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An evaluation of two approaches for teaching reading comprehension strategies in the primary years using science information texts

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Abstract

There are few research studies on the effects of teaching comprehension strategies to young children in the primary grades. Using a Dominant–Less Dominant Mixed Model design employing both qualitative and quantitative data collection, we evaluated two approaches for teaching comprehension strategies to 7- and 8-year-old children in four second-grade classrooms using science information texts. The first approach focused upon explicitly teaching a series of single comprehension strategies, one-at-a-time (SSI). The second approach focused on teaching a "set" or "family" of transacted comprehension strategies within a collaborative, interactive and engaging routine (TSI). Results showed no difference between teaching young children a "set" of comprehension strategies and teaching comprehension strategies explicitly, one-at-a-time on their reading comprehension performance as measured by a standardized test of reading comprehension, recall of main ideas from reading two 200 word passages from information texts, a reading motivation survey and a strategy use survey. Results showed significant differences between students taught a set of comprehension strategies on measures of elaborated knowledge acquisition from reading science books (detail idea units recalled), retention of science content knowledge, and significantly improved criterion or curriculum-based reading comprehension test scores. These benefits favoring TSI over SSI are important because the learning curve is relatively steep for teachers to develop the ability to teach and for young children to develop the ability to coordinate a "set" of transacted comprehension strategies.

Keywords: Reading comprehension; Teaching; Comprehension strategies; Dominant–less dominant mixed model

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Reading comprehension is defined by Snow and Sweet (2003, p. 1) "as the process of simultaneously extracting and constructing meaning." Within this definition the dual challenges of "figuring out how print represents words" and "how to integrate new meanings with old information" are acknowledged. The act of comprehending entails three essential elements: (1) the reader, (2) the text, and (3) the activity. These three essential elements of reading comprehension occur within a socio-cultural context that both shapes and is shaped by the reader including such aspects as socio-economic strata, ethnicity, neighborhood, school culture, and instructional group.

The first essential element in the definition of reading comprehension is focused on the reader. In 1978–1979 Durkin made, what was then, a startling discovery that U.S. elementary school children were not receiving much instruction on how to comprehend text. Since then there have been many significant efforts to identify cognitive strategies that can be taught to children to increase their understanding and memory for text (Brown, Pressley, Van Meter, & Schuder, 1996). Not all elementary school students have benefited equally from these efforts. Recent observations have revealed limited opportunities for young children in grades K-3 to experience comprehension strategy instruction with only 16% of teachers emphasizing comprehension as a part of primary grade reading instruction (Sweet & Snow, 2002; Taylor, Pearson, Clark, & Wadpole, 1999). Neuman (2001) similarly observed that there is "little" comprehension instruction occurring in early childhood classrooms (K-3) across the nation. Pearson & Duke, in 2002 commented that the terms "comprehension instruction" and "primary grades" do not often appear in the same sentence. Many early childhood educators do not consider comprehension instruction to be an important part of primary grade education (Pearson & Duke, 2002). Consequently, the National Reading Panel (2000) in their extensive review of research on teaching reading comprehension found a paucity of research focused on comprehension instruction in the early grades (K-2).

The second essential element in the definition of reading comprehension focuses on the text (Snow & Sweet, 2003). In many early childhood classrooms, children receive a steady and nearly exclusive diet of narrative or story texts (Pressley, 2002a). In 2000, Duke examined access to information texts in first grade classrooms in low and high socio-economic status schools. She observed that first-grade children read and wrote information texts on average only 3.6 min per day and only 9.8% of books on average in first-grade classroom libraries were found to be information books. In a similar analysis of children's school reading textbooks, Moss and Newton (2002) found that only 16–20% of all selections were information texts. Palmer and Stewart (2003) recently lamented the lack of access to information texts at varying levels of reading difficulty in the primary grades. And if young children were able to access information books in primary classrooms, Palmer and Stewart (2003) found they were unable to self-select these books at appropriate levels of reading difficulty. Finally, these same researchers noted that many primary-grade teachers believed that information texts were too difficult for most young children to read.

The lack of attention paid to information texts in the primary grades is unfortunate. It is occurring at a time when reports indicate that 86% of the texts read by adults (Duke, 2000; Duke, Bennett-Armistead, & Roberts, 2002), and that 50–85% of test items used to test reading comprehension of children are informational (Calkins, Montgomery, & Santman, 1998). Duke (2000) explains that the acquisition of comprehension strategies is thought to be "genre specific." In other words, comprehension strategies are learned within the confines of a particular genre or text type. Thus young children require specific instruction with informational texts to assure transfer and generalization of comprehension skills and strategies.

Duke et al. (2002) describe two myths related to the scarcity of information texts in primary grade classrooms. One myth asserts that children may not prefer information texts over narrative texts. Mohr

(2003) reported that 84% of first-grade children in a predominantly Hispanic population indicated a marked preference for information books in English over other books containing varying text types, genres, ethnic representation of characters, and languages (English and Spanish), etc.

A second myth centers on a belief among primary grade teachers that information texts may be too difficult for children to read. Research by Kamil and Lane (1997a,b) showed that first-grade students who were taught to read with information texts made normal or above-average progress compared to those learning to read with narrative texts. Neuman (2001) asserted that early childhood (K-3) programs have traditionally emphasized learning processes to the exclusion of content. The National Reading Panel (2000) suggested that connecting the instruction of comprehension strategies to learning information in content areas may be an efficient approach. Without access to and increasing use of expository texts in the primary grades, it is highly unlikely that teachers' instructional focus will be altered in such a way as to balance the attention given to process/skill learning and content knowledge acquisition in the early years.

The third and final essential element in Snow and Sweet's (2003) definition of reading comprehension focuses on the activity. One of the chief activities for helping young children learn and use comprehension strategies is comprehension instruction itself. Any examination of comprehension instruction as activity reveals two distinct, yet interrelated aspects: (1) the content of comprehension instruction, and (2) the mode of comprehension instruction.

The content of comprehension instruction has evolved over the past several decades from the teaching of long lists of comprehension skills such as noting the sequence, following directions, and finding details to a more recent emphasis upon teaching a more limited number of cognitive strategies such as activating background knowledge, making visual images, monitoring, and summarizing (Pearson, 2002).

The National Reading Panel (2000) examined 16 categories of comprehension instruction including: comprehension monitoring, cooperative learning, curriculum, graphic organizers, listening actively, mental imagery, **mnemonics, multiple strategies, prior knowledge, psycholinguistics, question answering, question generation, story structure, summarization, teacher preparation, and vocabulary–comprehension relationship. Although all 16 categories of comprehension instruction had some empirical research to support each category's use in classrooms, 8 of the 16 examined did not have sufficient numbers of studies to facilitate a meta-analysis (National Reading Panel, 2000; Pressley, 2002b). Of these 16 categories, 8 appeared to have a firm scientific basis for effective use in classroom instruction: (1) comprehension monitoring, (2) cooperative learning, (3) graphic organizers, (4) question answering, (5) question generating, (6) story structure (7) summarization, and multiple-strategy teaching.

The mode of comprehension instruction too has evolved from the teaching of single cognitive comprehension strategies in isolation in the past to the more recent teaching of a multiple "set" or "family" of cognitive comprehension strategies in coordinated use. Early on, comprehension strategy research typically involved teaching a single comprehension strategy to one group of students and then comparing the performance of the instructed group to a control group of students largely left to their own devices to figure how to comprehend the text (Brown et al., 1996; Dole, Duffy, Roehler, & Pearson, 1991; Pressley, Johnson, Symons, McGoldrick, & Kurita, 1989). Evidence drawn from past comprehension strategy research strongly supported the explicit teaching of single comprehension strategies in isolation, one-at-a-time, to help children and adolescents improve their comprehension when compared to a control group.

In a popular book written for classroom teachers entitled, Mosaic of Thought: Teaching Comprehension in a Reader's Workshop, Keene and Zimmerman (1997) describe how classroom teachers can provide

comprehension strategy instruction in elementary classrooms based upon the findings of this earlier cognitive comprehension strategy research. They (1997) assert as cited in Pressley (2002, p. 13) that "the best way to teach comprehension strategies is one-at-a-time with a great deal of time devoted to each." Even the title of their book bespeaks the concept of teaching comprehension strategies in pieces, one-at-a-time coming together into a mosaic or total picture of comprehension. Pressley in his 2002 Turn-of-the-Century Status Report on comprehension strategy instruction takes strong issue with this claim asserting, "There is a need for a lot of research on the Keene and Zimmerman (1997) approach and its effects on student reading" (p. 18).

In contrast, the National Reading Panel (2000, p. 4–6) endorsed an alternative view to the "mosaic" of teaching single comprehension strategies. The members of this panel along with other researchers (Pearson & Duke, 2002; Pressley, 2002a; Snow & Sweet, 2003; Stahl, 2004) suggested instead teaching a "set" or "family" of comprehension strategies embedded within a highly interactive, collaborate setting such as is found in Reciprocal Teaching (Palincsar, 2003) or Transactional Strategies Instruction (Brown et al., 1996). Although past basic research in comprehension instruction has taken a more analytical view of the impact of teaching and learning individual comprehension strategies, in contrast more recent applied comprehension instruction research has examined multi-componential interventions, whole modes, approaches, programs, or packages, as the unit of analysis. Evaluation of an entire mode, approach, or package of comprehension instruction is defensible when the interest is focused on whether or not that whole mode, package, or approach works as well in comparison to other whole modes, packages, or approaches. We, like others, believe this is particularly true if the time spent in actual classroom instruction is controlled, e.g. daily allocated time for instruction and the amount of time allocated within the school year (Brown et al., 1996).

Endorsement of multiple cognitive comprehension strategy instruction by the National Reading Panel (2000) is not only grounded in solid research, but also seems reasonable since good readers do not use comprehension strategies one-at-a-time as they read. Rather, they orchestrate and coordinate a "set" or "family" of strategies to comprehend a text (Pressley, 2002a). Teaching young children a "set" or "family" of transacted strategies within a collaborative, interactive and engaging routine as suggested by The National Reading Panel (2000) and Pressley (2002a) not only helps young children learn cognitive comprehension strategies, but it also helps them learn, with the help of their teacher, how to coordinate the use of these strategies when interacting over texts.

In summary, the act of comprehending entails three essential elements: (1) the reader, (2) the text, and (3) the activity embedded within a socio-cultural context (Sweet & Snow, 2003; p. 1). With respect to the reader element, there has been little emphasis upon teaching cognitive comprehension strategies in elementary classrooms, but most especially in the primary grades (K-3). As such, there are few research studies on the effects of teaching comprehension strategies to young children in the primary grades (National Reading Panel, 2000; Pearson & Duke, 2002). It is clear that a greater instructional emphasis and more research focused on the effects of teaching cognitive comprehension strategies to young children in the primary grades (K-3) are warranted.

