Improving the Reading Comprehension of Middle School Students With Disabilities Through Computer-Assisted Collaborative Strategic Reading

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ABSTRACT

This study investigated the effects of computer-assisted comprehension practice using a researcher-developed computer program, Computer-Assisted Collaborative Strategic Reading (CACSR), with students who had disabilities. Two reading/language arts teachers and their 34 students with disabilities participated. Students in the intervention group received the CACSR intervention, which consisted of 50-min instructional sessions twice per week over 10 to 12 weeks. The results revealed a statistically significant difference between intervention and comparison groups' reading comprehension ability as measured by a researcher-developed, proximal measure (i.e., finding main ideas and question generation) and a distal, standardized measure (i.e., *Woodcock Reading Mastery Test,* Passage Comprehension). Effect sizes for all dependent measures favored the CACSR group. Furthermore, a majority of students expressed positive overall perspectives of the CACSR intervention and believed that their reading had improved.

UNDERSTANDING AND LEARNING FROM TEXT IS at the heart of reading. As students progress through the grades, they are increasingly required to draw on their reading comprehension skills to learn from text (Williams, 1998). One of the most vexing problems facing middle and secondary school teachers today is that many students come into their classrooms without the requisite knowledge, skills, and disposition to read and comprehend the materials placed before them (Rippen & Brewer, as cited in Snow, 2002, p. iii). Students who are successful at meaning-making are able to monitor their understanding and to use various strategies to resolve problems and improve their comprehension. However, many students with learning disabilities (LD) have not developed this metacognitive awareness or the ability to skillfully apply comprehension strategies (Baker & Brown, 1984; Flavell, 1977).

Over the years, researchers and their collaborators have developed numerous strategies to help struggling readers interact with text in ways that improve their understanding. The effectiveness of these strategies for students with LD has been well documented (Gersten, Fuchs, Williams, & Baker, 2001; Pressley, Johnson, Symons, McGoldrick, & Kurita, 1989; Snow, 2002; Swanson, 1999; Weisberg, 1988; Wong, 1985). From such empirical evidence, we know that comprehension strategy lessons should include explicit instruction in the targeted strategies (Swanson, 1999) and incorporate careful modeling and the provision of extensive feedback to students (Gersten et al., 2001).

COLLABORATIVE STRATEGIC READING

Collaborative Strategic Reading (CSR) was designed to facilitate reading comprehension for students with reading diffi-

Volume 27, Number 4, July/August 2006, Pages 235–249

culties (Klingner & Vaughn, 1999; Klingner, Vaughn, & Schumm, 1998). CSR is an adaptation of reciprocal teaching (Palincsar & Brown, 1984) and includes many features associated with effective instruction (e.g., collaborative group work, interactive dialogue, clearly specified procedures). In CSR, students learn prereading, during-reading, and post-reading strategies. Before reading, they preview by brainstorming what they already know about a topic and predicting what they think they will learn. During reading, they monitor their comprehension and apply fix-up strategies to help them figure out unknown words when comprehension breaks down. This strategy is called *click and clunk*. During reading, they also *get the gist* by identifying the most important ideas about a topic in a section of text. After reading, students wrap up by generating questions and reviewing the key ideas they have learned. Initially, the teacher presents the strategies to the whole class using modeling and think-alouds. After the students have developed proficiency using the strategies, they are then divided into collaborative groups, in which each student performs a defined role to implement the strategies collaboratively while learning from expository text.

CSR was first implemented with 26 Latino middle school students with LD who were also English language learners (Klingner & Vaughn, 1996). The results were promising—even students who had very poor decoding skills made improvements in reading comprehension. In the next investigation of CSR, Klingner et al. (1998) provided strategy instruction in fourth-grade inclusive classrooms. Students who used CSR made statistically significantly greater gains than students in a comparison condition on the *Gates-MacGinitie Reading Test* (MacGinitie & MacGinitie, 1989) and demonstrated equal proficiency in their knowledge of the social studies content. Separate data for students with LD were not available in this study. In a more recent study, Klingner, Vaughn, Arguelles, Hughes, and Ahwee (2004) examined teachers' year-long implementation of CSR in fourth-grade inclusive settings. Students in CSR classrooms improved significantly in reading comprehension when compared with students in comparison classrooms. For students with LD, there was no statistically significant difference between the two groups on the comprehension measure, although the result was promising for students with LD in the CSR condition (standardized mean difference = .40).

Although a limited number of studies were conducted with students with LD to examine the effects of CSR, there appears to be considerable research support for several features of CSR. First, Gersten et al. (2001) identified two instructional components associated with improved comprehension for students with LD, and CSR incorporates these two components: (a) the use of small, interactive groups (e.g., applying CSR strategies in small, collaborative groups) and (b) the teaching of specific formats for students' generation of questions about what they read (e.g., wrap-up in CSR). Second, the use of reciprocal teaching, which significantly influenced the development of CSR, has resulted in positive effects on students' reading comprehension. Reciprocal teaching was originally designed to improve comprehension for students who can decode but who have difficulty with comprehension. A research synthesis on reciprocal teaching revealed a median effect size favoring reciprocal teaching. Particularly, with researcher-developed comprehension measures, reciprocal teaching was associated with the large median effect size of .88 (Rosenshine & Meister, 1994).

Computer-Assisted Instruction

Computer-assisted instruction (CAI) can provide teachers with a tool for enhancing teaching and learning in their classrooms. CAI has the potential to offer students with LD self-paced, individualized instruction that includes immediate feedback and multiple opportunities for practice (Hall, Hughes, & Filbert, 2000; Lewis, 2000; MacArthur & Haynes, 1995; Rieth & Semmel, 1991; Woodward et al., 1986). Students generally find CAI to be quite motivating, yet Wissick and Gardner (2000) cautioned that to maximize the benefits of technology, students with disabilities should not be left to their own devices but should receive assistance as needed.

Hall et al. (2000) reviewed 17 studies on CAI in reading interventions for students with LD. They noted that 3 of these studies focused on strategy instruction and included improving reading comprehension as a goal (Bahr, Kinzer, & Rieth, 1991; Keene & Davey, 1987; Woodward et al., 1986). Woodward et al. (1986) found significant differences favoring CAI. On the other hand, neither Bahr et al. (1991) nor Keene and Davey (1987) found significant differences between those students who used a software program and those who did not. In their review of meta-analyses in special education, Forness et al. (1997) described CAI as an intervention that "shows promise" in effectively helping students, rather than as an intervention that we know "works" (p. 6).

In general, studies using CAI as a provider of teaching practices (e.g., providing the main ideas or definitions) have demonstrated significant improvements in reading comprehension (Horton, Lovitt, Givens, & Nelson, 1989; MacArthur & Haynes, 1995), whereas studies using CAI as a simple tool in the classroom (e.g., providing text on the screen) did not yield significant improvements in reading comprehension for students with reading difficulties (Elkind, Cohen, & Murray, 1993; Farmer, Klein, & Bryson, 1992). These findings suggest that effective reading CAI programs should provide effective, specific comprehension instruction.

