct for each group was calculated for four unit tests completed every fifth lesson.

Student questionnaires. At the end of the study, a two-part student attitude questionnaire was completed by each student. On the first half, the items queried students on how well they liked working ratio problems, how well taught they thought the material was, and their perception of their own ability to work the problems. The second half of the questionnaire contained short-answer questions and asked students what they liked best about the instruction, what they liked least about the instruction, and what they felt could have been done differently.

Teacher questionnaire. The curricula were taught by four experienced teachers, one of whom was the researcher. Three teachers, excluding the researcher, completed a questionnaire at the end of the study. The short-answer questions asked the teachers to compare and rate the two programs, the ATB and ATCD.

Instructional Materials

Active Teaching with Basals. The ATB curriculum closely followed the Active Teaching paradigm articulated by Good, Grouws, and Ebmeier (1983). Each lesson began with 5 to 10 minutes of predevelopment, during which time the previous day's seatwork was corrected and the teacher led a brief review of the previous day's material. Following predevelopment, the teacher stated the objective for the current lesson and presented the material using short explanations and modeling with examples on the blackboard or overhead projector. Students were then asked 2 to 4 product questions, with an explicitly stated criteria of 80% correct responses for the teacher to determine if reteaching was needed. Two to 4 process questions followed, again with explicit specifications for a passing criterion and reteaching. Students then worked several controlled practice problems, either on written handouts or from examples displayed on the blackboard or overhead projector. If 80% of the students were able to correctly work the controlled practice problems, students began their independent seatwork. The seatwork was designed to take approximately 15 to 20 minutes to complete, so that each lesson lasted approximately 50 minutes, the same length of time as an ATCD lesson. The number of problems students were asked to respond to, either orally or written, was approximately the same number as that presented in the ATCD group. As recommended, and in maintaining consistency across the two curricula, a unit test covering material from the previous four lessons was presented every fifth lesson. On these days, the lesson began with predevelopment, then students completed the unit test for the remainder of the class period.

Materials for the ATB groups included an instructional guide for the teacher, student worksheets and answer keys, and an overhead projector. The instructional guide was divided into 16 daily lessons and four unit tests. For each lesson the guide contained semi-scripted material for teaching— specific examples to model for the students and specific questions to ask the students. The material included correction procedures,which were used depending on the percentage of students responding incorrectly to a question. Problems to use in guided practice were also provided.

The content in the ATB curriculum was derived from four general math and pre-algebra basal textbooks which were currently on the approved textbook list for the state of Oregon. They included: (1) Science Research Associates (SRA) Math, Level 7, (2) Heath Mathematics, Level 8, (3) HBJ Math Level 7, and (4) Houghton-Mifflin Essentials for Algebra. The content was designed to match the ATCD curriculum as closely as possible in terms of topics covered and the amount of practice students received. The strategies and specific examples that were used were those found most consistently throughout the four basal series.

Active Teaching with Empirically-Validated Curriculum Design. An entire ratios videodisc lesson is designed to take approximately 50 minutes to complete. Unless the lesson is immediately preceded by a test, it begins with predevelopment: a short quiz covering the previous day's lesson. The quiz takes approximately 10 minutes for students to complete. If student performance on the quiz meets the suggested criterion of 80% accuracy, the current lesson is presented. If the group's performance does not meet the suggested criterion, portions of the previous lesson may be reviewed.

Each lesson included 5-15 minutes of explanations and models of problems interspersed with controlled practice problems and both process and product questions presented to the students. Depending on the group's performance on key items, the teacher may replay certain segments of the lesson to reinforce a concept. Students then complete independent seatwork. Every fifth lesson in the videodisc program is a unit test covering material presented in the last four lessons. Depending on the group's performance on each section of the test, segments that provided instruction in the specific problem areas from the previous four lessons may be replayed. Replayed segments of the videodisc program that occur during the quizzes, lessons, or tests are called remedies.

The design of the ATCD curriculum is based on the principles of instructional design articulated by Engelmann and Carnine in *Theory of Instruction: Principles and Applications* (1982). Engelmann and Carnine discuss several important curriculum design principles that were incorporated in the ratios videodisc program: (1) instruct in small steps, (2) provide instruction that builds on previously learned material, (3) teach explicit rules and problem-solving strategies, (4) maintain a quick pace of presentation, (5) intersperse the instruction with frequent questions to maintain a high level of attending behavior and to provide a constant check on student understanding of material, (6) provide immediate systematic feedback, (7) maintain a high level of student performance and provide reteaching when necessary, (8) present a range of examples and include nonexamples for discrimination practice, (9) provide lots of opportunities for student practice, and (10) include frequent review, both immediate and cumulative. The program was the result of several extensive field tests of earlier versions.

Materials for each ATCD group included: (1) a Pioneer 7000 videodisc player, (2) a 30" TV monitor, (3) the Ratios videodisc program (Systems Impact, Inc., 1987) consisting of 3 double-sided discs, (4) the teacher's instructional material, (5) photocopies of student worksheets for each day, (6) lined paper for student's in-class written work, and (7) red pens or pencils for students to use when they corrected their written work. The instructional material for the teacher consisted of information on using the equipment and discs, a reference sheet of all the disc addresses for chapters and lessons, test summary sheets, an instructional guide on how to use the videodisc program, and answer keys.