With reference to the text element of reading comprehension, research has clearly shown that young children are not getting much experience with reading and writing information texts (Duke, 2000). And since the learning of reading strategies, comprehension strategies included, are learned in genre specific text environments (Duke, 2000), research is needed on how to support young children's (K-3) comprehension of texts other than narrative—such as expository or information texts (El-Dinary, 2002; Pearson & Duke, 2002).

The final element of reading comprehension instruction, the activity, is clearly related to the content and mode of comprehension instruction. The content of comprehension instruction has shifted over time from the teaching of many comprehension skills to the teaching of several cognitive comprehension strategies. The mode of comprehension instruction as shifted over time as well. Early comprehension instructional research focused on effective comprehension strategy instruction employing explicit explanation, modeling, and scaffolding of a single comprehension strategy. Based on this research, Keene and Zimmerman proposed that teachers should teach a series of single comprehension strategies, one-at-a-time. On the other hand, the National Reading Panel (2000) and others advocate the teaching of a "set" or "family" of transacted comprehension strategies within a collaborative, interactive and engaging routine around a text. The question of which instructional mode, approach or package is most effective for providing comprehension strategy instruction, teaching a series of single comprehension strategies, one-at-a-time or teaching a "set" or "family" of transacted comprehension strategies within a collaborative, interactive and engaging routine remains unresolved and requires further investigation.

1. Research questions

Based upon a review of comprehension instructional research, we designed the current study to explore several unresolved issues. First we asked, is the teaching of a series of comprehension strategies, one-at-a-time with a great deal of time and attention devoted to each, hereafter referred to as Single Strategy Instruction (SSI), compared to the teaching of a "family" or "set" of comprehension strategies embedded in a collaborative, interactive and engaging routine, hereafter referred to as Transactional Strategies Instruction (TSI), more or less effective in helping young children acquire and use comprehension strategies as well as comprehend what they read? Next we asked, will teaching young children comprehension strategies using expository or information texts reveal comparable results to previous studies in which narrative texts have been the focus of instruction? And then we asked the question, how do these two types of comprehension strategy instruction (TSI and SSI) affect students' acquisition of content or domain knowledge from reading information texts? We also felt it was important to ask, will young children express more or less motivation to read as a result of teaching comprehension strategies using different approaches with information books? And finally we asked the question, what difficulties and benefits will teachers and children encounter with the implementation and use of these two types of comprehension strategy instruction?

The dominant focus of the current study was to explore the effects of teaching two practically and theoretically different comprehension strategy instructional modes, approaches, or classroom packages to young children in the primary years (K-3): (1) teaching a series of comprehension strategies explicitly, one-at-a-time as described by Keene and Zimmerman (1997) versus (2) teaching a set of multiple "transacted" comprehension strategies within an interactive routine as described by Pearson and Duke (2002) and Stahl (2004). Specifically we were interested in exploring the effects, using a variety of outcome measures, of teaching these two comprehension instructional approaches on second-grade children's reading comprehension performance, strategy use, content or domain knowledge acquisition, and motivation while reading information books. A less dominant feature of the current research was focused on coming to understand the relative advantages and disadvantages of implementing both types of comprehension strategy instruction as indicated by qualitative analyses of classroom observations and written comments recorded in teacher reflection journals.

2. Methods

2.1. Participants

The study involved 4 classrooms, 4 second-grade teachers, and 80 second-grade children. Teachers were randomly assigned to one of two instructional treatments: Single Strategy Instruction or Transactional Strategies Instruction. The second-grade children were also randomly assigned to one of the two instructional treatment groups. There were two Single Strategy Instruction classrooms ($n = 38$) and two Transactional Strategies Instruction classrooms ($n = 42$). Random assignment involved listing children's spring administered (end of first-grade) state criterion referenced end-of-level reading test scores and then dividing them into three achievement strata: high, medium, and low. Students were randomly assigned from within their achievement strata: high, medium, or low, into one of the two treatment groups using a table of random numbers. Using stratification for accomplishing random assignment is a more precise approach to distributing variability especially when the scores used, i.e., reading achievement, differentiate among the strata of students on a criterion that correlates with the construct under examination, i.e. reading comprehension (Lee, 1975; Shadish, Cook, & Campbell, 2002).

Random assignment of these second-grade students took place over the summer months prior to the beginning of the second grade year. Students who moved into the area during the summer months were not included in the data for this study because there was no previous year's criterion referenced reading test scores available for randomly assigning new student move-ins to one of the two treatment groups. It is important to note that random assignment of students to treatment groups occurs very rarely in field-based educational research.

The school in which the study was conducted is designated a high poverty, low performing, school with approximately 35% diversity (African-American, Asian, and Hispanic) with over half of the children in the school qualifying for free or reduced lunch. The school had also been a participant for the full 3 years of the *Reading Excellence Act* (REA) grant program which targeted reading professional development and instructional materials funding to grades K-3 in "high poverty, low performing" elementary schools.

The four, second-grade teachers in this study had been also part of the school's federally funded *Reading Excellence Act* (REA) sub-grant for the entire 3 years. During this period of time, these teachers received extensive professional development on teaching comprehension strategy instruction. During their first year in the REA grant, all teachers were taught Keene and Zimmerman's (1997) approach for single comprehension strategy instruction. They received classroom-based coaching on at least a weekly basis from a school-based "reading mentor or coach" and weekly follow-up study in grade level "study groups." During the second and third years of the REA project, teachers were given monthly professional development workshops and in-class comprehension instruction demonstrations by the district's REA technical assistant, a university professor in early literacy. Reading coaches conducted weekly study groups for one to two hours on single and multiple comprehension strategy research and instruction where teachers read and studied about comprehension instruction intensively. During the summer preceding the study, teachers were paid an additional stipend to read and discuss together their strategy instructional approaches as well as jointly plan their comprehension strategy lessons. Thus teachers selected for this study were well versed in explicit comprehension strategy instruction and were certainly more than novices at providing explicit comprehension strategy instruction.

2.2. Measures

A variety of measures were employed to assess a range of comprehension related constructs such as students' overall comprehension performance, perceived strategy use, science content knowledge acquisition, and motivation levels.

2.2.1. Normative measure of reading comprehension—Gates–MacGinitie reading test, Level 3, Form T, comprehension subtest

The comprehension subtest of the Gates–MacGinitie Reading Test, Level 3, Form T (MacGinitie, MacGinitie, Maria, & Dreyer, 2000) was used to collect normative data on reading comprehension performance in this study. It was group administered by the classroom teachers under the direct supervision of one member of the research team. This test is a widely disseminated and nationally published norm referenced reading achievement test. It is composed of three subtests: (1) decoding, (2) vocabulary, and (3) comprehension and has 39 total items. The 3rd edition reports a .90 KR-20 reliability coefficient and professional-judgment-based content validity.

2.2.2. Criterion-referenced measure of reading comprehension—comprehension items within the state end-of-level reading test, second grade

Reading comprehension related items within the State End-of-Level Test in Language Arts was used as a criterion referenced outcome measure of reading comprehension performance. The total scores for the State Core Assessment End-of-Level Tests in Language Arts reports internal consistency reliabilities that (KR-20) range from a low of .90 at grade 1 to a high of .94 at grade 3 (Nelson & Fox, 1999). The number of comprehension related subtest items was 37 items out of 72 total items.

2.2.3. Informal assessment of reading comprehension—oral retellings of familiar and unfamiliar information text passages

Student oral retellings of 200 word passages taken from one previously read (familiar) information book and from one novel or not-previously read (unfamiliar) information book was an informal measure of student comprehension. Passage retellings were scored using a template modeled after the Developmental Reading Assessment (Beaver, 1999) test that parses comprehension of text into two major categories: (1) superordinate or main idea units recalled (four total in the familiar text; three total in the unfamiliar text), and (2) subordinate or detail idea units recalled (16 total in the familiar text; 12 total in the unfamiliar text).

2.2.4. Student motivation assessment—primary grade reading motivation student survey

Developed by Linda Gambrell while serving as a Senior Researcher at the federally funded National Reading Research Center at the University of Maryland, the Primary Grade Reading Motivation Student Survey (Gambrell, 2003) contains 20 total items to which students respond using a three-point Likert scale with different positive, neutral, and negative descriptors for each question, excepting the last item which uses a six-point response. The Primary Grade Reading Motivation Student Survey was group administered by the classroom teachers under the direct supervision of one member of the research team.

2.2.5. Modified classroom strategy use survey

Based on the published work by Pereira-Laird and Deane (1997), we used the modified survey of reading strategy use to examine second-grade student's self reported use of the comprehension strategies taught. This a 15 item survey that makes use of a three-point Likert scale, always (3), sometimes (2),

and never (1). The items on this survey tap into student's perceived reading behaviors and use of comprehension strategies that include activating background knowledge, determining importance of ideas, monitoring comprehension, asking questions, visualizing, summarizing, etc. The Modified Survey of Reading Strategy Use survey was group administered by the classroom teachers under the direct supervision of one member of the research team.

2.2.6. Science content knowledge acquisition test

The Science Content Knowledge Acquisition Test was composed of 40 multiple choice items. This test was created and pilot-tested by a group consisting of teachers not involved in the research project along with the school reading coach, district language arts coordinator, and members of the research team. This group studied the science big books used to teach comprehension strategies in the four second-grade classrooms in this research project. From these books, specific science knowledge related multiple choice test items were created, field tested, revised and field tested again. The committee reviewed wording and tried the exam out on children to see it they could read the items. If not, items were revised so that second grade students could read the items. A Cronbach's α was calculated on the item responses of the student group and revealed a coefficient of .78. The Science Content Knowledge Acquisition test was administered by reading the test aloud to the group by the school literacy coach in each classroom under the direct supervision of one member of the research team.

2.2.7. Classroom observation forms (teachers and students)

Two different observation forms were needed for observing the contrasting models of comprehension strategy instruction in this study because of the very different content and features of the two comprehension strategy instructional modes. The SSI Classroom Observation form focused on the explicit instruction of an individual comprehension strategy taught for a 2.5-week period over the length of the study. In contrast, the TSI Classroom Observation form was developed to specifically examine each of the eight strategies within the set of multiple comprehension strategies taught, coordinated, and released over the length of the study.

The SSI Classroom Observation form was composed of six characteristics of effective explicit, single strategies comprehension instruction including: (1) explicit explanation of the strategy, (2) explaining when the strategy is useful, (3) modeling or demonstrating the strategy using "think alouds," (4) gradually releasing responsibility for using the strategy over time, (5) group practice of the strategy, (6) prompting and reminding children to use the strategy in independent and other reading settings during the day. Each of the above six items was rated on a five-point Likert scale with three descriptor points under points 1, 3, 5. The item descriptors were: deficient, basic, and exemplary. Under each of the six items rated, an area for comments/descriptions was provided.