Computer-Assisted Collaborative Strategic Reading

Given the importance of helping students with LD become more efficient at comprehending, the potential of reading comprehension strategy instruction for achieving this goal,

and the challenges faced by classroom teachers when trying to teach comprehension strategies, models of strategy instruction that teachers find feasible and students find engaging remain a necessity. One promising CAI model for addressing these issues is Computer-Assisted Collaborative Strategic Reading (CACSR; Kim, 2002). CACSR was designed to build on what is known about the critical features of effective comprehension strategy and CAI instruction. Thus, CACSR provides students with an interactive learning environment intended to maintain their interest while teaching them how to apply comprehension strategies as they read expository text passages. CACSR provides an individualized learning pace, choices in learning paths and reading passages, and reading level options. The CACSR intervention also includes feedback and correction procedures through CACSR's built-in function of recording student performance. Teachers and students can monitor and evaluate student progress using the recorded data, and students receive immediate, corrective feedback based on their performance.

In a previous investigation, Kim (2002) taught high school students with LD how to use CACSR and compared the reading comprehension gains of these students with those of students in a language arts resource class. The results revealed that both groups improved significantly in reading comprehension during the 12 weeks of the study, with no statistically significant differences between groups. Effect sizes, however, favored the CACSR group—that is, the pretest to posttest mean difference effect size for the CACSR group was .81, whereas it was .33 for the comparison group. Students generally expressed favorable opinions about CACSR but did offer suggestions for improvement.

The purpose of the current study was to investigate the effects of CACSR on the comprehension of middle school students with LD and to examine the perceptions of participating students and teachers regarding the efficacy of CACSR. This study builds on previous work with CACSR in several ways. First, students worked in pairs to increase the interaction between students and to facilitate discussions, rather than each student interacting individually with the CACSR program, as in the previous study. Research findings have suggested that working with peers promotes interactive dialogue about text, thus encouraging students with LD to think while they read (Gersten et al., 2001). Also, Swanson and Hoskyn (1998) found that the use of small, interactive groups was associated with improved academic outcomes for students with LD, regardless of domain. Thus, we incorporated the partnering of students as a means of promoting the comprehension of students with LD.

Second, the trained teacher and trained research assistant provided supplemental, explicit instruction in the comprehension strategies based on the students' data (obtained from the CACSR program) at the beginning of each lesson. Explicitness in teaching comprehension strategies is one important factor that influences comprehension outcomes for students with reading difficulties (Rand Reading Study Group, 2002). Many students with LD struggle to understand how to use comprehension strategies when these strategies are presented in an implicit fashion, and they often fail to apply the learned strategies to a new task. Thus, teachers must respond to students' needs for explicit instruction in comprehension strategies (Gersten & Carnine, 1986; Gersten et al., 2001).

Third, a proximal measure of the intervention (i.e., the CSR measure) and a standardized comprehension measure (i.e., the *Woodcock Reading Mastery Test–Revised* Passage Comprehension subtest) were used. In the previous study, the standardized comprehension measure was used as the sole dependent measure. Given that reading comprehension has been documented as one of the most difficult components of reading to measure, we believed it was appropriate to use both a proximal measure of the comprehension strategies taught to students in the study (i.e., identifying the main idea and generating questions about what had been read) and a standardized measure to better understand students' comprehension outcomes. Finally, a larger sample (n = 34) than that used in the previous study (n = 23) was included to increase statistical power.

METHOD

Participants

Two female reading/language arts teachers working in an urban middle school and their students participated in the study. These teachers volunteered to participate. One teacher had a bachelor's degree, was certified in special education, and taught a reading resource class. The second teacher had a master's degree, was certified in special education and language arts, and taught a language arts class for students with reading difficulties. We included students in our data analysis if they met the following selection criteria: (a) Students were legally identified as having a disability; (b) students decoded words at a 2.5 grade level or above, as measured by the *Woodcock Reading Mastery Test–Revised* (WRMT-R) Word Identification (WI) or Word Attack (WA) subtests; (c) students were at least 1 year below grade level in reading comprehension, as measured by the WRMT-R Passage Comprehension (PC) or the *Gates-MacGinitie Reading Tests*; and (d) students attended a reading class for students with reading difficulties, including students with disabilities.

The two classroom sections of each teacher were randomly assigned to either the intervention group or the comparison group. A total of 16 students participated in the intervention group, and 18 participated in the comparison group. Although CACSR implementation in the intervention group was classwide, only the data from students with disabilities were analyzed in this study. From the first teacher's classroom, 24 students with disabilities participated (12 students in the CACSR group and 12 students in the comparison group). Students in the comparison group received resource reading instruction. Ten students with disabilities from the

second teacher's classroom participated (4 students in the CACSR group and 6 in the comparison group). Students in the comparison group received language arts instruction.

Students from the two teachers' classes were combined based on whether they were included in the CACSR or comparison group for the purpose of testing group differences (CACSR vs. comparison) on the demographic variables (i.e., grade, ethnicity, gender, socioeconomic status, age, and reading achievement scores) and the pretest measures of the outcome variables. An independent sample *t* test showed that there were no statistically significant differences between the two groups on the selected demographic variables and the pretest measures of the outcome variables, except on the CSR measure of Fourth-Grade Reading Level: Question. The profile of student participants is summarized in Table 1.

Procedure

General procedures used for all of the participants included (a) pretesting of all participating students; (b) training of participating teachers on the CACSR implementation procedure; (c) implementation of CACSR through collaboration between the trained teachers and research assistant; (d) posttesting of all participating students; and (e) interviewing of students in the CACSR group and participating teachers. First, students in both the CACSR and comparison groups were assessed on

TABLE 1. Demographic and Pretest Profiles of Participating Students by Group

	CACSR[a]		Comparison[b]		
Variable	***M***	***SD***	***M***	***SD***	***p***
Age (years)	13.23	0.77	13.34	0.94	.71
WRMT-R					
Word Identification	84.75	7.16	78.72	13.97	.13
Word Attack	91.63	5.82	88.00	11.14	.25
Passage Comprehension	83.88	5.63	85.17	16.32	.77
CSR-4					
Gist	2.68	0.56	2.72	0.68	.84
Question	2.04	0.56	2.53	0.68	.03
CSR-I					
Gist	2.65	0.66	2.48	0.49	.38
Question	2.41	0.76	2.61	0.87	.49
Gender	.17				
Boys	12		9		
Girls	4		9		
Ethnicity					.18c
African American	4		3		
Hispanic	7		5		
European American	5		10		
Grade[d]					
6	2		3		
7	7		9		
8	7		6		
SES					1.00
FM	8		9		
NFM	8		9		
Disability					1.00
LD	13		15		
Other	3		3		

Note. WRMT-R = *Woodcock Reading Mastery Test–Revised* (Woodcock, 1998); CSR-4 = *Collaborative Strategic Reading* measure, Fourth-Grade Reading Level; CSR-I = *Collaborative Strategic Reading* measure, Instructional Reading Level; SES = socioeconomic status; FM = eligible for free or reduced-price meal; NFM = not eligible for free or reduced-price meal; LD = learning disabilities. Other disabilities included other health impairments, speech impairments, and emotional disorders. [a]$n = 16$. [b]$n = 18$. [c]Due to the small sample, the statistical comparison was made between European Americans and all other ethnicities combined. [d]Due to the small number of sixth graders, statistical comparison was not possible.

reading comprehension as measured by the WRMT-R PC subtest and the CSR measures, and on decoding as measured by the WRMT-R WI and WA subtests. Based on their scores on these measures and on teacher recommendations, we then paired students in the CACSR group to work together on learning and using the CACSR program during the intervention period. The pairing procedure included (a) ranking the students according to reading ability; (b) splitting the list in half; (c) pairing the top-ranked student in the higher performing half (Partner 1) with the top-ranked student in the lower performing half Partner 2); and so forth.