Comparison of the two curricula. Both groups used what research has shown to be effective teaching methods. Teaching components that were similar across the two curricula included: (1) integrating models and demonstrations in the instruction, (2) interspersing questions to students during instruction, (3) providing structured guided practice before beginning independent work, and (4) providing students with daily independent seatwork. Additional components that were similar across the two curricula included: rapid pacing, ensuring student mastery before continuing, providing immediate feedback that was systematic, and monitoring students during independent work times.

The primary differences between the ATB and ATCD curricula, other than the respective mediums used to deliver the instruction, are found in the curriculum design features of each. While the ATCD curriculum taught students explicit strategies, the instructional method in the ATB curriculum did not teach explicit strategies for many problem types. For example, in teaching students how to determine whether information given in a problem was relevant or not, students were told simply to ask themselves: "Is this information important?" A strategy for determining the relative importance or unimportance of information was not presented. Students in the ATB group were also taught several procedures for solving a problem type, as opposed to being taught a single procedure that could be used across a variety of problem types. The procedures were also not taught in small steps. For example, to find a percent of a number in the ATB curriculum students were taught three different strategies in their entirety in a single lesson. Students were taught to: (1) change the percent to a fraction and multiply, (2) change the percent to a decimal and multiply, and (3) write and solve a proportion. Rather than building on prior instruction, these strategies were presented in isolation for this particular problem type. In the ATCD program, teaching students to find the unknown value in a simple ratio word problem was broken into many discrete steps, each taught individually until students had demonstrated mastery of the step. Teaching the entire strategy spanned several lessons. Once this strategy was taught, it was applicable across any type of ratio or proportion word problem, including percents.

The ATCD curriculum provided students with discrimination practice. Students practiced applying a newly learned strategy until they demonstrated mastery in solving problems with that strategy. These problem types were then mixed with previously-learned problems employing different strategies so that students could learn to discriminate between the correct application of different strategies. The problems in the ATB curriculum in a given lesson were typically all the same type and employed the same strategy so students were not taught to discriminate among problem types.

Results

Student Acquisition

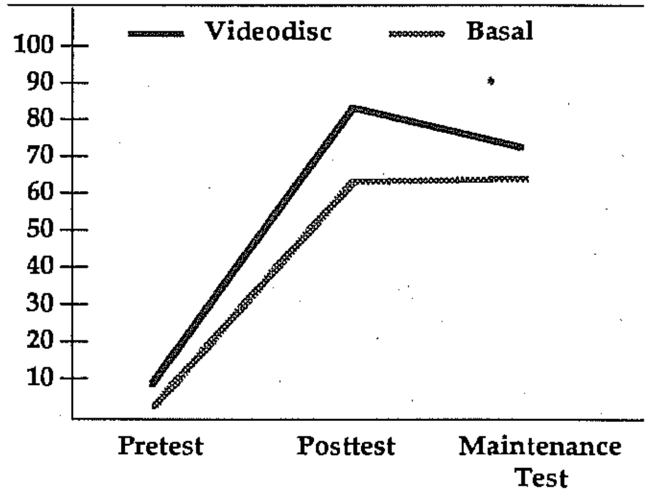
As shown in Table 1, students in the ATCD group obtained a mean of 17.15 (82%) on the posttest, compared with a mean of 13.88 (66%) for the ATB group. On the maintenance test, the mean for the ATCD group was 15.23 (74%). The ATB group's mean on the maintenance test was 14.13 (67%). A t-test performed on the ATCD group's post and maintenance test scores showed the drop in scores to be non-significant. A 2 X 2 analysis of variance was conducted on results from the tests. The between-subjects factor was the type of instruction and the within-subjects (repeated) factor was the time of test (post and maintenance). A significant interaction was found; $F = 3.98, p = .05$. A test of simple main effects favored the ATCD group over the ATB group on the posttest; $F(1, 27) = 4.2, p < .01$. The ATCD group's performance on the maintenance test was higher than the ATB group's, but the difference was not significant.

Prior to the start of the study, all students completed a 10-item pretest. This test contained a sampling of items involving ratios and proportions similar to those found on the post and maintenance tests. As expected, all students scored very low on the pretest. The mean was .9 with a range from 0 to 2. This is equivalent to a mean of 9% correct.

There were significant increases from the pretest mean of 9% to the combined posttest mean of 73% and the maintenance test mean of 70%. Figure 1 shows the percent correct for the two groups on the pretest, posttest, and maintenance test.

The number of students in each of the two treatment groups who reached an acceptable performance criterion was calculated, and a Chi-square performed. An acceptable criterion was defined as 17 out of 21 correct (i.e., roughly 80% or more correct).

Figure 1. Mean Percent Correct Scores on the Pre, Post and Maintenance Tests for ATCD and ATB Groups.



In the ATCD group, 10 of 13 students (77%) reached the acceptable criterion. In the ATB group, only 7 of 16 students (44%) reached an acceptable level of performance. The Chi-square was 3.25, approaching significance; $p = .07$.

Classroom Variables

The ATCD group's on-task behavior averaged 76% during observations over 14 days, higher than the mean of 68% observed over 13 days in the ATB group. The ATCD group was off-task less than the ATB group; 10% for the ATCD group compared to 20% for the ATB group. Table 2 shows the attending data for the two treatment groups.