The TSI Classroom Observation form was quite different from the one used to observe the SSI Classrooms. The TSI Classroom Observation form was composed of nine total items. The first eight items focused upon observing the explicit instruction, coordination of, and gradual release of the eight individual comprehension strategies contained within the set of multiple strategies in the Transactional Strategies Instruction. Each of the above eight items and the final ninth item was rated on a five point Likert scale with three descriptor points under points 1, 3 and 5. The item descriptors were: deficient, basic, and exemplary. Under each of the nine items rated, an area for comments/descriptions was provided. As teachers and students interacted over texts in each lesson, the expectation was that the instruction and coordination of each and all of the eight strategies within the set was observed, rated, described or commented upon.

The ninth item on the TSI Classroom Observation form probed evidence of prompting and reminders to students to use the strategy set in independent and other reading settings during the day.

2.2.8. Teacher response journals

Individual copies of a Teacher Response Journal (TRJ) were created for each of the four, second-grade teachers. Each TRJ had a cover and was bound into a three-hole punched three ring binder. The body of the TRJ was divided into two major sections. The first section of the TR journal contained weekly (16) response pages that required answers to three written questions with space for each response along with an open response area. In the second section of the TR journal, there was a summary response for sharing overall impressions and teacher conclusions. Within this section there were several pages allotted for teachers to respond to four different questions along with an open response category. Each journal was about 36 pages in length when allowing for two pages of response each week and four in conclusion.

2.3. Big book science information texts

The four, second-grade teachers in this study had previously identified the big books and the order of the presentation of big books to be used to support each unit of science content instruction prior to the onset of the study. All of the science information "big books" used in the shared reading comprehension strategy lessons were selected to address the science concepts and standards outlined in the state's second grade science core curriculum. The science information big books used for shared reading comprehension strategy instruction in the study were drawn predominantly from two publishers, Newbridge, Inc., and Wright Group.

The units of science instruction during this period of the school year included: (1) ocean life cycles, (2) pond life cycles, (3) African animals, (4) rock creation and erosion, (5) insect and plant life cycles, and (6) bird life cycles. Each second-grade teacher used the identical science information big books in the same order and during the same weeks as the other teachers to control for potential time and order of presentation effects. Each of the four second-grade teachers were also provided access to other "six packs" or small copies of science information books on these topics for placement into the four classrooms' libraries for student selected, independent reading.

2.4. Design

This research study used a Dominant–Less Dominant Mixed Model design employing both qualitative and quantitative data collection (Tashakkori & Teddlie, 1998). Within the Dominant structure of the mixed-model design, a Post-Test Only True Experimental design (Campbell & Stanley, 1963) was used. Within the Less Dominant structure of the mixed-model design, observations and teacher journals/discussions were analyzed to describe teaching, learning, and classroom management practices in each experimental condition. All four second-grade classrooms were located within a single school, thus eliminating potential school effects that could have confounded interpretations of the findings.

2.5. Instructional treatments: similarities

There were obvious similarities between the two instructional treatments, Single Strategy Instruction (SSI) and Transactional Strategy Instruction (TSI). Teachers in both the SSI and TSI instructional treat-

ments taught cognitive comprehension strategies explicitly. Explicit teaching of cognitive comprehension strategies was characterized by explanations of what strategy was to be learned, why it was important to learn, and where and when it was to be used. Scaffolding the gradual release of cognitive comprehension strategies from teachers to students involved three steps. First, teachers modeled through the use of "think alouds" how to use cognitive comprehension strategies when reading a text. This step allowed children to hear and see how one goes about applying a cognitive comprehension strategy while reading a text. Second, the teachers in both SSI and TSI groups shared the application of the cognitive comprehension strategy previously modeled through interactions around a text. During this step the teachers were highly engaged in showing how to use the strategy in text with the children taking responsibility where they could. Teachers also created charts, posters, and graphic organizers representing the processes and procedures used to apply the strategy during reading. Third, the teachers in both SSI and TSI groups gradually released the responsibility for applying cognitive comprehension strategies independently to the children. Teachers continued to monitor and periodically reviewed children's application of these strategies during small group guided and independent reading.

Children in both the SSI and TSI instructional treatments engaged in verbal interactions among one another using a variety of cooperative or collaborative learning activities such as think-pair-share, turn to your neighbor, numbered heads together, or jigsaw groups to complete group activities. Children in both the SSI and TSI instructional treatments took increasing responsibility over time for using cognitive comprehension strategies to understand text.

2.6. Instructional treatments: differences

The chief differentiating characteristic between these two instructional approaches for teaching cognitive comprehension strategies, SSI and TSI, to young children was a focus on how cognitive comprehension strategies were taught and gradually released to children for their use in comprehending text. In the SSI approach learners cumulatively added each strategy taught in isolation. Then each learner was left to figure out how to coordinate and use the individual strategies taught in isolation to understand text. Whereas in the TSI approach learners were initially taught each individual cognitive comprehension strategy in the set and then quickly helped to coordinate the use of this set of strategies while interacting over multiple texts over time. Table 1 highlights similarities and differences between the modes of single and multiple cognitive comprehension strategy instruction.

In the subsections that follow, we describe the instruction in the SSI and TSI treatment groups with an emphasis on how the modes of instruction differed between single and multiple strategies cognitive comprehension instruction.

2.6.1. The single strategy instruction condition

The Single Strategy Instruction (SSI) comparison group was composed of two classrooms of randomly assigned second-grade students and two randomly assigned classroom teachers who read science information books together using a shared reading approach during comprehension strategy instruction (Reutzel, Hollingsworth, & Eldredge, 1994). Students in this group were above average, average, and below-average readers as measured by the spring administered, State End-of-Level First Grade criterion referenced reading test.

The two teachers in the SSI comparison group had worked collaboratively to create the lesson plans for teaching each comprehension strategy, one-at-a-time, using science information big books. During

Table 1
Theoretical and practical analysis of the modes of single and multiple cognitive comprehension strategy instruction[a]

Mode characteristics	Single strategy	Multiple strategy
Purpose	Learn to apply a strategy	Learn to coordinate a set of strategies
Learning theory support	Molecular, isolated	Holistic, integrated
Strategy application	Isolated within a single or a few texts	Coordinated across many texts
Focus of instruction	Focused on teaching individual, single comprehension cognitive strategies. Learners are thought to add each strategy taught to a cumulative set that the learner must figure out how to coordinate and use as a set to understand text.	Focused on teaching a set of several comprehension strategies. Learners are taught each individual cognitive comprehension strategy in the set and helped to coordinate the use of this set of strategies while interacting over multiple texts over time.
Role of the information text	A vehicle for strategy application and knowledge acquisition	A vehicle for strategy application and knowledge acquisition
Manner of gradual release of strategies from teacher to students	Release one strategy at a time within several weeks	Release a set of strategies over months and years of time
Explicit instruction	Explicit instruction using teacher explanation of what, why, when, and where; modeling of how, and gradual release from teacher modeling to student use	Explicit instruction using teacher explanation of what, why, when, and where; modeling of how, and gradual release from teacher modeling to student use.
Classroom social learning context	Makes use of collaborative and cooperative learning strategies, activities, etc.	Makes use of collaborative and cooperative learning strategies, activities, etc.
Learner engagement	High teacher/low student → shared teacher and student → high student/low teacher	High teacher/low student → shared teacher and student → high student/low teacher
Scope and sequence	List of effective strategies taught one-at-a-time, no defined sequence, but reviewed periodically over time. Six single strategies taught: (1) activating background knowledge to make connections, (2) predicting, (3) visualizing, (4) monitoring, (5) questioning, and (6) summarizing.	Select a set of strategies to be taught individually and used as a coordinated set while interacting over time with many texts. Strategy set taught: (1) activating background knowledge, (2) text structure, (3) prediction, (4) asking questions, (5) goal setting, (6) imagery, (7) monitoring, and (8) summarizing.

[a] Shaded represents contrasts. Un-shaded represents similarities.

the semester-long study, SSI teachers taught six individual comprehension strategies: (1) activating background knowledge to make connections, (2) predicting, (3) visualizing, (4) monitoring, (5) questioning, and (6) summarizing (see Table 1—scope and sequence). The six individual cognitive comprehension strategies selected for instruction were chosen to assure that within the series of strategies taught there were those that could be used before, during and after reading of a text and based upon the recommendations for single strategy instruction found in the work of Keene and Zimmerman (1997). Typically, the SSI instructional treatment group lessons took about 35–40 min per day, 3 days per week.

The SSI teachers spent 2.5 weeks (13 days) to teach a single cognitive comprehension strategy using three science information big books. Within each 13-day instructional cycle, the SSI teachers spent 5 days modeling a single cognitive comprehension strategy using the first of three science information big books. The next 5–6 days, SSI teachers gradually released the responsibility for using the single cognitive comprehension strategy through interactive discussions during readings of the second and third science

information big books. For the final 2–3 days of the 13-day instructional cycle, the SSI teachers engaged students in small group and independent applications of the single cognitive comprehension strategy during re-readings of the second and third science information big books.

SSI teachers referred to previously taught strategies during subsequent lessons but did not engage in formal review sessions of each strategy taught in combination with new strategies taught. SSI teachers also did not attempt to show students how to coordinate the use of previously taught strategies during the study. The SSI teachers typically completed the reading of a single science information big book each week for approximately 80–120 total minutes of instructional time focused on the application of a single cognitive comprehension strategy.

2.6.2. The multiple strategies instruction condition-transactional strategies instruction

The Transactional Strategy Instruction (TSI) comparison group also was composed of two randomly assigned classrooms of second-grade students and two randomly assigned classroom teachers who read the identical set of science information books as in the SSI comparison group together using a shared reading approach during comprehension strategy instruction (Reutzel et al., 1994). Students in this group were also a mixture of above average, average, and below-average readers as measured by the spring administered, State End-of-Level First Grade criterion referenced reading test.

The two teachers in the TSI comparison group had worked collaboratively to create the lesson plans for teaching a set of comprehension strategies using science information big books. Typically, the TSI comparison group lessons also took about 35–40 min per day, 3 days per week. During the semester long study, TSI teachers taught a "set" or "family" of eight comprehension strategies: (1) activating background knowledge, (2) text structure, (3) prediction, (4) goal setting, (5) asking questions, (6) imagery, (7) monitoring, and (8) summarizing (see Table 1—scope and sequence). The eight cognitive comprehension strategies selected for the set were based on the basic components of TSI described in the work of Pearson and Duke (2002, p. 254).

Unlike the SSI teachers' 13-day instructional cycle for teaching a single cognitive comprehension strategy, the TSI teachers spent the first month of the study explicitly teaching each of the eight cognitive comprehension strategies in the set. This was followed by gradually releasing the responsibility for using the set of eight comprehension strategies over the remaining 2–3 months of the semester-long study.

