IMPACT OF AN INTEGRATED SCIENCE AND READING INTERVENTION (INSCIREAD) ON BILINGUAL STUDENTS' MISCONCEPTIONS, READING COMPREHENSION, AND TRANSFERABILITY OF STRATEGIES

by

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A Dissertation
Submitted to the
Graduate Faculty
of
George Mason University
in Partial Fulfillment of
The Requirements for the Degree
of
Doctor of Philosophy
in Education

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Date: March 4, 2008

Spring Semester 2008
George Mason University
Fairfax, VA
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A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at George Mason University

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Dedication

For my husband, Dioni, who encouraged me to follow my dreams, keep moving forward, and never regret steps taken. Thank you for keeping our hearts together during the three years of separation we had to confront to follow those dreams, “our dreams”.
Acknowledgements

I have many people to thank who have contributed to this dissertation in one way or another. First, I would like to thank my advisor, Dr. Brenda Bannan-Ritland, and my committee members, Dr. Anastasia Kitsantas and Dr. Michael Behrmann for their mentoring and support, from the beginning of this journey at George Mason University. The encouragement and unstoppable trust of Dr. Bannan-Ritland really made a difference at a time when I needed someone to believe in me. Your abstract mind motivated me to explore unknown horizons. You are the reason I was able to start this program and I am tremendously thankful. Dr. Kitsantas, your depth of knowledge in statistics, your analysis of my work and your gentle but concise feedback have made this dissertation the way it is. Finally, Dr. Behrmann, as my professor you helped me form the ideas for this dissertation. I have been very fortunate to have the three of you, who have mentored me and pushed me and my work to new limits, on my dissertation committee,

Throughout the four years of this journey, I had many other professors and students who contributed with your knowledge and encouragement to the completion of this dissertation. I want to thank you all, especially Dr. Haley and Dr. Scruggs for your patience and enthusiasm. Your ideas and clear direction shaped my dissertation work and pushed me to think outside of the box. I would also like to thank each member of the design research team who collaborated in the effort toward a common end and made a huge contribution with their ideas, feedback, and untiring support. They are: Dr. Brenda Bannan-Ritland, Dr. Erin Peters, Dr. John Baek, Jolin Qutub, and Quing Xia.

This dissertation and the research involved would not have existed without the support, understanding, and flexibility of the administration, teachers, and students of Key Elementary in the Arlington Public School System. I would particularly like to thank Marjorie Myers, the principal of the school, and my supervisor for the last ten years. You really made a difference in my life and made it possible for me to get to where I am now!

My sister, Isabel Martinez, being a scholar yourself, provided me with constant feedback and physical and emotional support. I thank you for the many hours of data collection and analyses with which you have generously contributed to this endeavor. I know you will become a doctor yourself very soon.

Finally, I am very fortunate to have my family who never doubted I was going to be able to finish. I thank my parents, Charo and Isidro, for your courage in accepting our distance. It has been most difficult to be apart from both of you, but now I can say that with your support, I made it! And I thank my older sister, who used every opportunity to remind me how proud she was of me. I am also proud of you. Most of all, I thank my
husband, Dioni, for providing me with intellectual challenge, and making the process fun. Now, we can focus on having this baby!

This research was supported by Dr. Bannan-Ritland’s Career Award from the National Science Foundation, Number 0238129.
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<td>American Association for the Advancement of Science</td>
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<td>AERA</td>
<td>American Educational Research Association</td>
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<tr>
<td>ANCOVA</td>
<td>Analysis of Covariance</td>
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<td>ILF</td>
<td>Integrative Learning Framework</td>
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<td>INSCIREAD</td>
<td>Instruction in Science and Reading</td>
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<td>IRA</td>
<td>Index of Reading Awareness</td>
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<td>NAEYC</td>
<td>National Association for the Education of Young Children</td>
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<td>NICHD</td>
<td>National Institute of Child Health and Human Development</td>
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<tr>
<td>NONSPED</td>
<td>No Special Education</td>
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<td>NRC</td>
<td>National Research Council</td>
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<td>NRP</td>
<td>National Reading Panel</td>
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<td>Request for Proposal</td>
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<td>SLI</td>
<td>Specific Language Impairment</td>
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<td>SPED</td>
<td>Special Education</td>
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<td>ZPD</td>
<td>Zone of Proximal Development</td>
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Abstract