Implementation levels were high for both groups. During the 13 observations for the ATB groups, there were 6 incidences of inappropriate implementation. During the 14 days in which ATCD teachers were observed, there were 4 instances of inappropriate implementation. None of these instances was significant.

Table 1. Means, Standard Deviations, and Mean Percent Correct Scores on the Posttest and Maintenance Test

	Posttest				Maintenance Test			
Curriculum Program	N	M	SD	M%	N	M	SD	M%
ATCD	13	17.15	2.12	82	13	15.23	3.00	74
ATB	16	13.88	3.85	66	16	14.13	3.85	67

Students' mean percent correct was calculated for the four weekly unit tests that occurred every fifth lesson (5, 10, 15 & 20). Figure 2 graphically depicts the two groups' performances on the unit tests.

A trend analysis showed a significant linear trend for the ATCD group and the ATB group; $p < .001$. A visual analysis shows the trend for the ATB group to be downward.

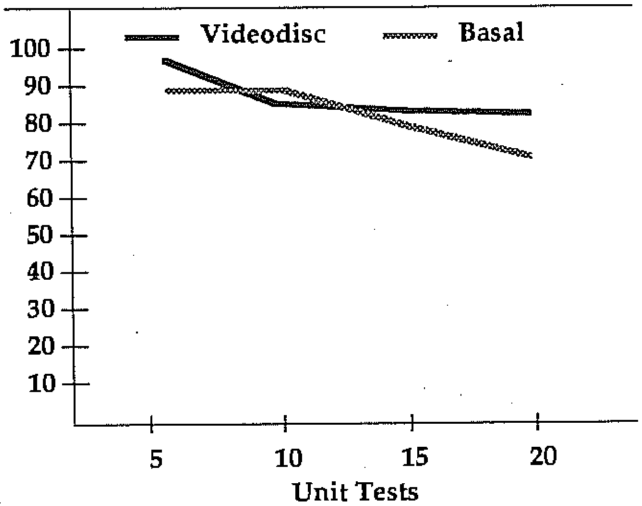
Table 2. Summary of Attending Behavior for the ATCD and ATB Groups.

	Percent of Time Behavior Observed for Each Category		
Group	**On-Task**	**Off-Task**	**Other**
ATCD	76	10	14
ATB	68	20	12

For each question on the student questionnaire, a 2 X 3 (Group by Rating) Chi square was calculated. Significance below the .05 level was indicated only for Question 6: "How well do you think you can work ratio word problems?" Twenty-five percent of the ATB group rated their ability to work ratio word problems as "not well", while no one in the ATCD group responded with "not well" to this question. All students in the ATCD group felt either "O.K." or "Great" about their ability to work ratio word problems, compared to 75% of the ATB group.

On questionnaires completed at the end of the study, the teachers consistently stated that they believed the ATCD program to have better curriculum design and that it was easier to teach the curriculum using the ATCD program. Teachers noted that the ATCD students required less help when they worked independently. This observation is consistent with the perception that the strategies they were asked to present to students in the ATB approach were confusing and inconsistent. One teacher stated that she was not comfortable with the problem-solving strategies used in either approach. Although teachers enjoyed the increased interaction with the students afforded them in the ATB curriculum, they felt that students were better able to learn from the ATCD curriculum because of the dynamic examples and consistency in use of teaching strategies. The teachers were also able to circulate and give feedback more in the ATCD treatment.

Figure 2. Percent Correct on Unit Tests for ATCD and ATB Groups.



Discussion

Both the ATCD group and the ATB group made substantial performance gains from the pretest to posttest. In fact, the six students from the special education class who participated in the study ended up comparable to regular education students on the posttest, regardless of treatment condition. The six students obtained a mean of 15 out of 21, or 71%, on the posttest. A group of 28 general education students who had received prior instruction in ratio and proportion word problems completed the same posttest. Their mean was 15.8 out of 21, or 75%. This finding has important implications for mainstreaming, in that high school learning disabled students can learn in a general education mathematics class and achieve at a level comparable to their non-handicapped peers.

Students in the ATCD group scored significantly higher than students in the ATB group on the posttest, and insignificantly higher on a maintenance test administered two weeks later. The only difference between the two groups were the mediums used to deliver the instruction and the curriculum design of the two programs.

Past research has consistently shown no effect on student learning for different types of technology used for instruction (Clark, 1983). In one study, Hasselbring, Sherwood, and Bransford (1986) specifically showed that students in both an interactive videodisc group and in a teacher-led group where the curricula incorporated the same curriculum design features performed significantly higher than students who were taught from curriculum that did not incorporate the same design features. More relevant to the current study was the finding of no significant difference in performance between the videodisc group and the teacher-led group that incorporated the effective curriculum design principles. Thus, the differences between the groups' performances are probably attributable to differences in the curriculum design.