The TSI teachers began their first month of lessons by explicitly defining, explaining and modeling the use of each of the eight cognitive comprehension strategies in the set to be learned. For example on the first day of instruction, the TSI teachers prepared students to read a new science information big book by spending roughly 10–15 min of instructional time per strategy (35–40 min total on that day) on the first three strategies in the set of eight: (1) activating prior knowledge, (2) text structure, and (3) prediction. On the second day of instruction, the TSI teachers began the shared reading of the science information big book spending roughly 5–15 min of instructional time per strategy (35–40 min total on that day) on the fourth through seventh strategies in the set: (4) goal setting, (5) asking questions, (6) imagery, (7) monitoring. On the third day to finish the shared reading of the science information big book, the TSI teachers again spent roughly 5–15 min of instructional time per strategy on the fifth through seventh strategies in the set: (5) asking questions, (6) imagery, and (7) monitoring, with most of the time (15 min) spent explaining and modeling the eighth strategy in the set, summarization (35–40 min total on that day). This TSI required 80–120 total minutes of instruction during 3 days over a week to teach the set of eight strategies using a single science information big book.

This initial week's explicit instruction cycle was repeated with three additional big books to complete the month's time devoted to explicitly teaching of each of the eight cognitive comprehension strategies in the set. We implemented Pressley's (2002a, p. 19) recommendations for TSI as set forth in the following statement "strategies were taught individually to acquaint students with the strategic process, typically such instruction yielded rather quickly to an emphasis on the repertoire of strategies and on learning to choose which strategy would be useful in a particular reading situation."

During the second and third months of the study, the TSI teachers gradually released the responsibility for using the set of eight strategies. This was accomplished by sharing with children the responsibility for selecting, explaining and applying all of the eight strategies when interacting over the remaining science information big books. Thus the TSI teachers' instruction of the set of eight strategies began to look more like natural interaction around the science information big books with the teachers and children "thinking aloud" as they discussed with each other how to apply all eight strategies in the set at various points in the text.

During the final few weeks of the study, TSI teachers engaged the students in assuming near total responsibility for selecting, explaining, and using all of the strategies in the set while reading and discussing the last four science information big books.

Throughout the reading of the big books in the TSI group, the teachers were constantly referencing all of the strategies in the strategy set. As such, over time, there was a gradual release of responsibility from the teacher in the first month of instruction to a sharing of responsibility between teachers and students during the second and third months of instruction. Students assumed near full responsibility for selecting and applying the entire strategy set in the final weeks of instruction while reading and interacting over science information big books.

Fig. 1 represents the shifts in the TSI instructional process that occurred over the duration of this study. This figure depicts the set of strategies taught, the initial phase of explicit explanation of

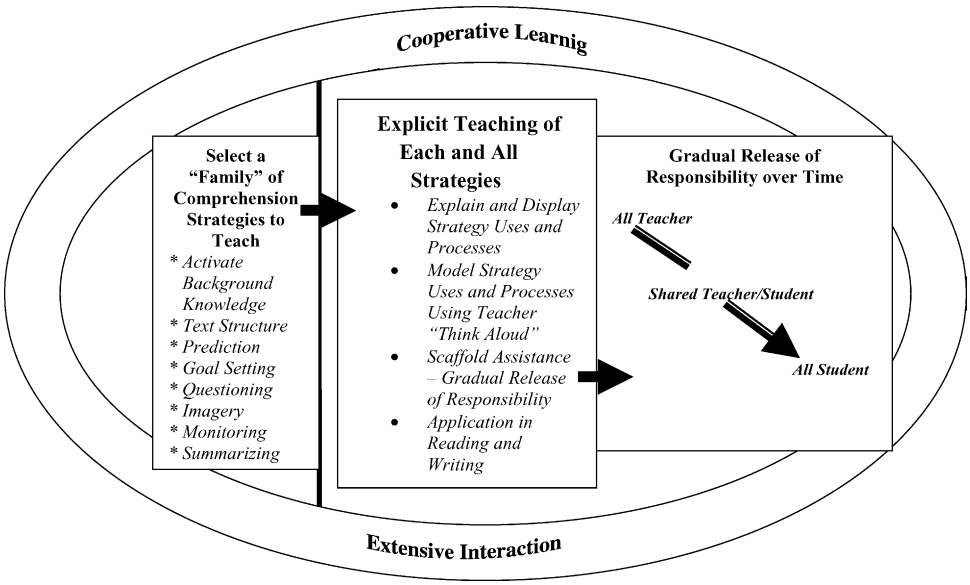

Fig. 1. Transactional strategy instruction (TSI) for teaching reading comprehension strategies.

each strategy in the set or family of strategies, and then the moving quickly to an emphasis upon using the entire set of strategies while interacting around shared readings of science information big books.

2.7. Procedure

Random assignment of the second-grade students took place over the summer months as described previously. To assess the effectiveness of the stratified random assignment procedures prior to the onset of the study, an ANOVA comparison of students' CRT (State Core Assessment End-of-Level Tests in Language Arts) scores confirmed no significant initial differences between the two randomly assigned comparison groups or the four second-grade classrooms, treatment groups: $F(1, 76) = .36$, $p = .55$; four second grade classrooms: $F(3, 76) = 1.29$, $p = .28$. A second ANOVA analyses revealed significant differences among the three levels of randomly assigned strata of reading achievement across the two treatment groups thus also confirming the effectiveness of the random assignment procedures made from the three strata of achievement, $F(2, 76) = 31.2$, $p = .000$ on the state CRT. The State Core Assessment End-of-Level Tests in Language Arts report internal consistency reliabilities that (KR-20) range from a low of .90 at grade 1 to a high of .94 at grade 3 (Nelson & Fox, 1999).

During the school year in which this study was conducted, eight of the original randomly assigned students ($n = 88$) moved from the school either during the summer after random assignment or during the study leaving a group of 80 total students for the final data collection and analysis. Attrition in the two treatment groups was slightly different with a loss of four more students in the Single Strategies Instruction ($n = 38$) group as compared with the Transactional Strategies Instruction ($n = 42$) group.

Prior to the beginning of the study, the four, second grade teachers in the study were randomly assigned to one of the two treatment conditions—single versus multiple strategy comprehension instruction. A previous year's classroom observation of teaching effectiveness by the school principal was used to partially account for potential teacher effects in this study. An analysis of these four teachers' instructional effectiveness ratings by the school principal on the district observation instrument showed no statistically significant differences using a χ^2 analysis: (4-1) (5-1) = 12 d.f., $\chi^2 = 2.13$, $p > .05$, among the four teachers' teaching effectiveness as perceived by the school principal's observation along five categorical dimensions of teaching effectiveness: management, presentation, preparation, professionalism, and assessment.

Teachers in both comparison groups were observed weekly by one member of the research team and monthly by three members of the research team. Teachers also kept reflection and planning journals, written lesson plans, as well as meeting at least monthly to debrief and reflect with a member of the research team as well as attending a weekly study group to prepare comprehension lessons with the assistance of the school-based reading coach.

The study was conducted for 16 weeks or one-half of the school year. At the conclusion of the study, student outcomes were measured using a variety of instruments and approaches for tapping motivation, strategy use, science content knowledge acquisition, and comprehension performance. The near transfer measure of the effectiveness of comprehension strategy instruction involved reading a 200 word passage from a previously taught information book and giving an oral retelling scored for main and detail idea units. The far transfer measure of the effectiveness of comprehension strategy instruction involved reading

a 200 word passage from an information book not previously taught or read and giving an oral retelling scored for main and detail idea units.

2.8. Data sources and analysis

Data were analyzed according to a sequential quantitative–qualitative process (Tashakkori & Teddlie, 1998, p. 127). The dominant quantitative data were analyzed by contrasting the SSI with TSI instructional conditions using separate univariate analyses of variance on the post-intervention measures of student comprehension performance, motivation, perceived strategy use, and science content knowledge acquisition. This approach to data analysis allows the inspection of differential treatment affects by each dependent variable (Lomax, 2004).

The student or the classroom was used as the unit of analysis in this report. The classroom was used as the unit of analysis when a classroom within treatment effect was statistically significant, and the student was used as the unit of analysis when the classroom within treatment effect was not statistically significant (Wain & Robinson, 2003). This involved a two-step data analysis process in which we first determined whether there was a classroom within treatment effect. When there was a classroom effect, the mean square for students nested within classrooms and treatments should not be used as the denominator for computing the F ratio to test the treatment effect, because the expected mean square for students does not include the variation associated with classrooms. Thus, using the student as the unit of analysis when there is a significant classroom within treatment effect might result in having too small a denominator, and a spurious treatment effect might be identified. We used Statistical Package for the Social Sciences, 2002 (SPSS) 11.0–11.5 for Windows within the general linear model (GLM) for the analysis of our nested design where classroom was nested within treatment to control for the effect of classrooms on treatment. Effect sizes were reported using partial Eta squared (η^2) statistics. We used Cohen's (1988) suggested guidelines for interpreting the magnitude of effect sizes ("small" = .01, "medium" = .06, "large" = .15). This approach is consistent with effect size measures suggested by Glass, McGraw, and Smith (1981). As a follow up to the univariate analyses, a descriptive discriminant function analysis was used to determine the relative contribution of the different variables in discriminating the outcomes of the two comparison groups and to identify which of the nine variables, if any, were redundant and therefore unnecessary in discriminating the two groups' performance.

Qualitative data were collected over a period of 16 weeks. Once weekly classroom visits by either a research team member or the school reading coach provided observational data to assess the degree to which the two treatments, SSI and TSI, were implemented with fidelity in the four classrooms. Each classroom observation lasted the full length of the comprehension strategy lesson, typically 35–40 min. Researchers and the school reading coach recorded field notes and ratings using observation forms created for each of the two comprehension strategy instruction conditions. On two occasions a panel of three observers went into classrooms to assess the inter-rater reliability among the observers. The reliability calculations for these observations ranged from 89 to 96% agreement. Teacher reflection journals were collected weekly to gain insights into the teacher's perceived struggles and triumphs in teaching comprehension strategies. Classroom observations were also periodically video taped to provide researchers with intact records of actual lessons and the accompanying dialogue between teachers and children. These data were used along with written observations to construct the classroom instructional and procedural descriptions in this report and to provide frequent checks for fidelity of treatment implementation.