IMPACT OF AN INTEGRATED SCIENCE AND READING INTERVENTION (INSCIREAD) ON BILINGUAL STUDENTS’ MISCONCEPTIONS, READING COMPREHENSION, AND TRANSFERABILITY OF STRATEGIES

Patricia Martínez, PhD
George Mason University, 2008
Dissertation Director: Dr. Brenda Bannan-Ritland, Ph.D.

This thesis describes a research study that resulted in an instructional model directed at helping fourth grade diverse students improve their science knowledge, their reading comprehension, their awareness of the relationship between science and reading, and their ability to transfer strategies. The focus of the instructional model emerged from the intersection of constructs in science and reading literacy; the model identifies cognitive strategies that can be used in science and reading, and inquiry-based instruction related to the science content read by participants. The intervention is termed INSCIREAD (Instruction in Science and Reading). The GoInquire web-based system (2006) was used to develop students’ content knowledge in slow landform change.
Seventy-eight students participated in the study. The treatment group comprised 49 students without disabilities and 8 students with disabilities. The control group comprised 21 students without disabilities. The design of the study is a combination of a mixed-methods quasi-experimental design (Study 1), and a single subject design with groups as the unit of analysis (Study 2).

The results from the quantitative measures demonstrated that the text recall data analysis from Study 1 yielded near significant statistical levels when comparing the performance of students without disabilities in the treatment group to that of the control group. Visual analyses of the results from the text recall data from Study 2 showed at least minimal change in all groups.

The results of the data analysis of the level of the generated questions show there was a statistically significant increase in the scores students without disabilities obtained in the questions they generated from the pre to the posttest. The analyses conducted to detect incongruities, to summarize and rate importance, and to determine the number of propositions on a science and reading concept map data showed a statistically significant difference between students without disabilities in the treatment and the control groups on post-intervention scores.

The analysis of the data from the number of misconceptions of students without disabilities showed that the frequency of 4 of the 11 misconceptions changed
significantly from pre to post elicitation stages. The analyses of the qualitative measures of the think alouds and interviews generally supported the above findings.
1. Introduction

This thesis describes and sets the context for using an instructional model designed for upper elementary dual language students, which is based on the parallel use of similar cognitive strategies in both inquiry-based science (geomorphology) and reading comprehension. The goal of the research study was to enhance students’ awareness of the relationship between science and reading and improve their comprehension of scientific texts and content knowledge.

The challenges dual language learners endure in today’s classrooms are compounded when these learners also have special needs. Many of these challenges are in the content areas. Intersecting literacy with science is of particular importance for these students as teachers adopt inquiry-based methods, which require more language and exposure to higher order skills.

A growing body of evidence indicates a strong relationship between inquiry-based science instruction and improved achievement not only in science, but across content areas (Amaral, Garrison & Klentschy, 2002). There is also increased recognition that if students are to engage in the authentic practice and processes of science, they must be able to use informational texts (Duke & Bennett-Armistead, 2003; Kouba & Champagne, 1998; Lemke, 1990; Osborne, 2002). Some promising research supports the explicit integration of science and literacy education (e.g. Palincsar & Magnusson, 2001; Guthrie,
Anderson, Alao & Rinehart, 1999; Romance & Vitale, 1992). Specifically, there is some evidence that a combined curricular approach helps advance conceptual scientific knowledge (Barber, Catz & Arya, 2006).

However, the reality of including special needs students, together with the increase of English Language Learners (ELLs) enrolled in U.S. schools (Meskill, 2005) makes implementing effective classroom interventions, such as an integrated curriculum, difficult. It has been shown that linguistically diverse students can learn school subjects and nonnative languages simultaneously (Harley, Allen, Cummins & Swain, 1990). In addition, while these children are learning a second language, they can also read scientific information during activities in order to formulate understandings (Bernhardt, Destino, Kamil & Rodriguez-Muñoz, 1995). Nonetheless, the role of literacy materials may be undervalued in second language science instruction (Bernhardt et al., 1995).