In both the Hasselbring, et al., (1986) and the present study the demands on teacher time have important practical implications. Although Hasselbring and his colleagues (1986) found no difference between a teacher-taught and a videodisc group when curriculum design and instructional variables remained constant, it was noted that the demands placed on the teacher in terms of pacing, monitoring and the number of examples to present may have been excessive with the print program. In fact, the *teacher was physically not able to parallel the videodisc curriculum without the help of a half-time aid.* Thus, the videodisc is able to do what it takes 1 1/2 people to do. Similarly, in the present study the ATB curriculum took about two weeks to prepare. The best explanations and examples from the four basal programs were identfied and then placed in the context of an Active Teaching program. The resulting program was more than three times as extensive as the most complete basal treatment of ratio and proportion. Expecting teachers to spend two full weeks to prepare 20 math lessons (as was the case for ATB treatment) is, however, unrealistic. In contrast, the ATCD treatment reduced both presentation demands (Hasselbring et al., 1986) and preparation demands (the present study).

Differences in curriculum design appear to have had a major impact on student performance. The lack of application of these principles likely contributed to the weaker posttest and maintenance test scores by the ATB group, as well as their increasingly poor performance on the unit tests. It is important to note that the principles apply to a range of technology and print applications (e.g , Carnine, in press), not just the videodisc.

Curriculum design features that were unique to the ATCD program included: (1) teaching explicit strategies in small steps, (2) a consistent use of strategies, and (3) including a large number and range of examples. The individual effects of each of these variables were not separated out in this study. However, it is clear from this and other research that empirically-validated curriculum design principles can clearly contribute to a quality education for remedial and learning disabled students. ◆

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Computer Assisted Video Instruction in Training Rehabilitation Paraprofessionals

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A good deal of special education services are provided by paraprofessionals in classrooms, homes, nursing homes, and group homes. Paraprofessionals are often asked to implement complex behavior management and instructional programs (Singer, Sowers, & Irvin, 1986). One particularly complex implementation problem is in working with those who survive traumatic head injuries. Many of these individuals live in group homes or nursing facilities following discharge from a hospital. In these settings, nurses aides are the paraprofessionals most often working with clients in an array of self-help and instructional programs.

Most of these paraprofessionals receive minimal training prior to working with clients. The high turnover rate among paraprofessionals and high cost of training make it difficult and frustrating for administrators to provide consistent staff training (Lakin, 1988). However, untrained staff cannot be expected to provide quality instruction to clients. A definite need exists for training rehabilitation paraprofessionals so that they can become effective instructors. However, to be utilized this training cannot be very labor intensive or costly.

This report describes and evaluates a program for training paraprofessionals in instructional techniques for working with head-injured clients. Computer assisted video instruction (CAVI) was used to provide examples of instructional techniques combined with computer-generated interactive questions. Video examples showing teachers using specific techniques with the head-injured clients provided clear demonstrations of how the procedures should be implemented. The trainer could replay the examples as needed. In addition, the CAVI lessons incorporated frequent assessment of the trainees' understanding of material recently covered and provided specific corrective feedback and remediation loops errors. Finally, trainees were provided with CAVI review of critical teaching skills.

Based on a review of the staff development literature, we concluded that other training might be necessary to insure that the paraprofessionals used the skills they learned when actually working with the clients (Burchard & Thousand, 1988). Coaching has been documented as an effective way to ensure that teachers transfer new teaching skills and strategies into their classroom repertoire (Carnine & Gersten, 1985; Joyce & Showers, 1980, 1982).

Central to the the CAVI training lessons was a focus on Engelmann's the *firming procedure* (Engelmann and Carnine,1982). The firming procedure was designed for use with severely handicapped individuals. The procedure provides the teacher or aide with a sequence for alternating new material with previously learned material. Preliminary results by Falco (1983) suggest that the firming strategy is an effective procedure for teaching new responses and information to learners with memory deficits, and may be more efficient than massed practice for teaching these individuals. Furthermore, pilot research with traumatically brain-injured aides indicate that the firming procedure was an effective strategy for this population (Glang, Singer & Kurlychek, 1987).

The three core components of the procedure are based on a solid body of instructional research. Researchers have documented the importance of distribution of trials involving the new item with easily discriminated tasks involving previously learned material (Carnine, 1978; Cuvo, Klevans, Borakove, VanLanduyt & Lutzker, 1980; Dent & Johnson, 1964; Hovland, 1940). The firming procedure requires rapid pacing of instruction, a factor which has been shown to increase the acquisition rate of new material (Carnine, 1976: Koegel, Dunlap & Dyer, 1980). The procedure also stresses the importance of maintaining high rates of learner success, a variable also found to correlate with increased acquisition and retention of newly learned information (Weeks & Gaylord-Ross, 1981; Falco, 1983; Gersten, White, Falco & Carnine, 1982).

This study evaluates the effects of CAVI on paraprofessionals' implementation of the firming strategy by using a multiple-baseline design. In addition, the study explores the paraprofessionals' maintenance of the teaching skills across time, and explores the impact of coaching on the paraprofessionals. Finally, the study investigates the paraprofessional's attitudes towards

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CAVI, and the impact of the firming procedure on clients.

Participants

The participants in this study were three paraprofessional aides, a client of each aide, and the trainers who coached the aides. The three paraprofessional aides worked as house managers in one of three group homes for head-injured clients. Their primary responsibilities in the group homes were scheduling other staff, managing house finances, and working with clients on cognitive and daily-living skills with their clients. None of the aides had received any formal training in teaching techniques.