Second, the participating teachers received a 2-hour training on CACSR implementation procedures. During this training, the teachers learned the four comprehension strategies of CSR, the partner reading strategy, how to use the CACSR program, and the daily lesson format.

Third, the trained teacher and research assistant implemented CACSR with students in the CACSR group twice a week for 10 to 12 weeks (i.e., 17–23 fifty-minute sessions). Students in the CACSR group received the same reading instruction as the comparison group during the other 3 days of the week. During the CACSR intervention, each student worked with a partner on the CACSR program to read (i.e., partner reading), discuss, and answer questions about each passage. Students in each pair were required to discuss their ideas with each other prior to answering any question on the CACSR program. Students alternated taking the lead in partner reading and controlling the keyboard and mouse from day to day. When a student's partner was absent during a session, the remaining partner worked independently on the CACSR program. After the intervention period, the students in both the CACSR and comparison groups were assessed individually on the same reading comprehension measures. Furthermore, students in the CACSR group were interviewed individually regarding their perceptions of the CACSR intervention.

Description of CACSR

The overall structure of CACSR is illustrated in Figure 1. The CACSR program consists of two parts: (a) Learning CSR, and (b) Using CSR to Learn. Students begin working on Learning CSR first and then move on to Using CSR to Learn. Learning CSR consists of (a) preview, (b) click and clunk,

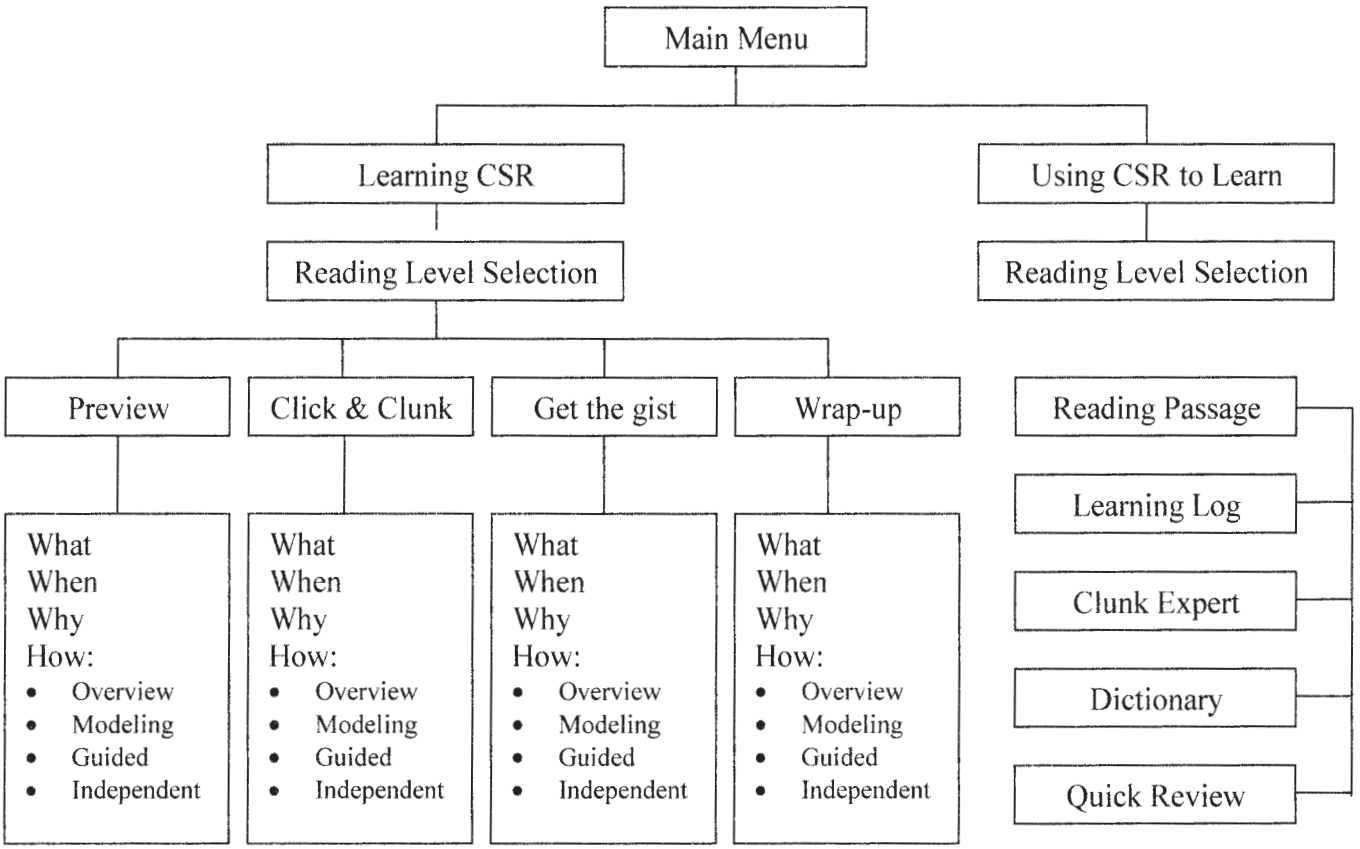

FIGURE 1. The structure of Computer-Assisted Collaborative Strategic Reading (CACSR). *Note*. Guided = guided practice; independent = independent practice.

(c) get the gist, and (d) wrap-up. Each section provides instruction on what each strategy is (i.e., preview, click and clunk, get the gist, and wrap-up); when each strategy is used; why it is important to use each strategy; and how each strategy is used. CACSR emphasizes teaching how each strategy is used. This section consists of (a) an overview, (b) modeling, (c) guided practice, and (d) independent practice.

Within Using CSR to Learn, CACSR provides ample opportunities for students to use CSR to learn the content of a reading selection. The students choose a reading passage appropriate for their reading level, and they are asked to fill out the learning log, in which they type what they learn by using the four strategies (i.e., preview, click and clunk, get the gist, and wrap-up). Once the students type in their gist, they can check their gist with the ideal gist that has been identified by the researcher and a reading expert (interrater reliability = 90%). The students can receive computer-driven supports from the clunk expert, dictionary, and quick review of CSR.

All reading passages in CACSR were taken from *Read Naturally* (Ihnot & Ihnot, 1997). *Read Naturally* passages are grade-level, expository text, consisting of several paragraphs (about three to four paragraphs; see Note 1). Topics of the passages include animals, historic figures, and mysterious events.