The literature on bilingual readers also suggests the most successful these readers frequently invoke prior knowledge, tend to approach Spanish and English texts using different strategies and possess an enhanced awareness of the relationship between Spanish and English (Glaser & Strauss, 1967; Jiménez et al., 1996). Research into how second language learners approach science is needed to understand how to help students become aware of the linguistic resources they posses, to explore the implications of instruction involving authentic literacy materials (Saul, 2004a), and to identify teaching principles that serve all second language learners (Saul, 2004a).

In addition, special educators historically have been skeptical about the effectiveness of discovery, inquiry, or constructivist methods for students with learning
disabilities (LD) (Mastropieri, Scruggs & Butcher, 1997). In fact, there is little evidence suggesting that an inductive style of instruction is effective for students with disabilities (Woodward & Noell, 1992). As a result, theory and research are badly needed on the effectiveness of inquiry-based methods and on the relationship between inquiry-based methods, literacy in the content areas, and challenges faced by dual language special education students.

This investigation will build on work which examines how an integrated approach to science and literacy benefits a student’s conceptual knowledge (Guthrie & Ozgungor, 2002; Palincsar & Magnusson, 2001). This study provides additional evidence that dual language learners with and without disabilities in an inclusion environment are better served by a combined science and literacy approach to learning science and reading than by comparable science only and reading only instruction. This study will also define the characteristics of an effective combined science and reading approach for all learners, and the transferability of cognitive strategies used in science and in reading to the comprehension of scientific text.

Background

The growing awareness over the past two decades of the importance of reading to students’ ability to function in the world, has led to increased demand for effective reading instruction (National Reading Panel [NRP], 2000; Snow, Burns & Griffin, 1998). This awareness is reflected in the reading initiatives of Texas and California, as well as in the announcements of former Presidents Clinton and George H. W. Bush. These initiatives aim to ensure that, by the end of third grade, all students, including those with
LD, are reading at least at the third-grade level. Traditionally, students with LD were assumed to be unable to learn comprehension strategies because they were struggling with early reading skills. In fact, difficulties in strategic reading and spontaneous comprehension monitoring have been consistently identified as causes for reading comprehension difficulty for students with LD (Brown & Palincsar, 1982). Research in reading shows that as good readers actively engage in texts, they use strategies to help them better comprehend (Brown & Palincsar, 1984). These comprehension strategies are not isolated processes, but occur in a network where each influences the others. Different methods have been proposed to help students become more strategic readers. Two of these methods are Reciprocal Teaching (Brown & Palincsar, 1984) and Collaborative Strategic Reading (Kim, Vaughn, Klingner, Woodruff, Reutebuch & Kouzekananai, 2006). These methods are the focus of this thesis and are further discussed in the Literature Review.

When students begin secondary school, reading comprehension becomes very important for several reasons (Berninger, 1995). First, secondary school students are expected to read independently and to demonstrate comprehension in a variety of content areas. Second, students are expected not only to understand what they read but also to learn from what they read. Third, textbooks are the predominant materials that teachers use as instructional tools in the classroom (Armbruster, 1988). Despite the importance of reading comprehension, effective instruction in reading comprehension for students with LD is often neglected in secondary schools. Hence, many students with LD in secondary schools are provided little or no special assistance in this area.
In science education, the most serious reform effort over the last fifty years involves presenting science as an active way of asking questions and investigating the world (Barber et al., 2006). In order to use firsthand experiences in elementary classrooms, focus switched from text-only approaches to the process of science, and then to science as the interplay of content and process that shapes the basis for scientific inquiry (National Research Council [NRC], 2000). The role of activity in science education has concerned science teachers for some time. Recently Blank (2000) provided a concise and pointed illustration of “activity mania” in which teachers and students equate learning with doing. In this context, both teachers and students believe that the completion of an inquiry activity results in understanding, and furthermore, that any lack of understanding just requires another activity. The inquiry-based science movement needs correction as we observe the effect of adoption of hands-on approaches (Barber et al.). Text-only approaches are not widely used, but a first-hand experience-only approach also fails to meet the needs of all students. According to Barber et al. this failure is mainly due to (a) limited opportunities for reflection and discourse (Metz, 2000), (b) the need to garner some information from texts rather than direct observation (Palincsar & Magnusson, 2001), (c) the embodiment of the discourse of science in the ways scientists situate their work (Duschl & Osborne, 2002), and (d) the fact that scientists situate their work by reading what others in the field have learned and then using language to communicate their findings (Osborne, 2004).