The three clients were men between the ages of 22 and 32, one from each of the three group homes for head-injured individuals. Each client had sustained a severe head injury secondary to a motor vehicle accident and exhibited significant learning and memory deficits. On a standardized assessment of memory ability, the Wechsler Memory Scale (Wechsler & Stone, 1945), all three clients scored in the severely impaired range (below the 20th percentile). On delayed portions of the test (administered 30 minutes after the initial presentation), each client 's score fell below the 1st percentile, indicating that no client remembered any information from the initial presentation.

Following the initial training session (in which the aides viewed a CAVI lesson), the aides were coached by one of two trainers, the researcher or a research assistant. Both trainers had experience in teacher training and supervision at the university level; both had previously taught head-injured clients. The trainers were randomly assigned to aides. To insure that both trainers utilized similar coaching techniques, the trainers agreed upon a standardized coaching format prior to beginning their intervention.

Procedures

The firming procedure controls teaching examples so that the learner first practices target examples in an easy context (repeated examples of the task) and then practices the examples in increasingly more difficult contexts. The procedure has three stages. In stage 1, repeated examples of the new task are presented. In stage 2, trials on the new task are mixed with trials on a familiar task (e.g., the target task, "What's your phone number?" might be followed by a familiar task, "How old are you?"). In stage 3, the new task is interspersed with several trials using familiar tasks. Tasks are presented in rapid succession to reduce the effect of time as an additional interference variable.

The learner progresses from level-to-level by responding correctly to the target task three or four times in a row. If the learner makes an error, the instructor returns to an easier level. Thus, the firming strategy adjusts the difficulty of the demands for memory and discrimination according to the learner's performance.

The firming strategy calls for a minimum of 12 trials, and additional trials are added if the learner makes an error. Interspersed tasks must be familiar ones (i.e., tasks at which the learner can succeed), and only 1, 2, or 3 tasks are interspersed between trials on the instructional task. Figure 1 illustrates the three levels of the procedure and how errors are corrected (the clients already know tasks A, B, and C; the new task is designated by X).

Figure 1. Graphic Representation of the Firming Procedure.

Format 1. Learner makes no errors

Steps

1. XXX
2. AX CX BX
3. BCX ABX CAX
4. ACBX BCAX CABX

Format 2. Example of Correction Procedure: Learner makes error on sixth trial on new task (X).

Steps

(1) XXX
(2) BX CX AX
(3) CBX ABX (error made)
(correction loop)
1. XXX
2. CX AX BX
3. BAX CBX ACX
4. CBAX BACX ACBX

Instructional Tasks

Prior to the baseline phase, the researcher evaluated each learner and met with group home staff to select appropriate instructional tasks based on each learner's individual rehabilitation goals. All three clients worked on remembering their phone number, their address, and the name of one group home staff member. Only one task was tracked throughout the study: remembering their phone number.

CAVI Training Materials

The CAVI lesson presented the firming procedure using video examples of aides teaching head-injured learners. In the lesson, information about how to use the procedure and why it was effective was integrated with frequent questions to test the aide's understanding of the material. A series of review questions appeared at the end of the lesson.

The instructional equipment consisted of an Apple

IIe computer, a black and white monitor, a video recorder, and a color television set. The microcomputer and video recorder were connected with an interface card (produced by BCD, Inc.). Instructional sessions took place at the head-injury rehabilitation clinic where each client received daily speech and occupational therapies.

Design

A multiple-baseline-across-aides design was used to assess the extent to which aides demonstrated proficiency with the firming procedure. Aides were trained sequentially; i.e., Aide 2 entered training after Aide 1 demonstrated mastery of the firming procedure.

There were four experimental conditions: baseline, CAVI training, coaching, and maintenance. All instructional sessions were videotaped. During baseline, aides were told to "work with their learner to help him remember" the instructional tasks. The experimenter did not observe these sessions or intervene in any way.

After establishing baseline performance, each aide attended the 90 minute CAVI training session. Aides were told to begin using the firming procedure after viewing the CAVI lesson. Instructional sessions following the CAVI lesson were held daily and lasted approximately 20 minutes. The aides received no assistance in implementation during this phase, and were told to keep track of their learner's progress on a daily data form.

During the coaching phase, aides continued to work with their learners on the pre-arranged tasks. The coach observed the instructional sessions an average of twice a week during this phase. Each observation session usually began with an analysis of the aide's collected data from the previous sessions. The coach and the aide discussed the learner's progress and talked about ways to improve the learner's accuracy and retention of instructional material. The coach then observed the aide teach, took data on the learner's accuracy and then discussed the instructional presentation and its effects on the learner.

During the maintenance phase, each aide continued to work independently with their learner during daily scheduled times at the rehabilitation facility.

Measures

A trained observer viewed videotapes of each aide and their learner during randomly selected sessions and coded both the aide's questions and the learner's responses. Three measures of aide performance were taken during each of the observations: (a) percent of appropriate steps in the firming procedure, (b) percent of learner errors corrected appropriately (this included ratings for complete corrections as well as any attempt at a correction), and (c) instructional pacing.

The observer also tracked the learner's performance by keeping data on the learner's accuracy level and his performance on daily probes. The percent correct for acquisition trials was calculated by dividing the number of target task trials responded to correctly by the total number of target task trials presented in each session. Retention was tested at the beginning of the next session.

In addition to the observational measures, a knowledge test (pre and post) was used to measure aide's understanding of the firming procedure and the rationale behind it.