Table 2
Descriptive statistics for post-tests by classroom and treatment

Post-tests		SSI classrooms			TSI classrooms		
		Class 1	Class 2	Treatment group	Class 1	Class 2	Treatment group
Comprehension	*M*	30.00	32.00	30.90	32.00	34.4	32.00
Subtest—Gates–MacGinitie, Form T	S.D.	5.65	5.29	5.49	6.04	2.91	5.31
End-of-level							
Criterion referenced	*M*	31.47	32.53	31.93	31.74	35.16	34.11
Comprehension test items	S.D.	4.35	4.22	4.25	2.99	1.95	2.72
Familiar retell							
Superordinate	*M*	2.29	2.54	2.40	2.05	2.54	2.50
Idea units	S.D.	1.05	0.88	0.97	0.94	0.88	0.98
Familiar retell							
Subordinate	*M*	5.41	6.46	5.87	8.80	10.89	9.79
Idea units	S.D.	2.50	2.76	2.62	2.44	3.18	2.97
Unfamiliar retell							
Superordinate	*M*	0.94	1.15	1.03	1.15	1.83	1.47
Idea units	S.D.	0.66	0.90	0.76	1.03	0.99	1.06
Unfamiliar retell							
Subordinate	*M*	5.24	4.85	5.07	5.35	7.06	6.16
Idea units	S.D.	1.79	2.12	1.91	2.89	2.12	2.59
Primary student							
Motivation	*M*	30.59	29.31	30.03	32.05	28.50	30.37
Survey	S.D.	4.33	6.38	5.26	7.56	3.70	6.23
Modified classroom	*M*	32.83	34.08	33.37	32.70	34.72	33.67
Strategy use survey	S.D.	4.39	5.95	5.07	5.71	2.85	4.64
Science content							
Knowledge	*M*	21.00	24.85	22.67	32.05	32.89	32.45
Acquisition test	S.D.	4.99	3.72	4.82	5.11	4.83	4.92

M: mean, S.D.: standard deviation.

3. Results

Table 2 displays means and standard deviations for the four second-grade classrooms and the two comparison/treatment groups on comprehension, motivation, strategy use, and science content knowledge post-intervention scores.

The first set of univariate analyses addressed whether the SSI or TSI comprehension strategy instructional treatment was more effective using a normative and criterion referenced measure of reading comprehension performance.

3.1. Comprehension performance

For the comprehension subtest of the Gate–MacGinitie Reading Test, Level 3, Form T, there was a statistically significant effect for classroom, $F(2, 76) = 5.0$, $p = .01$. Therefore to test the difference between the SSI and TSI interventions, we used the classroom as the unit of analysis. There was no significant difference between the SSI and TSI groups, $F(1, 2) = .054$, $p = .85$.

For the State End-of-Level criterion referenced comprehension related test items, the classroom effect was not statistically significant, $F(2, 76) = .52$, $p = .60$. Therefore, we used the student as the unit of analysis to examine the difference between the SSI and TSI comprehension strategy groups' performance on the State End-of-Level test items. The results indicated a statistically significant difference, $F(1, 76) = 3.94$, $p = .05$, and a small to moderate effect size, $\eta^2 = .05$, with students in the TSI group scoring an average of 2.2 (total score possible = 37) points higher than students in the SSI group. Estimates of magnitude of effect sizes were interpreted using Cohen's (1988) guidelines ("small" = .01, "medium" = .06, and "large" = .15).

3.2. Science information book comprehension performance

On the oral retelling measure of super-ordinate idea units (big ideas) recalled from reading a 200 word passage drawn from the familiar or previously read science information book, Is it a Fish? (Cutting & Cutting, 2002), published by the Wright Group/McGraw-Hill Sunshine Science series revealed a statistically significant classroom effect, $F(2, 76) = 5.3$, $p = .01$. Therefore, we used the classroom as the unit of analysis to examine the difference between the SSI and TSI comprehension strategy groups' performance on this comprehension measure of science information book reading. The results indicated no statistically significant difference between the SSI and TSI groups recall of super-ordinate idea units from a reading of this science familiar information text, $F(1, 2) = .40$, $p = .59$.

In contrast, on the oral retelling measure of subordinate idea units (details) recalled from reading a 200 word passage drawn from the familiar or previously read science information book, Is it a Fish? (Cutting & Cutting, 2002) published by the Wright Group/McGraw-Hill Sunshine Science series, there was no statistically significant classroom effect, $F(2, 76) = 2.5$, $p = .09$. Therefore, we used the student as the unit of analysis to examine the difference between the SSI and TSI comprehension strategy groups' performance on this comprehension measure of science information book reading. The results indicated a statistically significant difference between students' performance in the SSI and TSI groups recall of subordinate or detail idea units from a reading of this familiar science information text, $F(1, 76) = 42.7$, $p = .000$, and a large effect size, $\eta^2 = .36$, with students in the TSI group scoring an average of 3.9 out of 16 total subordinate idea units (details) higher than students in the SSI group.

A similar pattern of results was obtained for the oral retelling measure of super-ordinate and subordinate idea units recalled from reading a 200 word passage drawn from the unfamiliar or not previously read science information book, Our Eyes (Robinson, 2002) published by the Wright Group/McGraw-Hill Sunshine Science series. Because there was not a statistically significant classroom effect, $F(2, 76) = 2.3$, $p = .10$, we used the student as the unit of analysis to examine the difference between the SSI and TSI comprehension strategy groups' performance on this comprehension measure of science information book reading. The results indicated no statistically significant difference between the SSI and TSI groups recall of super-ordinate idea units from reading this unfamiliar science information text, $F(1, 76) = .48$, $p = .49$.

On the oral retelling measure of subordinate idea units (details) recalled from reading a 200 word passage drawn from the unfamiliar or not previously read science information book, Our Eyes (Robinson, 2002) from the Wright Group/McGraw-Hill Sunshine Science series, there was no statistically significant classroom effect, $F(2, 76) = 3.0$, $p = .06$. Therefore, we used the student as the unit of analysis to examine the difference between the SSI and TSI comprehension strategy groups' performance on this measure. The results indicated a statistically significant difference between students' performance in the SSI and TSI groups on recall of subordinate or detail idea units from reading this unfamiliar science information text, $F(1, 76) = 4.5$, $p = .04$, and a moderate effect size, $\eta^2 = .06$, with students in the TSI group scoring an average of 1.2 subordinate idea units (details) higher than students in the SSI group.

3.3. Perceived comprehension strategy use

For the Modified Survey of Reading Strategy Use, the classroom effect was not statistically significant, $F(2, 76) = 1.4$, $p = .25$. Therefore, we used the student as the unit of analysis to examine the difference between the SSI and TSI comprehension strategy groups' performance on the Modified Survey of Reading Strategy Use. The results indicated no statistically significant difference, $F(1, 76) = .27$, $p = .61$ on Modified Survey of Reading Strategy Use indicating no statistical or practical difference in students' perception of having learned comprehension strategies or their perceived use of those comprehension strategies.

3.4. Science content or domain knowledge acquisition

For the Science Content Knowledge Acquisition Test, the classroom effect was not statistically significant, $F(2, 76) = 3.0$, $p = .06$. Therefore, we used the student as the unit of analysis to examine the difference between the SSI and TSI comprehension strategy groups' performance on the Science Content Knowledge Acquisition Test. The results indicated a statistically significant difference, $F(1, 76) = 51.9$, $p = .000$, and a large effect size, $\eta^2 = .41$, with the TSI group scoring an average of 9.8 (total score possible = 40) points higher than the SSI group.

3.5. Student reading motivation

For the Primary Grade Reading Motivation Student Survey, there was a statistically significant effect for classroom, $F(2, 76) = 3.1$, $p = .05$; therefore to test the difference between the SSI and TSI interventions, we used the classroom as the unit of analysis. There was no significant difference between the SSI and TSI groups' motivation as measured by the Primary Grade Reading Motivation Student Survey, $F(1, 2) = .04$, $p = .86$ showing that the two comprehension strategy treatment conditions did not differentially affect students' reading motivation.

3.6. Descriptive discriminant function analysis of treatment group differences

The results of a descriptive discriminant function analysis were used to determine the relative contribution of the different variables in discriminating among the outcomes of the two comparison groups and to identify which of the nine variables, if any, were redundant and therefore unnecessary in discriminating the two groups. The effect of this discrimination was significant (Wilk's $\lambda = .40$, $F(8, 76)$, $p = .000$). A single discriminant function, Function 1, accounted for 100% of the variation between the two groups. Three

variables correlated the greatest with Function 1: science content knowledge (.82), criterion-referenced comprehension subtest items (.26), and recall of details from reading an unfamiliar science information book passage (.19). Acquisition and retention of science content knowledge was the single largest variable discriminating between the two groups performance on the nine outcome measures used in this study. This finding can be interpreted to mean that the TSI comprehension instructional approach had its greatest effect upon children's acquisition and retention of content knowledge when reading science information texts.

3.7. Qualitative results

Were the comprehension strategy treatments well implemented? Based on consistent, weekly classroom observations, the research team judged the fidelity of treatment implementation to be good, with the teachers regularly implementing the specified comprehension strategy instructional approaches as per the written lesson plans. As mentioned earlier in this report, two observations were examined for percent of inter-rater agreement. The reliability calculations for these observations ranged from between 89 and 96% agreement. Each week teachers were asked to respond in writing to three questions during the study. These questions and example comments are discussed below.

Teacher Reflection Journal Question 1: What difficulties are you encountering with comprehension strategy instruction? Initially, there was clear evidence that teachers in both groups (SSI and TSI) were unsure of themselves. This may have been due to conditions where their teaching was under such intense observation and the attendant scrutiny of their written lesson plans. All four teachers indicated a concern about whether or not they were "doing the strategy instruction right." Comments such as: "I felt a little unsure about how I should teach the lessons," or "I was worried that I was not doing the lesson right; maybe I was leaving something out." As time progressed the four teachers seemed to relax and feel very comfortable with their lessons and the on-going process of classroom observations. Comments included, "I felt more relaxed and less stressed," or "Seems to be going well; feels very comfortable." The reading coach noted in her observations at the end of the study, "Teaching one strategy at a time seemed contrived and unnatural. . . Every time a single strategy [lesson] concluded teachers had to rethink their instruction to find the best ways for teaching the next strategy. Everything was new."

A constant-comparative analysis of the classroom observations made by members of the research team indicated similar trends. Teacher implementation of the strategy instruction began a little unsure but within a matter of 2–3 weeks from the onset of the study the teachers were implementing their assigned forms of comprehension strategy instruction well and with less stress and increased confidence. This is not to say that implementation even at the initial stages of the study was poor. On a five point observation scale at the second week, initial teacher implementation was judged on average to be a 4.2. However, by the end of the study, 14th week, the four teachers were averaging a 4.7 observation rating showing the improved confidence and skill.