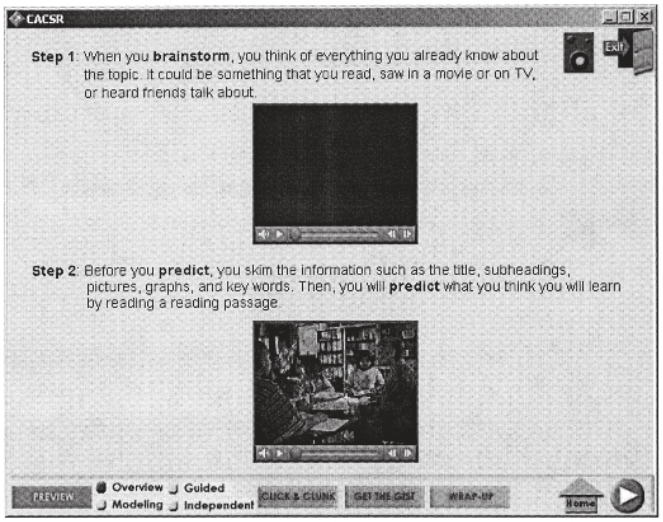

FIGURE 2. An example of the overview section.

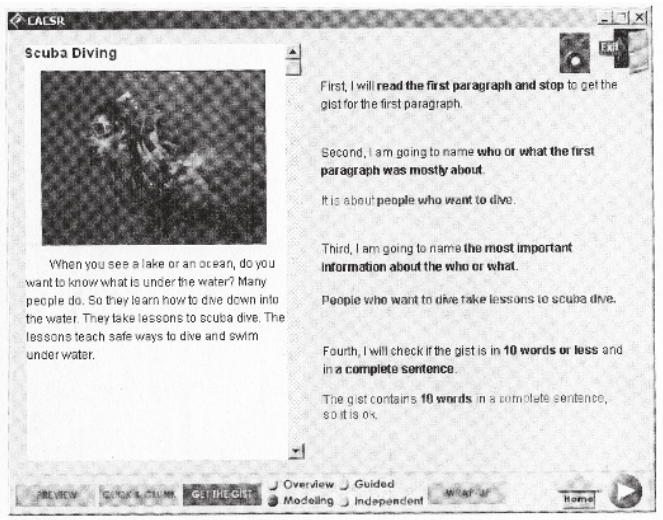

FIGURE 3. An example of the modeling section (Get the gist).

Implementation of CACSR

Implementation of CACSR was conducted in three phases: (a) overview of CACSR, (b) Learning CSR, and (c) Using CSR to Learn.

Overview of CACSR. During the first session, the participating students received an overview of CACSR. The overview session provided students with the purpose of the study, an overall description of the CACSR program (i.e., its focus and overall structure), specific steps on how to use the program, a demonstration of it, and practice using CACSR. During the student practice, the researcher guided students through each screen and required students to follow her step by step.

Learning CSR. During the next five sessions, students engaged in the Learning CSR section. In this phase, students learned the four strategies of CSR (preview, click and clunk, get the gist, and wrap-up). For each strategy, the CACSR program provided instructions on what each strategy was, when each strategy was used, why each strategy was important, and how to use each strategy. Within the instructions on how to use each strategy, the program provided overview, modeling, guided practice, and independent practice sections.

The get-the-gist strategy is used as an example to demonstrate how these four sections work to provide comprehension instruction. In the overview section, the CACSR program played the role of a teacher presenting specific steps for using each strategy. Students learned three steps for getting the gist: (a) Identify who or what the paragraph is about, (b) identify what the most important information is about the who or what, and (c) write the gist in 10 words or less in a complete sentence. Also, students watched video clips of a teacher using these three steps to get the gist (see Figure 2). The modeling section demonstrated step by step how to get the gist with a sample reading passage (see Figure 3). In the guided practice section, the CACSR program played the role of a teacher asking students to engage in activities followed by immediate feedback. Students engaged in a multiple choice, question-and-answer activity to review each of the three steps for getting the gist (see Figure 4). The CACSR program provided immediate feedback based on students' answers. During the independent practice, students com-

pleted activities without initial feedback from the CACSR program and later checked their answers. Students were required to follow the three steps to get the gist, followed by checking the correct answer (see Figure 5).

Using CSR to Learn. During the next 11 to 17 sessions, the students engaged in the Using CSR to Learn section, which required students to apply the four CSR strategies while reading passages (see Figure 6). Nine different reading levels, each including 19 reading passages, allowed each student to read at his or her instructional level (see Note 2). Other CACSR features included a built-in learning log, clunk expert, dictionary, and quick review. Students filled out the learning log with their answers as they read, while they received instructional support from the clunk expert, dictionary, and quick review. The clunk expert and dictionary provided guidance for figuring out how to sound out and define difficult words (i.e., *clunks*; approximately 1500 words) that students may encounter (see Figure 7). The quick review provided specific steps for using each CSR strategy.

CACSR also has a built-in function that records students' performance data. By looking at the performance data from each of these sessions, the trained teacher and research assistant found areas of the CACSR program in which students needed improvement. Then, at the beginning of each session, before the students began working with the CACSR program, the instructor would spend 5 to 10 minutes discussing how to improve their responses and reminding them about the procedures for using the CACSR program. For instance, the instructor would provide example gists that students had written during the last intervention session and lead a discussion with the whole class about how to improve on them. As another example, the instructor reminded students about the rules for working with their partners and discussing their answers before typing their responses into the CACSR program.

Comparison Condition

Students in the first teacher's class participated in a reading resource class, and students in the second teacher's class participated in a language arts class for students with reading difficulties. Both classes took place for 50 min every day. Students in both teachers' classes received similar reading instruction designed to improve fluency. During fluency instruction, the whole class received short passages to read, and they partnered with each other. One partner would read the passage while the other partner listened and helped them with vocabulary. The teacher timed each of these sessions, and at the end of 1 minute, the students would change roles, and the teacher would time the other student reading aloud. Both teachers provided vocabulary instruction, which involved the use of the dictionary to identify definitions of unknown words. In addition to fluency and vocabulary instruction, the first teacher provided comprehension instruction, which consisted of reading passages and answering questions. This (first) teacher, however, did not teach any comprehension strategies. The second teacher did not provide comprehension instruction.

Although teacher effects are always difficult to control, we believe that they were mitigated by the design of this study in the following ways: (a) Both teachers had students in both the CACSR and comparison conditions; (b) both teachers worked closely together to implement the same core program; and (c) observations conducted by the research assistant in both teachers' classrooms revealed that the teachers

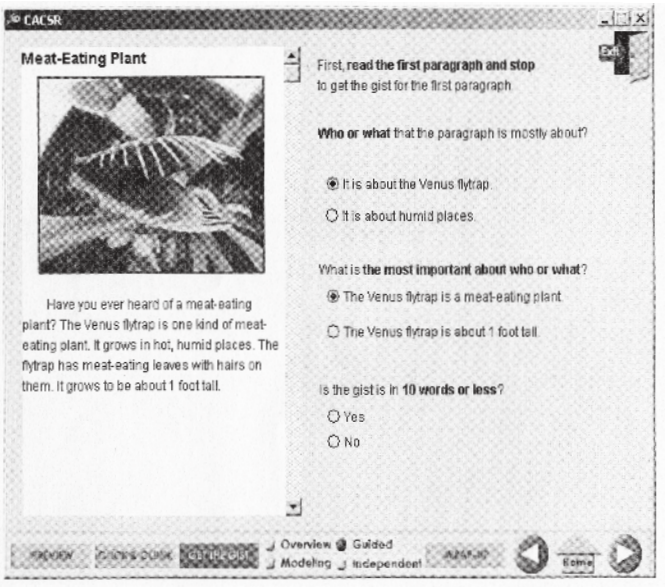

FIGURE 4. An example of the guided practice section (Get the gist).