Reliability. Interobserver reliability checks were made on 21 of the 57 videotaped observations (6 to 8 observations for each aide). Reliability was calculated by dividing the number of agreements by the number of agreements plus disagreements. Reliabilities for the following four measures averaged as follows: aides implementation of procedure (96%), learner accuracy (94%), total number of learner responses (98%), learner performance on probes (100%).

Results

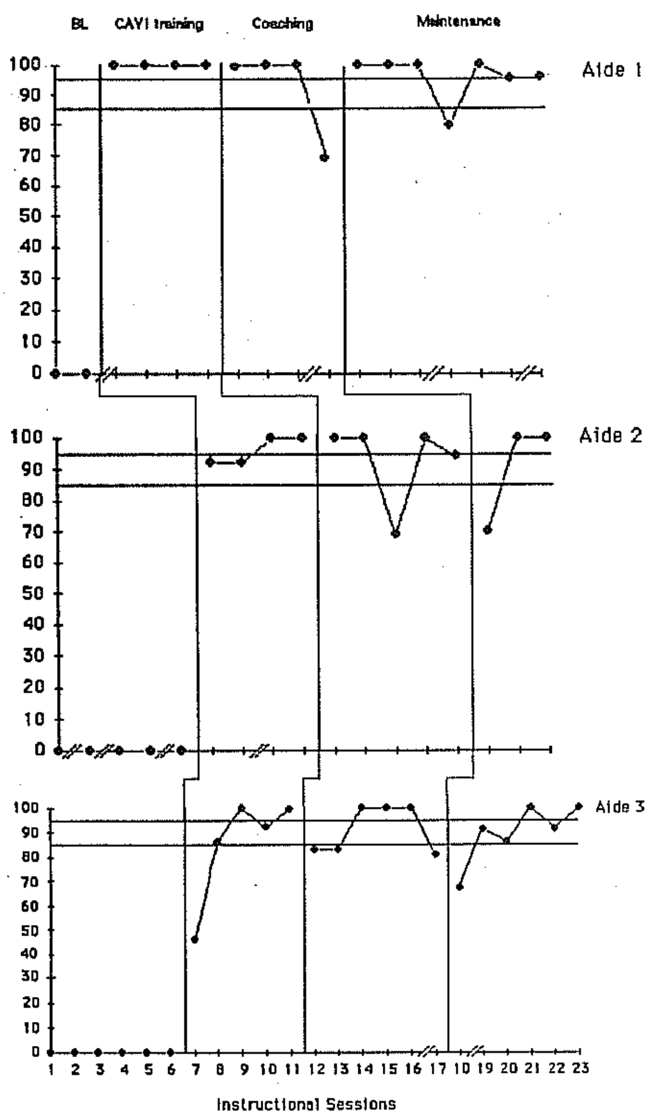
Implementation of the Firming Strategy

The primary purpose of this study was to evaluate the effects of computer assisted video instruction (CAVI) on the paraprofessionals' use of the firming procedure. Implementation of the firming strategy is graphically presented in Figure 2. Baseline measures were consistently at zero for all aides. None of the three aides used a procedure which was in any way similar to the firming strategy during the baseline phase. While all three aides provided massed practice on each task during baseline (between 2 and 20 trials during each session), none of the aides used spaced or distributed practice to facilitate retention.

The effects of the 90 minute CAVI training were *immediate* for all three aides. After viewing the CAVI lesson, two of the aides were able to implement the firming strategy at acceptable levels of 90 to 100 percent on a consistent basis. Aide 3 demonstrated proficiency with the procedure on the second day of the CAVI phase and continued at a high level for three more days. During the CAVI phase, Aide 1 implemented the procedure with 99% accuracy, Aide 2 averaged 98%,and Aide 3 averaged 88.8%.

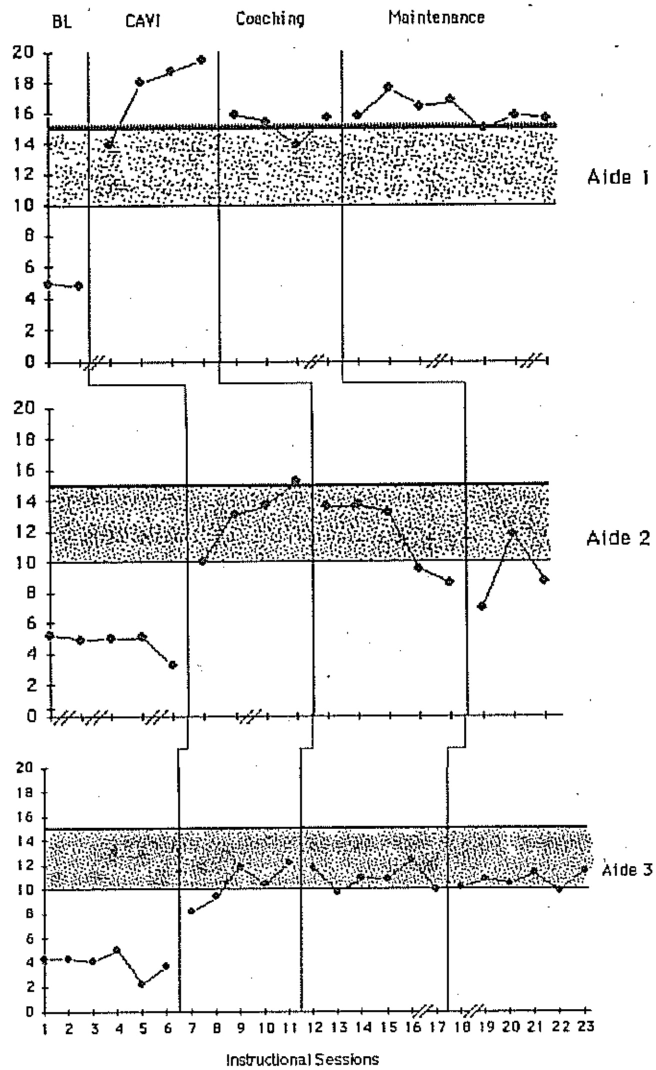
Performance did not improve during the coaching phase. However, only Aide 3 fell below an acceptable implementation level of 85% more than once during this phase. Slight variability is present in the coaching