Teacher reflection journal question 2: What is going well for you with the comprehension strategy instruction? There was once again some evidence within responses to this question that initially teachers in both groups were unsure of their teaching of the comprehension strategy lessons under these conditions. However, the preponderance of responses to this particular question seemed to focus on the students and their understanding and participation rather than on the teachers and their comfort levels. For example comments were made such as the following: "The students are starting to understand the procedures and are feeling more comfortable participating." Or, "The kids seemed more involved and interested;" and "Kids are really enjoying it and understanding what the strategy is." As the study progressed responses

to this question varied significantly. For example, "The students are noticing that there are no headings on these last books we have done. They keep asking why the author does not put the headings in the book, when the table of contents has headings." Another example, "The lessons are going faster, with more and more student participation. The students are asking a lot more questions;" or "The students loved listening to teacher make mistakes." (This was done while modeling comprehension monitoring and fix up strategies.) At the end of the study the reading coach noted in her observations, "Every teacher, including myself, learned a lot about teaching comprehension. I saw confidence grow in every teacher and they will make new connections easily with future training. Even (teacher name withheld), who is painfully shy, volunteered that she is getting better as a teacher."

A constant-comparative analysis of the classroom observations made by members of the research team indicated similar trends. Student participation, questions, and comments were growing more frequent in both comparison conditions. One TSI teacher commented, "They are actually listening and learning from each other!" One SSI teacher commented while teaching the single comprehension strategy of questioning, "The students have a lot of questions. The students wrote questions from the books we are reading. Other students would find the answers in their books. It was a great class activity."

Teacher reflection journal question 3: What are the effects of comprehension strategy instruction, if any, you are noticing on your students? During the initial stages of the study, teachers complained about lack of interaction among the students as they adjusted to the instruction using the science big books. One teacher wrote, "The students are tuned in, but not much interaction." Another wrote, "I feel my students are getting more comfortable and getting familiar with the routine of the lessons." However as time progressed, the teachers felt that students were really getting into the lessons. A SSI teacher recorded, "I notice them thinking deeper and using the strategies in independent reading." A TSI teacher wrote, "The strategies are being used in reading other than the big books. One girl had her eyes shut for a couple of minutes during Book Nook reading and I asked her to start reading aloud for me. She told me that she was making an image." On another occasion a week later this same teacher wrote, "A week ago, I wondered if one girl was pretending to image when she told me was making an image. But during a test today, an ESL student was doing the same thing and I told him he needed to get working. He said, 'I am making an image in my mind.' He was taking the state's end of level reading test."

Further evidence of the impact these forms of comprehension strategy instruction were having was captured routinely throughout the project. One example included, "The kids are really getting good at remembering what we are supposed to do and knowing the strategies." However, one student's comment during a video taped observation was classic. As one TSI teacher and her group were reading a big book on the life cycle of frogs, one young male student sighed aloud and remarked, "I just love this stuff!".

Another trend in the answers to this third question was a consistent response of all four teachers that students were in fact learning the science content and enjoying it. Toward the end of the study, one teacher noted some fatigue with the instruction in her classroom. She wrote, "The kids are starting to get a little tired of the same things over and over again."

At the end of the study, teachers responded to four "concluding" questions used in teacher interviews and recorded in the teacher reflection journals. Written teacher responses to each of these four questions are shown in Table 3.

The school reading coach summed up the reflections, observations, and classroom trends well in relation to Question 3 when she wrote in her final reflections, "Teachers were transferring comprehension strategy instruction into other instruction. I saw teachers making excellent strategy connections for students in guided reading and read aloud as well."

Table 3
Concluding questions and answers recorded in teacher response journals

Question	Sample SSI comments	Sample TSI comments
1. What has been the most valuable outcome of participation in this research project for you as a teacher?	Teacher 1: "I never realized how much information there was to learn in this area. It was hard work but very worth it in the end."	Teacher 1: "It took what I was already doing and expanded it. I have always integrated science and reading. But using these big books, the manipulatives, and strategies has given the students a better way to absorb and comprehend non-fiction books."
	Teacher 2: "This study has been worth the effort. The strategies taught are important to learn."	Teacher 2: "I think that learning a way to teach science content using all the strategies with a big book has been so valuable to me as a teacher. I was surprised to see how much content they remembered from this way of teaching. I will continue on with these lessons."
2. What has been the most valuable outcome of participation in this research project for your students?	Teacher 1: "They have loved science more than ever before. They loved the books and even parents got more involved with science and reading."	Teacher 1: "The students are using strategies to comprehend. They know them and use them. The summary sheets really helped the comprehension."
	Teacher 2: "The students love science this year. They enjoy reading all the books."	Teacher 2: "I think they have learned strategies to help them read nonfiction books and remember the content. I think they will carry these strategies with them and it will help them to succeed in comprehension."
3. What do you think would have improved your ability to offer effective comprehension strategy instruction the most?	Teacher 1: "Another year to fine- tune and improve upon what we have learned. I will do this on my own next year."	Teacher 1: "Having the lessons all done to use each year. It took me close to 100 h to make up the lessons."
	Teacher 2: "I want to keep working on this next year."	Teacher 2: "I think more time would have improved instruction. I think we had too much to cover in a short amount of time."
4. What weaknesses do you think persisted throughout the project that may have influenced the quality of the implementation and the outcomes?	Teacher 1: "Time and other school obligations. There were many valuable projects going on and I just wish there were more hours in the day."	Teacher 1: "I do not know. I can tell that the students, special education, ESL, or any others all benefited from the study."
	Teacher 2: "Less interruptions and a regular time in the day."	Teacher 2: "I think that the routine got boring to them after a long period of time."

4. Discussion

The results of this study must be interpreted with caution due to the moderate sample size, $n = 80$ students. We now discuss each of the findings within the context of the research questions we posed at the outset of the study.

4.1. Research question 1: comprehension performance

Our first research question inquired into whether the teaching of a "family" or "set" of comprehension strategies embedded in a collaborative, interactive and engaging routine, Transactional Strategies Instruction (TSI), as compared with teaching a series of single comprehension strategies explicitly, one-at-a-time, Single Strategies Instruction (SSI), would be more, less, or equally effective in helping young children comprehend what they read. The results revealed a mixed pattern of findings in relation to the question of comprehension performance.

On the comprehension subtest of the Gates–MacGinitie Reading Test, Level 3, Form T, there was no significant difference between the SSI and TSI groups after 16 weeks of instruction. This finding contrasts sharply with previous TSI findings examining the comprehension performance of children and adolescents. Three previous studies have evaluated the effects of TSI on children and adolescent's comprehension (grades 2 through 11) as measured by standardized, norm referenced tests of comprehension performance. In previous evaluations of the effects of TSI, the strategy groups uniformly outperformed control groups on standardized comprehension tests. However the nature of the comparisons made in previous TSI evaluation studies and the comparison reported in the present study were quite different.

In previous TSI evaluation studies, comparisons of comprehension performance on standardized or norm-referenced tests were made against control groups that did not receive explicit, systematic comprehension strategy instruction. In many cases, the control comparisons used the school or teacher's on-going eclectic comprehension instruction or the comprehension instruction associated with a core or basal reading program. Thus, the effects of TSI found in these previous studies on norm-referenced tests may have validated that any program or package of explicit, systematic comprehension strategies instruction was superior to no, implicit, or eclectic comprehension instruction. We say this, because TSI evaluation studies turned up similar results to the earlier studies that compared the teaching of only one comprehension strategy to a control group that received no teaching, eclectic teaching, or traditional teaching of comprehension skills or strategies.

Also unlike previous evaluations of TSI, this study compared two groups that were explicitly and consistently taught complex, multi-componential comprehension strategy instruction only using a different mode or approach. In the SSI comparison group using the Keene and Zimmerman (1997) approach children were intensively, explicitly, and systematically taught a series of six single comprehension strategies one-at-a-time for 2.5 weeks each. During the 2.5 weeks of instruction on each comprehension strategy in the series, teachers gradually released the use of each strategy taught in the series to the students. Thus, the intent was that by learning a series of single comprehension strategies taught one-at-a-time, over time, young students would also gradually learn to orchestrate the series of comprehension strategies taught to increase their comprehension of text. In the TSI comparison group however, children were initially taught an each of eight strategies in an entire set of strategies ala' the processes described by Brown et al. (1996). Each strategy in the set was taught explicitly and individually with instruction of the entire set quickly moving to an emphasis upon using the entire set or repertoire of strategies in reading. Over the course of the entire study, the use of the entire strategy set taught was gradually released to the students.

Hence, the findings of this study point to the conclusion that explicit, systematic, and multi-componential comprehension strategy instruction of the two modes or approaches (TSI and SSI) evaluated do not produce significantly different results from one another on standardized measures of reading comprehension.

On the State End-of-Level criterion referenced comprehension related test items, the results indicated a statistically significant difference and a moderate effect size, $\eta^2 = .05$ for the TSI treatment over the SSI treatment. Previous TSI evaluation studies have not examined student performance using curriculum-based measures of reading comprehension tied to state curriculum standards. In many states, curriculum-based or standards-based assessments are used not only to make judgments about student progress but also teacher performance. And with the escalating cost of standardized assessment, many states are turning increasingly to state constructed criterion tests as alternative measures of reading progress. Thus these findings provide evidence that the mode of teaching comprehension strategy instruction as a "set" or "family" of strategies yields measurable benefits on a curriculum-based, criterion-referenced measure of reading comprehension.

In conclusion, the complex, two multi-componential types of comprehension strategy instruction evaluated in this study (TSI and SSI) do not differ one from another in their power to promote student comprehension as measured by a norm-referenced, standardized comprehension subtest. On the other hand, the findings did show statistical and practical differences favoring the TSI comparison group on a state, curriculum-based measure of comprehension standards. In spite of the equivalent performance findings of TSI and SSI on young children's comprehension standardized test scores in this study, we believe the cost of learning to teach TSI is still worth the extra effort for classroom teachers. We take this position largely because this study has shown that TSI has clear added value for promoting young children's comprehension development when measured by curriculum-based comprehension criterion test items which are increasingly used to evaluate teacher performance and student comprehension progress.

4.2. Research question 2: science information book comprehension performance

Our second research question explored whether the use of science information texts to teach young children comprehension strategies would reveal similar results when compared to previous studies in which narrative texts have been the focus of instruction. The results were most encouraging with respect to teaching young children to use comprehension strategies to read and comprehend science information texts. This question was investigated using students' oral retellings of science information book content—main ideas (super-ordinate) and details (subordinate).

The oral retellings investigated the number of super-ordinate idea (big ideas) and subordinate idea (details) units recalled from reading 200 word passages drawn from one familiar (near transfer) and one unfamiliar (far transfer) science information book. With respect to the recall of super-ordinate idea units there was no statistically significant difference between the TSI and SSI groups. Thus, it appears that teaching comprehension strategies either as a set or one-at-a-time produces similar results on recall measures of super-ordinate or main ideas from reading science information texts.

In contrast however, the recall of subordinate idea units (details) from reading 200 word passages drawn from familiar (near transfer) and unfamiliar (far transfer) science information books showed statistically significant differences between the TSI and SSI groups favoring the TSI group with effect sizes ranging from a moderate effect size, $\eta^2 = .06$ with unfamiliar science information books to a large effect size, $\eta^2 = .36$ with familiar science information books. These findings demonstrate that differences between the effects of TSI and SSI comprehension strategy instruction are found at the micro or nuanced levels of reading comprehension measurement—the acquisition and retention of detailed information.