In a keynote address at a recent workshop on science literacy sponsored by the National Science Foundation/National Science Teachers Association E. W. Saul pointed
out that there are two ends to a continuum used in literacy education (Saul, 2004b). On one end is learning how to use verbal language (reading, writing, talking) on the other, using language to learn a topic/subject. In other words, Saul distinguishes learning the mechanics of the language from understanding that language can operate as an epistemological tool.

The role of reading in science and the potential benefits of science and literacy integration are at the heart of this thesis. Integrating reading and science is critical not only because the two depend on each other, but also because comprehension and inquiry share goals and strategies (Pearson, 2006). Questioning and self-monitoring are two such shared strategies (Palincsar & Brown, 1984) which improve comprehension of informational texts and are important for science achievement (Yore, 2004). In a study conducted in 2006, Taboada and Guthrie concluded that low-and high-level questions are differentially associated with low and high levels of conceptual knowledge gained from a text. Furthermore, the participants in the study showed a clear alignment between questioning levels and reading comprehension levels. Given the use of the strategies of questioning and self-monitoring in both science and reading, these are the strategies used in this intervention.

Complementing first-hand experience with access to science texts reinforces the need for helping students improve comprehension. Finding ways to increase understanding by developing strategies that readers can use to facilitate meaningful processing is one of the issues that has proven to be important in comprehending of texts (Goldman & Bisanz, 2002). These efforts assume a general text-processing model that
asserts that readers build mental representations of information contained in text (Goldman & Bisanz). The aspect of the representation is where prior knowledge, in this case in science, exerts its most powerful influence (Kintsch, 1998).

In an attempt to provide students with science experiences which are enriched by firsthand experiments combined with other forms of science learning, recent science reform documents call for students to develop deep understandings of scientific concepts and scientific reasoning through inquiry-based instruction (NRC, 1996). While many aspects of inquiry-based instruction speak to its appeal, it is a very complex form of instruction placing many demands on students and teachers alike (Palincsar, Magnusson, Collins, & Cutter, 2001). The complexity of this learning and teaching is clearly exacerbated when it takes place in an inclusive classroom where students identified as having learning disabilities increase the heterogeneity that is already characteristic of most classrooms in the upper elementary and middle school years (Palincsar et al.).

An extensive review of the literature by Miller (1999) indicated that there have been very few studies of students with special needs in the kinds of guided inquiry classrooms that are called for in the science reform documents. From studies of traditional science instruction, we know that special needs students fare poorly and express doubts about their capacity to perform successfully in these classes (e.g. Carlisle & Chang, 1996).

One might expect similar if not more extreme results in the face of the complexity and challenge of learning via inquiry (Palincsar et al. 2001); however, early research regarding inquiry-based instruction suggests otherwise (e.g. Dalton, Morocco, Tivnan, &
Mead, 1997). These claims remain to be tested in science classrooms employing inquiry-based instruction.

The complexity of inquiry-based instruction in today’s classroom is even more evident when dealing with challenging scientific content. Geological inquiries refer to objects with histories, and therefore they demand concepts that necessarily contain an irreducible element of ambiguity (Ault, 1998). Geologists often reason by comparing and contrasting structures of interest such as mountains, valleys, and river deltas and by inferring past events from the present (Kitts, 1977). Learning to observe in a geomorphological manner is essential to being able to compare and contrast structures and is an essential part of this study. However, before effective learning can occur, the teacher and the child need to start talking science according to the same pattern of meaning. When this does not happen, a mismatch occurs that may result in the child’s understanding being at odds with the teacher’s intentions. Researchers label this mismatch a misconception (Ault, 1994). This research explores ways in which children’s perceptions, explanations, and concepts help identify misconceptions they have in the area of slow geomorphological change. Since children have their own informal everyday explanations of natural phenomena (Black & Simon, 1992), it is essential to identify how students are interpreting what they see and integrating it with what they learn in the science classroom.