Figure 2. Implementation of Procedure



and maintenance phases for all three aides.

Figure 3. Instructional Pacing



Instructional Pacing

The pacing of each observed instructional session was measured by dividing the number of learner responses by the number of elapsed minutes in each observation. Instructional pacing data for each aide are presented in Figure 3. The shaded area between 10 and 15 responses per minute indicates an acceptable level for instructors of learners with severe cognitive impairment (Koegel, Dunlap & Dyer, 1980).

Baseline measures were consistently low for all three aides. All three aides presented tasks at the rate of approximately 4 to 5 responses per minute. After viewing the CAVI lesson, in which quick presentation of cognitive tasks was stressed, each aide made significant changes in their instructional pacing.

During the coaching and maintenance phases, Aides 1 and 3 maintained stable mean presentation rates of 15.2 and 16.1 (Aide 1) and 10.9 and 10.7 (Aide 3), within the acceptable range. Although the trend of the data in the CAVI phase for Aide 2 suggests an increase in presentation rate, during the coaching phase, Aide 2's pacing decreased substantially .

During the maintenance phase, Aide 2's pacing level varied considerably from session to session. This variability seemed to be related to interspersed tasks used during the maintenance phase. She tended to include very difficult tasks (e.g. "Look up the phone number for a department store in the phone book").

These tasks took a great deal of time for the learner to complete and thus greatly influenced the pacing data for this phase.

Corrective Feedback to Learners

A major component of the firming procedure is the provision of corrective feedback. However, all three learners made so few errors during the CAVI, coaching, and maintenance phases that the paraprofessionals had few occasions for using any type of corrective feedback during these phases.

Learner Performance

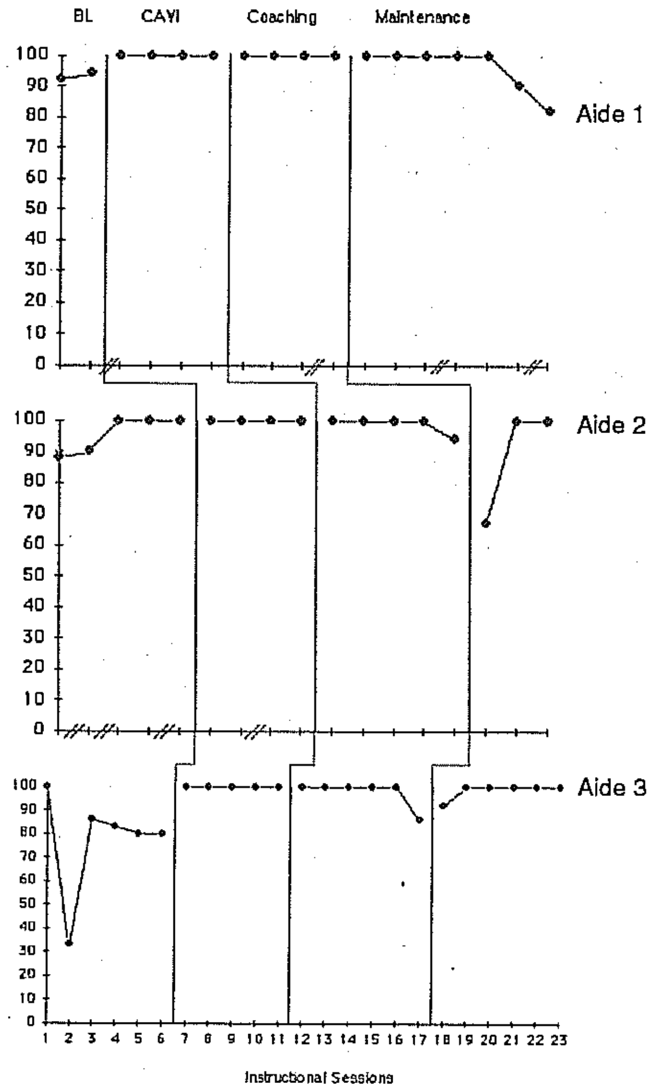
Two measures of learner performance were used to determine the effects of each aide's implementation: (a) the percent correct during acquisition trials, and (b) performance on retention measures.