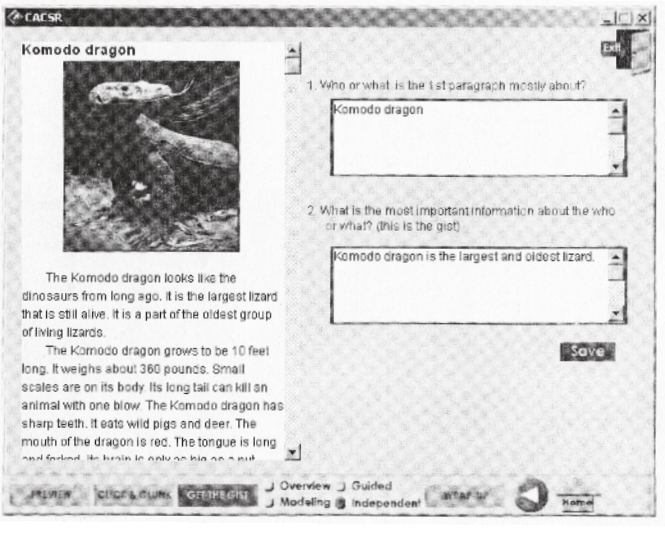

FIGURE 5. An example of the independent practice section (Get the gist).

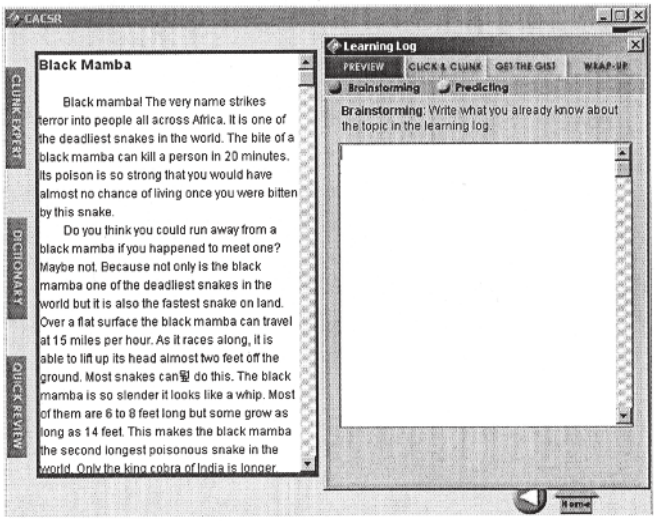

FIGURE 6. An example of Using CSR to Learn.

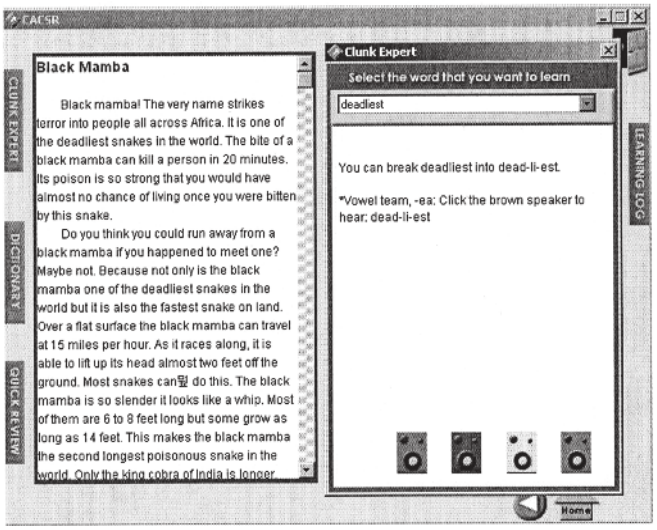

FIGURE 7. An example of the clunk expert.

provided very similar instruction and would be considered comparable teachers (see Note 3). Also, observations revealed that both teachers did not employ any CSR strategies in the comparison class.

Measures

Woodcock Reading Mastery Test–Revised. The *Woodcock Reading Mastery Test–Revised* (WRMT-R) is a battery of individually administered subtests that measure important aspects of reading ability (Woodcock, 1998). For this study's purpose, the WRMT-R Passage Comprehension (PC) subtest was used as the pretest and posttest measure of students' reading comprehension. A modified cloze procedure, the WRMT-R PC requires students to identify keywords missing from passages. In the data analysis, raw scores from each of the two alternate equivalent forms of the WRMT-R PC subtest were used—one as the pretest score and one as the posttest score. Each form of the PC subtest has internal consistency reliability coefficients ranging from .82 to .92 (*Mdn* = .92). The correlation between the *Woodcock-Johnson Psychoeducational Battery* Reading Tests/Total Reading and the WRMT-R PC ranges from .52 to .71. The researcher and trained research assistants individually administered the WRMT-R PC test to each student.

CSR Measure. To measure the specific skills that the CACSR program teaches, we developed a proximal measure focused on students' abilities in writing the main ideas of and asking questions about specific passages that they had read. Administered individually to each student by either the researcher or the trained research assistant, the CSR measure consisted of asking the student to read a short passage and then write the main idea of each paragraph (the Gist subtest) and write a question about each paragraph (the Question subtest). The researcher and trained research assistant asked students to do this for four passages—two passages written at their instructional reading level, which ranged from the midpoint of second grade to the sixth grade, and another two passages written at the fourth-grade reading level. Students' instructional levels were determined using both teacher recommendations and students' performance on two standardized tests (the WRMT-R WI and WA subtests). More than half of the students' scores on the WRMT-R WI and WA subtests ranged between third- and fifth-grade reading levels; thus, two passages at the fourth-grade reading level were used for one section of the CSR measure.

This assessment, like the WRMT-R PC subtest, was given at both pretest and posttest. We randomized the order in which these measures (i.e., the WRMT-R PC subtest and our CSR measure) were given, and we also randomized the order in which the passages were given to the students during the CSR measure. Different passages for the two different reading levels (i.e., instructional and fourth grade) were used at pretest and posttest.

To score the main ideas and questions written by the students, we developed two 5-point rubrics—one for the main ideas and one for the questions (see Appendix). We conducted both pilot testing and scoring of the measure before pretesting the participants. Modifications in the measure and the scoring rubric were made based on these initial tests and scoring processes during several meetings held by the researcher and the trained research assistant, both of whom would be scoring the CSR measure. During the scoring of the pretest and posttest measures, the researcher and the trained research assistant met several times to discuss the scoring process and discrepancies that arose. Twenty percent of the students' responses were scored independently by the two raters at pretest and posttest, with an interrater agreement of 86% and 87%, respectively. These percentages represent the number of items the raters agreed on, divided by the total number of items.