Students’ erroneous ideas, once uncovered, can then used to develop activities explicitly targeting common student errors. Identifying misconceptions before and after an intervention can also help diagnose the effectiveness of the particular set of activities.
The recent emphasis on inquiry-based science teaching methods and reading comprehension strategies, discussed in detail above, has brought attention to the intersection of literacy and science processes with a particularly pronounced need for additional research at the upper elementary school level (Palincsar & Magnusson, 2001; Snow, 2002). The connection of strategies and the interdependence of skills learned in science and reading are evident in the reality of every scientist. In fact, Goldman and Bisanz (2002) explain that as scientists engage in the ongoing process of inquiry, written texts often serve as mediators in their grappling with the ideas, thoughts, and reasoning of others. Further, exploration and investigation provide a rich source for the study of students’ science and literacy reasoning (Reardon, 2004). Reardon explains that the exposure to language in the context of exploration is especially beneficial to English as a second language students in the classroom.

This need for exposure is particularly acute in the fourth grade when children are expected to shift from reading narrative text to expository materials that involve long passages, less familiar content, and more complex structures. This problem has been characterized as the “fourth-grade slump” providing compelling evidence of a significant decline in the comprehension of expository or informational text around the fourth grade (Chall, 2003). This problem is particularly significant since students at all levels are now expected to read more text as well as more complex texts and recent studies found that fewer than one third of students at the fourth-grade level demonstrated reading proficiency (Snow, 2002).
In conclusion, there is a long history of investigating metacognitive strategies in science education; however, multiple important issues remain to be examined related to the relationship between inquiry-based science activities, metacognition, and science reading comprehension. There is a documented need in the literature for studies in which diverse students with and without disabilities participate in inquiry-based learning in an inclusive setting. Further, studies which will help illuminate the essential instructional principles to prepare all students to be successful readers and scientists when dealing with complex science content are necessary. Toward that end, this research asks the questions introduced below.

In order to arrive at stronger conclusions, this investigation includes two studies. The first study is a mixed-methods quasi-experimental: Study 1 and the second is a single subject: Study 2. Research Question 1A is answered in both studies and Research Question 5 is answered as part of Study 2 only. Data from students with special needs are presented as part of the single subject: Study 2.

Quantitative Research Questions for Study 1

Research question 1 (A-D) is does explicit instruction of scientific text content and comprehension fostering cognitive based strategies (questioning and self-monitoring) (INSCIREAD) have an effect on 4th grade children’s

1A. Science text recall?

1B. Level of generated questions?

1C. Ability to monitor their comprehension as measured by their ability to detect incongruent sentences, before and after controlling for guessing?
1D. Ability to summarize and rate importance?

Research question 2 is does INSCIREAD have an effect on 4th grade children’s number of misconceptions as shown by descriptions and illustrations they create to answer open-ended questions?

Research question 3 is does INSCIREAD have an effect on 4th grade children’s awareness of the parallelism and the interdependence of science and reading, as shown by the number of connections they are able to make on a science and reading concept map?

*Qualitative Research Question for Study 1*

Research question 4 is how does INSCIREAD impact 4th grade children’s use of the online cognitive strategies of questioning and self-monitoring as shown by a think-aloud protocol using texts with anomalous sentences?

*Quantitative Research Question for Study 2*

Research question 1 A is also answered in Study 2 and it is does explicit instruction of scientific text content and comprehension fostering cognitive based strategies (questioning and self-monitoring) (INSCIREAD) have an effect on 4th grade children’s science text recall?

*Qualitative Research Question for Study 2*

Research question 5 is how does INSCIREAD have an effect on 4th grade children’s awareness of the parallelism and the interdependence of science and reading, as shown by their answers to interview questions?