Acquisition. Figure 4 presents the accuracy data for each learner during each instructional session across all four phases. During the baseline and maintenance phases, all three learners varied somewhat in their overall accuracy levels. In general, the learners were quite accurate (100% correct on most days) in their responses during the CAVI and coaching phases.

The patterns for all three aides show a relationship between level of implementation and learner accuracy. (Compare Figures 2 and 4.) During the baseline phase, no aide used the firming procedure, and none of the learners were consistently accurate on acquisition trials. During the CAVI and coaching phases, all three paraprofessionals maintained high levels of implementation, and their learners accuracy levels were higher. In the maintenance phase, the data points for learners depict a similar pattern; on most days, the learner's accuracy level varied with the aide's implementation level.

Retention. Daily probes occurred at the beginning of each session to measure the learner's retention of instructional material across sessions (i.e., 24 to 72 hours). A probe response was considered correct only if the learner answered accurately without any prompts. No clear effects were seen in this measure. The clients of Aides 1 and 3, the most severely impaired of the clients, never gave the correct response on the daily retention probe. Aide 2's client, the least cognitively impaired, appeared to improve over time on daily probes; he was never correct during the baseline phase, 25 % correct during CAVI, and responded correctly to 100% of the retention probes during the coaching phase. However, when a new task was introduced during the maintenance phase (because he had mastered the original one), he was again unable to respond correctly on any of the retention probes.

Figure 4. Client Accuracy During Acquisition



Knowledge Test

Two knowledge tests were administered to aides to measure their understanding of the firming procedure and the rationale behind it. The ten questions on the pretest included items relating to the use of interference tasks, instructional pacing, and reinforcement . Items on the posttest included all of the pretest questions plus ten additional questions of a more specific and technical nature.

All three aides scored at or below 50% on the pretest. On the posttest (which aides completed after viewing the CAVI lesson), all aides scored at or above 85%, indicating that the CAVI lesson effectively presented the information.

Social Validation Measure

In an effort to socially validate the direct measures of the aide's implementation of the firming procedure, they participated in an interview and completed an attitude survey. In general, the paraprofessionals' attitudes were positive towards all three aspects of the training program. Each of the paraprofessionals felt that CAVI was an effective way to learn the firming strategy. They each stated that the lesson was enjoyable to watch and presented the information clearly. Each of the aides stated that the firming procedure was useful in helping their learners to remember information and that they would continue to use the procedure after the completion of the study. However, two of the aides felt that the firming procedure had some disadvantages: Aide 2 felt that the procedure was too repetitive, and Aide 1 felt that it was too time-consuming. All three aides felt that the assistance they received from their coach was helpful, but only two of the three paraprofessionals felt that this assistance was necessary.

Discussion

After one 90 minute CAVI session, the paraprofessionals learned the firming strategy quickly and were able to implement it with their clients at acceptable levels of 85-100 percent. The CAVI lesson also appears to have been a factor in achieving dramatic increases in the aides' instructional pacing rates. After viewing the lesson, all three aides increased their presentation rate significantly (from approximately 5 responses per minute to 10 or more responses per minute), and these presentation rates were maintained consistently by two of the aides for the remainder of the study. The increases in aides' presentation rates are particularly important because instructional pacing influences the degree to which learners acquire and retain instructional material (Koegel, Dunlap & Dyer, 1980).

The procedure used was probably easier to master than other more involved teaching techniques discussed in reviews by Joyce and Showers (1980, 1982). In their study, Singer, et al., (1985) found that although an aide was able to implement several simple instructional procedures after one viewing of a CAVI lesson, the aide was unable to implement a more complex correction procedure after only one viewing.

The ultimate criterion for evaluating the effects of any staff training program is improvement in learner performance (Sparks, 1983). In this study, the impact of the staff development program on the learners is mixed. The data clearly show that learner accuracy increased after the aides began implementing the firming procedure. However, learners did not make significant gains on daily retention probes given at the beginning of each day.

The learners' poor performance on retention probes indicates that the 5-minute daily sessions of the firming procedure did not significantly affect the learners' ability to retain information over a 24-hour period. The lack of long-term retention is a cause of concern. It is clear that the one five-minute session per day did not provide the learners with sufficient practice on the target task (about 12 trials a day). Learners with severe memory problems often require many trials in order to retain new information (Ben-Yishay & Diller, 1983). In addition, the amount of time between the instructional session and the delayed probe (24 - 72 hours) was likely too long. On initial assessments, none of these learners was able to recall information presented 30 minutes earlier.

Although the design of this study does not permit general conclusions about the effectiveness of CAVI and coaching, the results do have several implications for individuals involved in designing staff training programs.

The results suggest that CAVI is an effective means for training para-professionals on fairly specific teaching techniques. CAVI's interactive capabilities make it possible to design lessons which incorporate important principles of instructional design. For example, carefully selected examples and non-examples can be used to illustrate the salient features of a given technique. The CAVI lesson can also incorporate frequent assessment of trainee's understanding, and can provide specific feedback and remediation when errors occur. Finally, CAVI can provide trainees with a review of critical skills, and the lesson can be shown several times if necessary.

Although CAVI may be an effective vehicle for presenting information on some teaching procedures, it may not be sufficient, in and of itself, for training staff in more complex skills. Research by other staff development specialists suggests that practice and coaching may play more important roles in training staff in more complex skills. ◆

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