Interview Questionnaires. An interview questionnaire developed by Kim (2002) was used to examine students' perceptions about CACSR and their understanding of the CACSR strategies. Specifically, students were asked 10 open-ended questions about the CACSR intervention and the factors that may have influenced their views of it. Sample questions included, "What aspects of CACSR were helpful or not helpful?" and "Would you continue with the CACSR class? Why or why not?" Furthermore, the participating teachers were asked seven open-ended questions about their perceptions of the CACSR intervention. Teachers shared responses to such questions as, "In general, how did you like using the CACSR program in your class?" and "How helpful or not helpful was the CACSR program in your class?" A research assistant who was not affiliated with the participants in the CACSR group was assigned to interview each student in the CACSR group and the participating teachers.

Fidelity of Implementation Checklist. A 3-point Likert-type scale that addressed the fidelity of CACSR implementation was developed to evaluate the extent to which students participated in CACSR and the instructor implemented CACSR. The fidelity checklist had student items (e.g., "Student is involved in a brainstorming activity before reading," "Students write down gist in less than 10 words") and instructor items (e.g., "Instructor guides a brainstorming activity," "Instructor provides instruction based on students' recorded data"). For student items, a score of 1 for a particular activity meant that a student did not engage in the activity when he or she was supposed to; a score of 2 meant that a student engaged in the activity in a limited way (e.g., he or she used the strategy but not correctly or comprehensively; he or she was often off-task while using the strategy); and a score of 3 meant that a student engaged in the activity consistently and as it was supposed to be done. For instructor items, a score of 1 for a particular item meant that an instructor did not implement a specific strategy; a score of 2 meant that an instructor implemented the strategy but not consistently throughout the lesson; and a score of 3 meant that an instructor implemented the strategy appropriately.

The researcher and trained research assistant used the checklist to assess the fidelity of CACSR implementation for both students and the instructor within the classroom five to seven times during the intervention period. High levels of fidelity of implementation were demonstrated over time by both the students (Class 1: $M = 2.68$, $SD = 0.26$; Class 2: $M = 2.66$, $SD = 0.35$) and the instructor (Class 1: $M = 2.97$, $SD = 0.06$; Class 2: $M = 2.89$, $SD = 0.18$). The interrater agreements using 20% of the implementation checklists for the two classes were 88% and 81%, respectively.

Data Analysis

Quantitative Data Analysis. Due to the quasi-experimental nature of the study, pretest measures were used to adjust the posttest measures, and a series of univariate analyses of covariance (ANCOVAs) was performed to compare the experimental and comparison groups on the basis of adjusted outcome measures. The assumption of the homogeneity of regression slopes (i.e., no covariate by intervention interaction effect) was met in all analyses.

Standardized mean difference (SMD) effect sizes were used to examine the practical significance of the results. Specifically, for each measure, the difference between the adjusted posttest means for the experimental and comparison groups was divided by the pooled standard deviation to obtain the SMD (Howell, 1992, pp. 211–214), and values of .2, .5, and .8 were used to characterize the effect size as small, medium, or large, respectively (Cohen, 1988, pp. 25–27). The Statistical Package for Social Sciences (SPSS) was used for the purpose of data entry, manipulation, and analysis.

Interview Data Analysis. Student interviews were audiotaped, transcribed, and then analyzed using primary readings, open coding (i.e., theme identification), and axial coding (Strauss & Corbin, 1990). During primary readings, the researcher and the trained research assistant worked separately to read the entire set of interviews several times and make notes about repetitive ideas and other critical details. During open coding, the researcher and the trained research assistant independently identified salient themes in the data and categorized the data around those themes. During axial coding, the researcher and the trained research assistant independently refined and narrowed the themes by relating them to subcategories and recategorizing the data around these refined/narrow themes. After completing the aforementioned steps independently, the researcher and the trained research assistant met to negotiate categories (Vaughn, Schumm, & Sinagub, 1996).

Results

Quantitative Results

The observed and adjusted means, standard deviations, p values, and SMD effect sizes for all posttest measures are summarized in Table 2.

WRMT-R Passage Comprehension. An ANCOVA using the WRMT-R PC scores showed that the experimental (CACSR) group had outperformed the comparison group on the basis of the adjusted posttest Passage Comprehension scores, $F(1, 31) = 4.75$, $p < .05$. The assumption of the homogeneity of regression slopes was met, $F(1, 30) = 2.80$, $p = .10$. The SMD effect size was .50

CSR Fourth-Grade Reading Level. There were 7 Gist and 9 Question items on the CSR measure at both pretest and posttest. For each set of items, an average score was computed. For the Gist subtest, the difference between the experimental and comparison groups on the basis of the adjusted posttest measures was statistically significant, $F(1, 30) =$

TABLE 2. Means, Standard Deviations, and Effect Sizes for Posttest Measures

Measure	CACSR			Comparison				
	M_1	M_2	*SD*	M_1	M_2	*SD*	*p*	*ES*
WRMT-R Passage Comprehension	87.44	87.81	7.24	83.44	83.07	11.26	.037	.50
CSR 4th-Grade Reading Level								
Gist	2.86	2.86	0.43	2.42	2.42	0.49	.010	.95
Question	2.88	2.98	0.57	2.34	2.24	0.67	.002	1.18
CSR Instructional Reading Level								
Gist	2.88	2.85	0.50	2.38	2.40	0.64	.031	.77
Question	2.92	2.96	0.47	2.36	2.32	0.93	.012	.87

Note. M_1 = observed mean; M_2 = adjusted mean; WRMT-R = *Woodcock Reading Mastery Test–Revised* (Woodcock, 1998); CSR = *Collaborative Strategic Reading* measure; *ES* = standardized mean difference effect size (.2 = small; .5 = medium; .8 = large).

7.47, $p < .05$. The assumption of the homogeneity of regression slopes was met, $F(1, 29) = 2.06$, $p = .16$. The SMD effect size was .95. Furthermore, statistically significant group differences were demonstrated using the adjusted posttest measures for the Question subset, $F(1, 30) = 11.34$, $p < .01$. The assumption of the homogeneity of regression slopes was met, $F(1, 29) = .29$, $p = .60$. The SMD effect size was 1.18.

Instructional Reading Level. At pretest, there were 8 Gist and 10 Question items. At posttest, there were 10 Gist and 12 Question items. For each set of items, an average score was computed. An intervention effect based on the adjusted posttest Gist subset scores was statistically significant, $F(1, 31) = 5.13$, $p < .05$. The assumption of the homogeneity of regression slopes was met, $F(1, 30) = 1.02$, $p = .32$. The SMD effect size was .77. An ANCOVA using the adjusted posttest scores for the Question subset showed that the intervention effect was statistically significant, $F(1, 31) = 7.14$, $p < .05$. The assumption of the homogeneity of regression slopes was met, $F(1, 30) = 2.67$, $p = .11$. The SMD effect size was .87.

In summary, ANCOVA results showed that on the basis of adjusted posttest measures, the experimental group outperformed the comparison group on all measures and that these differences were statistically significant.

Qualitative Results

In addition to examining the effects of CACSR on reading comprehension as measured by quantitative dependent measures, this study examined the perceptions of participating students and teachers regarding the efficacy of CACSR. Analysis of students' and teachers' interview data revealed seven themes: (a) overall perceptions of the CACSR intervention; (b) helpful strategies and features of the CACSR intervention; (c) less helpful strategies and features of the CACSR intervention; (d) perceptions of reading improvement as a result of CACSR; (e) comparison of the CACSR intervention to other classes; and (f) desire to continue with the CACSR intervention and reasons to continue with it.