**Definition of Terms**

**Attention Deficit Disorder:** According to the Disabilities Resource Manual (2005) from the Department of Student Services of Arlington Public Schools, key elements of an attention deficit disorder are chronic and pervasive problems with inattention and/or impulsivity and/or, in the case of attention deficit hyperactivity disorder, hyperactivity.

**Authentic Texts:** Text used in their original form in purposeful and meaningful contexts.

**Awareness:** According to the definition from *Webster’s Ninth New Collegiate Dictionary* (1984), awareness means having or showing realization, perception, or knowledge. The definition also includes “having knowledge of something.” Awareness, then, does not necessarily imply understanding, just an ability to be conscious of, or perceive. For the purposes of this study awareness of the relationship between science and reading is defined as the students’ ability to realize and to be able to express (verbally, with drawings, or in writing) that reading and science depend on each other, because reading science texts and working in science are both needed to explore and construct scientifically viewed concepts. Additionally, the two share a common set of cognitive strategies.

**Cognitive Reading Strategies:** Cognitive strategies which facilitate reading comprehension and may be teachable (Garner, 1987).

**Cognitive Strategy:** Generally deliberate, global, rather than domain-specific (Chi, 1987), planful activities undertaken by active learners, many times to remedy perceived cognitive failure (Garner, 1987). A cognitive strategy has four properties (Chi):
• General and domain-independent
• Has a goal
• Can have several components
• The total number of strategies in memory must be finite

*Cultural Congruence*: Communication and interaction patterns which are familiar and intelligible to students (Villegas & Lucas, 2002). Utilizing children’s home-language resources in the teaching and learning process is emphasized in the literature (Moll, Diaz, Estrada & Lopes, 1992). Instructional congruence emphasizes the role of instruction (educational interventions) as teachers explore the relationship between academic disciplines and students’ cultural and linguistic knowledge and devise ways to link the two (Lee, 2002, 2003, 2004; Lee & Fradd, 1998).

*Culturally Sensitive Contexts*: The efforts or classroom attempts at more closely matching school culture with student culture to promote academic success.

*Dissonance*: “A negative drive state which occurs whenever an individual simultaneously holds two conditions (ideas, beliefs, opinions) which are psychologically inconsistent” (Aronson [as cited in Otero, 2002]).

*Emotional Disturbance*: According to the *Disabilities Resource Manual* (2005) from the Department of Student Services of Arlington Public Schools, emotional disturbance is a condition exhibiting one or more of the following characteristics over a long period of time and to a marked degree that adversely affects a student’s educational performance: (a) an inability to learn that cannot be explained by intellectual, sensory or health factors, (b) an inability to build or maintain satisfactory interpersonal relationships
with peers or teachers, (c) inappropriate types of behaviors or feelings under normal circumstances, (d) a general pervasive mood of unhappiness or depression, or (e) a tendency to develop physical symptoms or fears associated with personal or school problems. According to the *Disabilities Resource Manual* the term includes schizophrenia. The term does not apply to students who are socially maladjusted, unless it is determined that they have an emotional disturbance.

*Inquiry:* A central strategy for teaching science consisting of inquiring into authentic questions generated from students’ experiences (NRC, 1996). According to The National Science Education Standards’ definition of inquiry, when students generate questions for the purpose of finding “answers to questions derived from curiosity about everyday experiences,” they are participating in scientific inquiry (NRC, 1996, p. 22).

*INSCIREAD:* An instructional model utilized in this research study, based on the parallel use of similar cognitive strategies in both inquiry-based science, and reading comprehension of science texts in order. The model presents a sequence meant to improve students’ comprehension of scientific text, help students acquire scientific concepts closer to those held by scientists, and enhance students’ awareness of the relationship between science and reading.

*Misconceptions:* Prior concepts by which individuals explain concepts and processes in the physical world (Kendeou & van den Broek, 2005), which have been found to hinder learning (Alvermann, Smith & Readence, 1985) because they are markedly different from the concepts of the teaching program. Misconceptions have also
been called children’s science, erroneous ideas, everyday physical conceptions, or alternative framework, among others.