From this finding, one can conclude that TSI helps young children elaborate their knowledge and recall of science texts to a greater degree than does SSI.

In addition, the finding that TSI significantly affected the recall of details from reading an unfamiliar science information text is of particular interest because it signals a potential transfer effect for TSI. Taken together, this set of findings portends that the more elaborated text recall associated with TSI might also be expected to yield tangible differences in the quality and quantity of science knowledge acquired from reading as was found in the results of the Science Content Knowledge Acquisition Test. Nonetheless, the findings of this study that children in the primary grades can be taught to use comprehension strategies to read science information books is entirely consistent with previous TSI and other strategy research using narrative texts. Pressley (2002c) observed the following in relation to young children's abilities to learn and use TSI to read narrative texts. "One of the most compelling differences between Brown and colleague's (1996) transactional strategies-instructed students and control students was a demonstration that the students who had learned strategies acquired more content from their daily lessons" (p. 261).

In conclusion, the two modes of comprehension strategy instruction evaluated in this study (TSI and SSI) do not differ one from another in their power to promote second-grade students' comprehension of science information books (familiar and unfamiliar) as measured by the recall of super-ordinate/main ideas. On the other hand, the findings did show statistical and practical differences favoring the TSI comparison group on the recall of details from reading familiar and unfamiliar science information texts in the second grade.

In spite of the equivalent performance findings of TSI and SSI on young children's recall of main ideas in this study, we once again assert the belief that the cost of learning to teach TSI is worth the extra effort for classroom teachers. We once again take this position because this study has shown that TSI promotes young children's acquisition of elaborated knowledge from reading familiar and unfamiliar science information books.

4.3. Research question 3: student perceived comprehension strategy use

The third research question explored whether teaching of a "family" or "set" of comprehension strategies embedded in a collaborative, interactive and engaging routine, Transactional Strategies Instruction (TSI), as compared with the explicit teaching of a series of comprehension strategies, one-at-a-time, Single Strategies Instruction (SSI), would be more effective in helping young children acquire and use comprehension strategies. The results for both groups were most encouraging with respect to young children's perceived acquisition and use of comprehension strategies to read and comprehend science information texts.

The results of the Modified Survey of Reading Strategy Use showed no statistical or practical difference in students' perception of having learned and used comprehension strategies during reading. This finding was not particularly surprising again given the strong emphasis in both strategy comparison groups on explicitly and systematically teaching children to use cognitive comprehension strategies. From these findings, the modes of teaching comprehension strategies either as a "set" of transacted strategies or as a series of strategies taught one-at-a-time do not cause children to feel differently about their acquisition or use of comprehension strategies during reading. An inspection of the mean scores across both groups on this survey (2.3 out of 3.0) demonstrated that the second-grade children in this study had a fairly strong sense that they had learned and were using comprehension strategies when they read.

4.4. Research question 4: science content knowledge acquisition

The third research question explored how two approaches to comprehension strategy instruction (TSI and SSI) affected students' acquisition of science content or domain knowledge. The results from the Science Content Knowledge Acquisition Test indicated a statistically significant difference between the TSI and SSI groups as well as a large practical effect size, $\eta^2 = .41$. In addition, the results of the follow-up descriptive discriminant function analysis indicated that the amount of science content knowledge acquired was the single largest discriminating variable separating the TSI and SSI comparison groups.

For several reasons, this finding alone seems sufficient to argue strongly that teachers should learn how to teach TSI to young children. First, this finding clearly demonstrates the value of TSI in balancing the teaching of processes and skills to young children with the acquisition of content knowledge as recommended by Neuman (2001) and others. Second, this finding provides evidence to address concerns whether teaching comprehension strategies will have an impact on the acquisition of content knowledge as expressed by the National Reading Panel (2000) when it stated, "However, it is not clear whether instruction of comprehension strategies leads to learning skills that improve performance in content areas of instruction" (p. 4–7). Third, this finding suggests that teaching young children to use TSI may help them achieve and maintain content knowledge related literacy, in this case science literacy (El-Dinary, 2002; Spence, Yore, & Williams, 1999). And finally, this finding not only squares with results from previous TSI evaluation studies where narrative texts were read, but also extends the validation of using TSI to teach young children to comprehend information texts.

The qualitative results supported and helped to explain this finding as well. Teachers in the TSI group consistently remarked about "how much science *content* the children were learning and remembering." By way of comparison, the SSI teachers often remarked instead about the level of interest the students had in the science books but did not remark as frequently or as consistently as did the TSI teachers about their students' science content knowledge acquisition.

Reflecting back on the classroom observations, this finding was anything but startling. As we observed the teachers in the two comprehension strategy instructional conditions (TSI and SSI), we noted two very different types of interaction occurring in classrooms. In the SSI classrooms, the science books seemed to be viewed and treated by teachers as a "vehicle" for teaching young children each of the single comprehension strategies. Hence, the focus of discussion and instruction was largely directed toward learning and applying the comprehension strategy rather than focusing on the use of the comprehension strategy to acquire the content found in the science information books. In fairness, SSI teachers complained occasionally that the science information big book to be read was not as useful in teaching a specific comprehension strategy as were perhaps other books. But even this comment can be construed to demonstrate the SSI teachers' nearly singular focus on instructing each comprehension strategy using the science books as vehicles rather than using each comprehension strategy to acquire science content knowledge. And the school reading coach at the end of the study confirmed this observation when she wrote that, "Teaching one strategy at a time seemed contrived and unnatural. . . Every time a single strategy [lesson] concluded teachers had to rethink their instruction to find the best ways for teaching the next strategy. Everything was new."

In comparison the "set" or "family" of strategies taught in the TSI classrooms seemed to be seamlessly woven around reading and discussing the science information books in such a way as to be the virtual "tools" for acquiring the science content knowledge available in these information books. In other words, in the TSI classroom the transacted "set" or "family" of strategies taught and used seemed to have a clear,

focused purpose in the minds of the teachers and the young children—to get the science knowledge, understand it, organize it, and talk about it. Thus, the findings relative to science content knowledge acquisition appear to represent an artifact of the teachers' comprehension strategy instructional emphases—strategy instruction as an end in and of itself OR strategy instruction in the service of the larger goal of "getting smarter" by acquiring content knowledge.

There is, however, one possible alternative explanation for the difference in content knowledge acquisition results when examined from an analytic or at a micro-strategy level. The SSI group only learned to use six cognitive comprehension strategies during the study while the TSI group learned a set of eight. It is possible that the inclusion of two additional strategies, goal setting and text structure analysis, in the TSI set could have resulted in giving young children in the TSI group an advantage in learning more about the unfamiliar organization of information texts yielding increased content knowledge acquisition. Future research should control for the number and types of cognitive comprehension strategies taught. Given the findings of this study, we can only say that the set of eight cognitive comprehension strategies taught in the TSI group resulted in larger amounts of content knowledge acquired than the mode of teaching young children a series of six single cognitive comprehension strategies in the SSI group. Future research might also examine how packaging different sets of cognitive comprehension strategies together in TSI or other forms of multiple comprehension strategy instruction differentially affect young children's specific comprehension performance and content knowledge acquisition.

4.5. Research question 5: student reading motivation

The fourth research question explored whether teaching comprehension strategies using two different approaches (TSI and SSI) was more motivating for young learners. Using the Primary Grade Reading Motivation Student Survey to measure student motivation, there was no significant difference between the SSI and TSI groups' reading motivation. This finding indicates that teaching comprehension strategies as a "set" or "family" of transacted strategies or as a series of strategies taught one-at-a-time does not affect young children's reading motivation differently.

The qualitative results from the observations and the responses from the teachers consistently indicated that students in all four classrooms were motivated by the science content of the big books as well as the format of the comprehension strategies instruction. These findings were not particularly surprising given the research team's observations in classrooms, interviews with teachers, and the analysis of teacher responses. Students in all four second-grade classrooms appeared to be engaged and motivated to learn comprehension strategies and to read the science information big books. We suspect, however, that the genre of the big books, science information books, read during the shared reading comprehension strategy instruction lessons (TSI and SSI) may very well have influenced the reading motivation survey results to a greater degree than did young children's perceptions of the two types of comprehension strategy instruction (TSI and SSI) evaluated in this study.

4.6. Research question 6: teacher and student observations and comments

The qualitative results of this study suggest several important conclusions. First, learning to teach comprehension strategy instruction is hard work, regardless of whether it is TSI or SSI. This is consistent with previous findings that many young children are not receiving adequate instruction in comprehension during the primary years. Second, learning to teach TSI is even harder work. This too, squares with

previous findings by TSI researchers (Brown et al., 1996; Stahl, 2004) that it takes several years of effort and practice to learn to implement comprehension strategy instruction well, especially TSI. Third, young children enjoy reading and discussing science information books. This finding suggests that teachers can use information books to teach young children comprehension strategies without unnecessary concerns related to student motivation, comprehension performance, or knowledge acquisition. Fourth, the use of TSI presents measurable and practical advantages for helping young children acquire content or domain knowledge. Hence, it seems reasonable to conclude that TSI is particularly well suited to the teaching of comprehension strategies to young children when they are reading information books. And finally, the qualitative results suggest that both teachers and children were beginning to use comprehension strategies beyond the boundaries of the lessons taught. This finding suggests that young children can be taught to effectively use and orchestrate a "set" or "family" of comprehension strategies to become increasingly self-regulated and strategic readers of narrative and expository texts.

4.7. Limitations and educational implications

This study was limited in several important ways. First, the study was limited in duration. A longer study, perhaps a full year, may have resulted in finding additional differences between TSI and SSI not uncovered in the shorter time frame of this study. We say this because previous TSI research suggests that the effects of TSI require a minimum of a half-year to emerge. Although it is not entirely impossible that additional time may have benefited the SSI students as well. Second, the study was limited to a particular socio-cultural context—one high poverty, low performing school in the southwestern U.S. Thus the results may not be generalizable to all children attending middle or upper class and high performing schools. Third, the sample size was limited to 80 second-grade students. Although this moderate sample size allowed for careful control and fidelity related to internal validity, the sample size also limited the generalizability of the findings as well as the degrees of freedom available for conducting hypothesis testing. Future research should employ more comparison and/or control groups as well as larger numbers of students to increase the external validity and the degrees of freedom for hypothesis testing. Fourth, the study evaluated "whole" programs for teaching comprehension strategies and did not engage in analytic comparisons of each and every comprehension strategy taught. This has been the case with all previous TSI evaluation studies as well. It is possible that only one or two specific comprehension strategies taught may have accounted for the differences between the TSI and SSI groups. Future research may need to take a more analytical approach to uncover potential differences that may have occurred between the groups as this relates to the inclusion or exclusion of specific comprehension strategies. And finally, the study was limited to TSI as the only multiple strategy comprehension instructional condition evaluated. We believe a logical step for future research would involve the evaluation of various "configurations" or "sets" of multiple comprehension strategies such as those found in Reciprocal Teaching (Palincsar, 2003), Collaborative reasoning (Chinn, Anderson, & Waggoner, 2001), or Concept Oriented Reading Instruction (Guthrie, 2003; Swan, 2003).