Overall Perceptions of the CACSR Intervention. A majority of students (12 out of 16) perceived the efficacy of the CACSR intervention in a positive way. The two participating teachers also reported positive perceptions of the CACSR program and concurred that the CACSR program was an effective instructional tool. Of the four students who did not report consistently positive responses, two students reported both positive and negative attitudes toward the CACSR intervention, and the other two students reported only negative perceptions of the intervention. Negative perceptions regarding the CACSR intervention across the four students revealed one consistent aspect: These four students described the CACSR intervention as "boring."

Helpful Strategies and Features of the CACSR Intervention. When asked about helpful aspects of the CACSR intervention, students identified a variety of strategies and features of the CACSR intervention. Among the helpful aspects mentioned, three strategies of CSR (i.e., click and clunk, get the gist, and wrap-up) and four features of the CACSR intervention (i.e., student control, reading passages, having fun, and paired learning) were more salient than others.

Less Helpful Strategies and Features of the CACSR Intervention. Those students who did mention negative aspects of the program most frequently described the CACSR intervention as boring—particularly the Learning CSR section of the program. Interesting enough, click and clunk, the strategy most frequently identified as helpful, was also most commonly identified as less helpful by four students.

Perceptions of Reading Improvement as a Result of the CACSR Intervention. All students except one felt that their reading had improved as a result of the CACSR intervention. When asked if anyone else had noticed improvement in their reading, seven students answered that either their teachers or their parents had commented on their progress. Both students and teachers discussed comprehension and vocabulary more frequently as areas of improvement than other areas.

Comparison of the CACSR Intervention to Other Classes. In comparison to other classes, students identified several unique attributes of the CACSR intervention, of which four were particularly salient: (a) focused instruction, (b) learning with a partner, (c) more opportunities to read, and (d) having fun while learning.

Desire and Reasons to Continue With the CACSR Intervention. A majority of students (n = 11) expressed their desire to continue with the CACSR intervention; three students answered "maybe" when asked if they would want to continue using the program, and another two did not want to continue with it. Only one reason for discontinuing the CACSR intervention was identified—that students were bored by the program. Both teachers discussed continuing to use the CACSR program as a part of their reading instruction.

Discussion

This study investigated the effects of CACSR on the comprehension of middle school students with disabilities and the perceptions of participating students and teachers regarding the efficacy of CACSR. A series of statistical tests revealed that students significantly improved their reading comprehension, as measured by both a researcher-developed, proximal measure (the CSR measure) and a distal, standardized measure (WRMT-R PC). Standardized mean difference (SMD) effect sizes also demonstrated positive outcomes that support the use of the CACSR intervention (SMD = .50–1.18).

In general, the findings of this study concur with those of previous CSR and reciprocal teaching studies on these instructional approaches having positive effects on comprehension for students with reading difficulties. Also, similar to the review of the research on reciprocal teaching (Rosenshine & Meister, 1994), higher effect sizes were obtained on researcher-developed measures (SMD = .77–1.18) than on standardized measures (SMD = .50). One possible explanation for this finding is that researcher-developed measures are more closely aligned with the content of the intervention than are standardized tests. It is important to note, however, that the CACSR intervention was still associated with a moderate effect size on the standardized measure (SMD = .50).

Compared to previous studies, one distinct finding was the positive effect of CACSR on the quality of student-generated questions. A review of the research on reciprocal teaching revealed that there was no difference between reciprocal teaching groups and control groups in the quality of student-generated questions (Rosenshine & Meister, 1994). Effect size findings in the present study, however, indicated that students improved most in generating questions about what they read (SMD = .87–1.18). Generating questions has been cited as one of the most effective comprehension strategies students can use (National Reading Panel, 2000). By generating questions, students become more aware of whether they have understood what they read, and the strategy provides them with a good opportunity to review and summarize what they have read. The significant effect that the CACSR intervention had on students' ability to use a question generation strategy suggests that the CACSR intervention was effective in teaching students how to use such a strategy and, thus, could lead to improvements in reading comprehension.

This study attempted to provide effective instruction in comprehension strategies through *technology*. Numerous researchers have reported that many teachers have found it challenging to teach reading comprehension strategies and that only some of the teachers in their studies were able to implement comprehension strategy instruction (Klingner et al., 2004; Pressley & El-Dinary, 1997; Scanlon, Deshler, & Schumaker, 1996; Vaughn, Hughes, Schumm, & Klingner, 1998). CSR research studies also revealed that although some teachers have caught on to the practice quickly, other teachers have found it challenging to learn and implement in their classrooms (Bryant et al., 2000, 2001; Klingner et al., 2004). Based on the positive results of this study, CACSR is a promising approach to teaching reading comprehension strategies for several reasons. First, the CACSR program itself provides explicit instruction consisting of modeling, guided practice, and independent practice in comprehension strategies, so that it can serve as a framework for teaching comprehension strategies. Second, the CACSR program provides instructional supports such as the clunk expert, which provides decoding strategies (i.e., syllable patterns) and vocabulary strategies (i.e., structural analysis). Third, CACSR's built-in recording function, which allows teachers to track student performance, facilitates teachers' understanding of students' progress, thus resulting in more targeted instruction to meet students' needs.

Another positive aspect of using CAI such as the CACSR program is the reduction in teachers' instructional demands related to large class size, which can lead to more time for teachers to interact instructionally with students (Carnine, 1989). However, it is important to note that the mere existence of supports in the CACSR program cannot resolve the challenges that teachers experience during comprehension instruction. Also, the CACSR program is meant not to supplant the teachers' reading instruction but to supplement it.

Teachers' structured efforts to integrate the CACSR program and the teaching of comprehension strategies into their own instruction are important.

Not only did the quantitative data analyses reveal positive effects for the CACSR intervention, but also an examination of both students' and teachers' interview data uncovered generally positive perceptions of the CACSR intervention. A majority of students expressed positive overall perspectives of the CACSR intervention, believed that their reading had improved (e.g., in comprehension and vocabulary), and expressed a desire to continue using the program. Both teachers stated that the CACSR intervention was effective; perceived that some students, if not all, had improved their comprehension and vocabulary; and expressed a desire to continue using CACSR in their classes.

Besides providing information about the participants' perceptions of the efficacy of the CACSR intervention, the qualitative analysis also yielded more specific findings and provided valuable suggestions for future CACSR interventions. One important finding derived from the interview data related to students' reflections on the Learning CSR section. Several students described this section as less helpful, somewhat boring, and slow. The design of the Learning CSR section was based on the assumption that students had not been exposed to the four comprehension strategies of CSR prior to the intervention, so that they needed to learn both the strategies themselves and the way to use them. Furthermore, the Learning CSR section was designed to be used by the teachers immediately, without requiring extensive professional development on their part. Thus, the Learning CSR section consisted of four subsections—an overview, modeling of the strategies, guided practice, and independent practice. Each subsection further consisted of multiple screens that introduced each comprehension strategy in a step-by-step manner. Also, this section provided repetitive practice activities in the guided practice and independent practice sections. The large number of screens and the amount of repetition used throughout the Learning CSR section may have caused students to view it as boring and slow. One possible improvement would be to incorporate more teacher-led direct instruction at the beginning of implementation. If the teacher provides direct instruction on the four comprehension strategies of CSR prior to starting the CACSR program, the Learning CSR section may be used to a lesser extent.

Not only did student feedback provide insights into possible revisions of the intervention, but also teacher feedback provided new perspectives on using the program. One teacher discussed her idea of incorporating the CACSR program with flexible grouping in her reading instruction. Because the CACSR program provides self-paced instruction in research-based comprehension strategies, a group of students with comprehension difficulties can use the CACSR program while a teacher provides small-group instruction for other students who demonstrate reading difficulties in other areas (e.g., decoding problems). In this way, the CACSR program can be easily integrated into the teacher's reading instruction.

Limitations

To build on previous work with the CACSR program, this study was designed to improve several methodological issues from the previous study by including a larger sample and a proximal comprehension measure (the CSR measure). With a more rigorous design, this study revealed more positive effects of the CACSR intervention than had been shown in the previous study. Although we attempted a more rigorous design, there were several methodological limitations to this study.

One limitation was the teachers' not taking primary responsibility for implementing the CACSR intervention. We planned for the collaborative implementation of CACSR—that is, the trained research assistant initially taking the lead in implementing CACSR, and the trained teacher gradually taking over primary responsibility for implementing it. This gradual transfer of responsibility from the trained assistant to the teachers, however, was challenging. As a result, the trained research assistant took primary responsibility for implementing CACSR, and the teachers played a less significant role in assisting the research assistant over the intervention period. One possible explanation for the limited teacher involvement was the low-intensity professional development prior to the intervention. In our recently completed feasibility study, we developed an instructional manual that contained specific guidelines for using the CACSR program, and examined the extent to which classroom teachers independently implemented CACSR with limited support from a research team. A 3-point Likert-type observation scale was used during this study to evaluate the accuracy with which participating teachers implemented the CACSR intervention as planned. The mean score for participating teachers was 2.43. Scores for each of the four teachers involved in the study fell in the narrow range of 2.35 to 2.57, indicating that the teachers showed similar, relatively moderate levels of implementation. This finding suggests that CAI such as the CACSR program could assist teachers in implementing systematic comprehension strategy instruction when adequate professional development with specific guidelines is provided.

Another limitation of this study was the possibility for experimenter bias. Pretest and posttest measures were administered and scored by the researcher and the trained research assistants. Although the importance of an unbiased administration and scoring of tests was emphasized during the training, it is possible that the data may have been unconsciously influenced by the expectations of the person collecting the data.

Although we attempted to mitigate the confounding effects of having two different reading classes (i.e., a language arts class and a resource reading class) as comparison condi-

tions, this condition remains a confounding variable of the intervention effect. Furthermore, the number of participating teachers and students was still limited. Thus, future studies with larger sample sizes that employ a homogeneous comparison condition are warranted to contribute to the validation of the CACSR intervention.

Implications for Future Research

Not only do the methodological limitations give cause for further investigation, but also an examination of participants' specific reading difficulties in relation to their improvements due to participating in the CACSR intervention is warranted. The ability to decode words rapidly and accurately is important for readers to focus on constructing meaning from text (Moats, 1998); therefore, reading comprehension difficulty often relates to deficits in decoding skills. Some students, however, have difficulty comprehending text even when they possess adequate decoding skills (Englert & Thomas, 1987; Klingner & Vaughn, 1996)—a pattern that is often observed in older students and adults with reading difficulties (Strucker, 1995). A previous review of reciprocal teaching attempted to analyze the effects of this approach by type of student—that is, (a) studies in which all the students were included; (b) studies in which students who showed good decoding but poor comprehension participated; and (c) studies in which students were classified as poor readers, but no attempt was made to determine their decoding ability (Rosenshine & Meister, 1994). There was no difference in the results between studies conducted with all students and studies conducted with students who had good decoding ability but poor comprehension. The results from these two groups of studies (i.e., those using all students and those using students with good decoding but poor comprehension), however, were quite different from those of studies conducted with poor readers. Furthermore, the results from the studies conducted with poor readers were inconsistent across studies. This finding suggests that differences in the type of student examined can lead to differential effects of comprehension instruction on performance. Due to the small sample size of this study (e.g., only two adequate decoders based on the WRMT-R WI), we could not conduct a secondary analysis on the effects of CACSR by type of student. Future research examining the effects of CACSR by type of student is warranted to ascertain which group of students can benefit the most.

Finally, this study had one independent variable with two levels—the CACSR condition and a comparison condition. As CACSR was developed to incorporate CSR strategies, an important empirical research question is how the effects of CACSR on the reading comprehension of students with LD compare with those of CSR. To better understand the contribution of technology to the improvement of reading comprehension, future research comparing the effects of the three conditions (i.e., CACSR, typical CSR, and a comparison condition) on the comprehension of students with LD is warranted. ■

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NOTES

1. *Read Naturally* used the following readability formulas to level reading passages: (a) Fry and Spache readability formulas for levels 0.8 through 2.7; (b) Harris-Jacobson readability formulas for levels 3.0 through 5.0; and (c) Dale Chall readability formulas for levels 5.6 and above. According to the *Read Naturally Teacher's Guide*, the reading levels of *Read Naturally* correspond to grade levels in that the readability score for each passage at each level falls within three tenths of the grade level named.
2. Students' instructional reading level was based on their decoding scores, as measured by the WRMT-R Word Identification or the WRMT-R Word Attack.
3. Each comparison class was observed four times over the intervention period. Observers documented multiple aspects of classroom reading instruction (e.g., components of reading instruction, materials, grouping patterns) in narrative format every 5 minutes over the total time of the observation.

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Received: 7/9/2004
Initial acceptance: 11/10/2004
Revision received: 6/14/2005
Final acceptance: 6/22/2005

APPENDIX
SCORING RUBRICS

Collaborative Strategic Reading (CSR) Measure: Get the Gist

1 point: Given for inaccurate information about "who or what the paragraph is about," and inaccurate, wrong, or unimportant information about "what the most important information is about the who or what."

2 points: Given for accurate information about "who or what the paragraph is about," but inaccurate, wrong, or unimportant information about "what the most important information is about the who or what."

3 points: Given for accurate and complete information about "who or what the paragraph is about," and accurate but incomplete information about "what the most important information is about the who or what." Also given for accurate but incomplete information about "who or what the paragraph is about," and accurate and complete information about "what the most important information is about the who or what."

4 points: Given for accurate and complete information about "what the most important information is about the who or what," with *more than 15 words* or in *multiple sentences*.

5 points: Given for accurate and complete information about "what the most important information is about the who or what" *with 15 words or less*.

Collaborative Strategic Reading (CSR) Measure: Generating Questions

1 point: Given for no question, a question that is irrelevant, or a question that is not important.

2 points: Given for a true/false, yes/no, or choice (A/B) question.

3 points: Given for a question for which the answer is right in the text.

4 point: Given for a question for which the answer is in the text, but the student has to read the text and compose the answer him- or herself based on what he or she has read.

5 points: Given for a question for which a student has to use his or her own previous experiences and integrate them with what he or she has learned from the text.