In spite of these limitations, we also believe this study effectively addressed several design concerns found in previous comprehension strategy research. In 2000, the National Reading Panel noted in their report that: "Criteria of internal and external validity should be considered in the design of future [comprehension] research, to address problems that were noted in prior studies. Specifically, these issues were random assignment of students to treatments and control conditions; exposure of experimental and control participants to the same training materials; provision of information about the amount of time spent on

dependent variable tasks; the study of fidelity of treatment and analyzing teacher and reader performance during instruction; use of appropriate units (individual, group, classroom) in analyses; and assessment of either long term effects or generalization of the strategies to other tasks" (p. 4–7). In this study, each and every one of these previous research design weaknesses was addressed at some level.

With respect to the educational implications of this study, in 2000 the National Reading Panel observed that "There is little research at the K to second grade level on teaching reading comprehension" (p. 4–126) and that there is a need for research that examines "which strategies, in combination, are best for younger readers" (p. 4–7). In 2002 Pearson and Duke also observed that younger readers in the primary grades (K-3) were not receiving adequate instructional emphasis on comprehension instruction. In practice, they contended that many early childhood educators do not consider comprehension instruction to be an important part of primary grade education.

This study clearly demonstrated that young children in the primary grades (K-3) can be taught to use a "set" or "family" of comprehension strategies effectively. Moreover, young children can be taught to use this set or family of strategies to read science information books in addition to previous studies showing the value of TSI used to read narrative texts. This study also found that not only will teaching second-grade students a "set" or "family" of comprehension strategies such as is found in TSI result in the acquisition of reading comprehension strategies as well as those students who were taught comprehension strategies explicitly, one-at-a-time, but that TSI students reaped additional significant benefits such as substantially elaborated knowledge acquisition from reading science books, increased acquisition and retention of science content knowledge and significantly improved criterion or curriculum-based reading comprehension test scores. These additional benefits favoring TSI are important because the learning curve is relatively steep for developing the ability to teach TSI comprehension instruction for teachers and for developing the ability to orchestrate a "set" or "family" of transacted comprehension strategies for young children. Were such additional benefits not demonstrated for TSI using information books, it would likely present fewer challenges for teachers to teach and children to learn comprehension strategies one-at-a-time as is the current norm in primary grade classrooms where comprehension strategy instruction is occurring at all.

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References

Beaver, J. (1999). *Developmental reading assessment, K-3*. Lebanon, IN: Celebration Press, Pearson Education.

Brown, R., Pressley, M., Van Meter, P., & Schuder, T. (1996). A quasi-experimental validation of transactional strategies instruction with previously low-achieving second-grade readers. *Journal of Educational Psychology, 88*, 18–37.

Calkins, L. M., Montgomery, K., Santman, D., & Falk, B. (1998). *A teacher's guide to standardized reading tests: Knowledge is power*. Portsmouth, NH: Heinemann.

Campbell, D. T., & Stanley, J. C. (1963). *Experimental and quasi-experimental designs for research*. Boston, MA: Houghton Mifflin.

Chinn, C. A., Anderson, R., & Waggonner, M. (2001). Patterns of discourse in two kinds of literature discussion. *Reading Research Quarterly*, *36*(4), 378–411.

Cohen, J. (1988). *Statistical power analysis of the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum.

Cutting, B., & Cutting, J. (2002). *Is it a fish?—Sunshine science series*. Bothell, WA: Wright Group/McGraw-Hill Publishing.

Dole, J. A., Duffy, G. G., Roehler, L. R., & Pearson, P. D. (1991). Moving from the old to the new: Research on reading comprehension instruction. *Review of Educational Research*, *61*, 239–264.

Duke, N. K. (2000). 3.6 min per day: The scarcity of informational texts in first grade. *Reading Research Quarterly*, *35*(2), 202–224.

Duke, N. K., Bennett-Armistead, S., & Roberts, E. M. (2002). Incorporating informational text in the primary grades. In C. M. Roller (Ed.), *Comprehensive reading instruction across the grade levels: A collection of papers from the 2001 Reading Research Conference, 41–54.*. Newark, DE: International Reading Association.

Durkin, D. (1978–1979). What classroom observations reveal about reading comprehension instruction. *Reading Research Quarterly*, *12*, 481–538.

El-Dinary, P. B. (2002). Challenges implementing transactional strategies instruction for reading comprehension. In C. Collins-Block & M. Pressley (Eds.), *Comprehension instruction: Research-based best practices* (pp. 201–218). New York: Guilford Press.

Gambrell, L. B. (2003). *Primary student reading motivation survey*. Clemson, S.C, Personal correspondence.

Glass, G. V., McGaw, B., & Smith, M. L. (1981). *Meta-analysis in social research*. Beverly Hills, CA: Sage.

Guthrie, J. T. (2003). Concept-oriented reading instruction. In C. E. Snow & A. P. Sweet (Eds.), *Rethinking reading comprehension* (pp. 115–140). New York: Guilford Press.

Kamil, M. L., & Lane, D. (1997a). A classroom study of the efficacy of using information text for first-grade reading instruction. Paper presented at AERA, Chicago, IL.

Kamil, M. L., & Lane, D. (1997b). *A follow-up report on the classroom study of the efficacy of using information text for first grade reading instruction*. Paper presented at the National Reading Conference, Scottsdale, AZ.

Keene, E. O., & Zimmerman, S. (1997). *Mosaic of thought: Teaching comprehension in a reader's workshop*. Portsmouth, NH: Heinemann.

Lee, W. (1975). *Experimental design and analysis*. San Francisco, CA: W.H. Freeman and Company.

Lomax, R. G. (2004). Whither the future of quantitative research? *Reading Research Quarterly*, *39*(1), 107–112.

MacGinitie, W. H., MacGinitie, R. K., Maria, K., & Dreyer, L. G. (2000). *Gates–MacGinitie Reading Tests, Level 2, Forms S & T*. Itasca, IL: Riverside Publishing.

Mohr, K. A. J. (2003). Children's choices: A comparison of book preferences between Hispanic and Non-Hispanic first-graders. *Reading Psychology: An International Quarterly*, *24*(2), 163–176.

Moss, B., & Newton, E. (2002). An examination of the informational text genre in basal readers. *Reading Psychology: An International Quarterly*, *23*(1), 1–14.

National Institute of Child Health and Human Development (2000). Report of the National Reading Panel: Teaching children to read. Washington, DC.

Nelson, D. E., & Fox, D. G. (1999). *Technical manual for Utah state office of education core assessment series* (2nd ed., form A). SLC, UT: Institute for Behavioral Research in Creativity.

Neuman, S. B. (2001). The role of knowledge in early literacy. *Reading Research Quarterly*, *36*(4), 468–475.

Palincsar, A. S. (2003). Collaborative approaches to comprehension instruction. In C. E. Snow & A. P. Sweet (Eds.), *Rethinking reading comprehension* (pp. 99–114). New York: Guilford Press.

Palmer, R. G., & Stewart, R. A. (2003). Nonfiction trade book use in primary grades. *The Reading Teacher*, *57*(1), 38–49.

Pearson, P. D. (1967). American reading instruction since. In N. B. Smith (Ed.), *American reading instruction* (pp. 419–486). Newark, DE: International Reading Association.

Pearson, P. D., & Duke, N. K. (2002). Comprehension instruction in the primary grades. In C. Collins-Block & M. Pressley (Eds.), *Comprehension instruction: Research-based best practices* (pp. 247–258). New York: Guilford Press.

Pereira-Laird, J. A., & Deane, F. P. (1997). Development and validation of a self-report measure of reading strategy use. *Reading Psychology*, *18*(3), 185–235.

Pressley, M. (2002a). Comprehension strategies instruction: A turn-of-the-century status report. In C. Collins-Block & M. Pressley (Eds.), *Comprehension instruction: Research-based best practices* (pp. 11–27). New York: Guilford Press.

Pressley, M. (2002b). *The rest of the story from research*. Washington, DC: National Education Association.

Pressley, M. (2002c). *Reading instruction that works: The case for balanced teaching* (2nd ed.). New York: The Guilford Press.

Pressley, M., Johnson, C. J., Symons, S., McGoldrick, J. A., & Kurita, J. A. (1989). Strategies that improve children's memory and comprehension of text. *Elementary School Journal*, *90*, 3–32.

Reutzel, D. R., Hollingsworth, P. M., & Eldredge, J. L. (1994). Oral reading instruction: The impact on student reading development. *Reading Research Quarterly*, *23*(1), 40–62.

Robinson, V. (2002). *Our eyes—sunshine science series*. Bothell, WA: Wright Group/McGraw-Hill Publishing.

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2000). *Experimental and quasi-experimental designs for generalized causal inference*. Boston, MA: Houghton Mifflin.

Snow, C. E., & Sweet, A. P. (2003). *Rethinking reading comprehension*. New York: Guilford Press.

Spence, D. J., Yore, L. D., & Williams, R. L. (1999). The effects of explicit science reading instruction on selected grade 7 students. *Journal of Elementary Science Education*, *11*(2), 15–30.

Stahl, K. (2004). Proof, practice, and promise: Comprehension strategy instruction in the primary grades. *The Reading Teacher*, *57*(7), 598–609.

Statistical Package for the Social Sciences, Version 11.0–11.5 Base and Advanced Models (SPSS). (2002). Chicago, IL: SPSS, Inc.

Swan, E. A. (2003). *Concept-oriented reading instruction: Engaging classrooms, lifelong learners*. New York: Guilford Press.

Sweet, A. P., & Snow, C. (2002). Reconceptualizing reading comprehension. In C. Collins-Block, L. B. Gambrell, & M. Pressley (Eds.), *Improving comprehension instruction: Rethinking research, theory, and classroom practices* (pp. 17–53). San Francisco, CA: Jossey-Bass.

Tashakkori, A., & Teddlie, C. (1998). *Mix-methodology: Combining qualitative and quantitative approaches*. Thousand Oaks, CA: Sage Publications.

Taylor, B. M., Pearson, P. D., Clark, & Wadpole. (1999). *Beating the odds in teaching all children to read (CIERA Report #2-006)*. Ann Arbor, MI: Center for the Improvement of Early Reading Achievement.

Wain, H., & Robinson, D. H. (2003). Shaping up the practice of null-hypothesis significance testing. *Educational Researcher*, *32*(7), 22–30.