**Questioning:** The strategy referenced to as questioning helps to foster active comprehension (NRP, 2000), and is important in both science inquiry and reading. Someone who asks a substantial number of questions may be described as an active learner (Graesser, McMahen, & Johnson, 1994). Having readers generate questions during reading has been shown to be an effective and promising strategy for classroom instruction (NRP). Questioning is related to the regulation part of self-monitoring (see the definition of self-monitoring, p. 15) because one of the appropriate regulation actions is asking questions about problematic information to be processed (Costa, Caldeira, Gallástegui, & Otero, 2000). Higher order inferential questions induce more thorough processing than lower level questions (Davey & McBride, 1986).

**Self-Monitoring:** A metacognitive strategy related to the awareness of what one knows and what one does not know, and requires knowing which of the different parts to be learned require more attention and effort (Chi, 1987). The relationship between monitoring and metacognition is as follows. Metacognition engages different levels of cognitive activity in relation to reflection in action involving the real-time thinking about a task, as one is doing the task, to improve the performance of that task (Yore, Florence, Pearson, & Weaver, 2006). Monitoring is a process of self-reflection that leads to planning and self-regulation, which are involved in the simple form of metacognition (Yore et al., 2006). Comprehension monitoring involves deciding whether or not we understand something (evaluation) and taking appropriate steps to correct whatever
comprehension problems we detect (regulation) (Baker, 2004). For the purposes of this study, self-monitoring focuses on three questions students asked when engaged in science and reading. The three questions take students to different levels of processing. Deep processing leads to more accurate judgments of what is actually learned (Maki, 1998 [as cited in Elshout-Mohr & van Daalen-Kapteijns, 2002]). The three questions are:

- Does it make sense with the text, with what I already know? If not, what do I do about it? (Shallow processing)
- Do I understand? If not, what do I do about it? (Shallow processing)
- What’s the main idea? (Deep processing)

In order to help students learn and implement the strategy of self-monitoring, the teacher-researcher guides students through three steps: (a) making a prediction; (b) asking oneself if the information makes sense and is understood, then recording it using a plus or a minus sign, and clarifying whenever needed; and (c) identifying the most important words or sentences before generating a short summary of each paragraph. (Students are encouraged to use a highlighter.)

Special Education Students: In this study, the term special education students is used to refer to those students who have an identified disability, such as a learning disability or an attention deficit disorder.

Specific Learning Disability: According to the Disabilities Resource Manual (2005) from the Department of Student Services of Arlington Public Schools, a specific learning disability is a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest
itself in an imperfect ability to listen, think, speak, read, write, spell or do mathematical
such conditions as perceptual disabilities, brain injury, minimal brain dysfunction,
dyslexia, and developmental aphasia, but does not include learning problems that are
primarily the result of visual, hearing, or motor disabilities; of mental retardation; of
emotional disturbance; or of environmental, cultural, or economic disadvantage.
2. Literature Review

To provide a theoretical context for this study, this literature review attempts to interconnect the following wide-ranging areas of research: dual language learners, special education, literacy, and inquiry-based science and technology. To conduct this explanatory synthesis, I relied on the literature review methodology described by Cooper (1988). He promotes the use of the literature review to “build bridges between topic areas.” (Cooper, 1985, p. 3). Integrating these important areas of focus is crucial to providing the necessary grounding for further study of linguistically and cognitively diverse learners and their unique needs in literacy and inquiry in science that may be served by technology. Building conceptual, theoretical and research bridges by integrating literature in this review will provide a foundation for future research and technology development to assist dual language learners with and without special needs.

The researcher reviewed studies and articles addressing content reading comprehension; cognitive strategies in science and reading; inquiry-based science; the interdependence of science and reading; the importance of prior knowledge; and students’ misconceptions in earth science, and technology and learning. Articles connecting these areas and students with learning disabilities and/or students at risk or learning a second language were the foci of the review. The articles were located by a search of computerized databases including ERIC (1996-2006), PsycINFO (1996-2006), and ProQuest (1996-2006). In addition, I searched digital dissertations, followed up on
references given in the most significant articles, and conducted an ancestry search of articles.

The key descriptors included: reading comprehension and science, inquiry and reading and science, special needs/learning disabilities/low impact disabilities and inquiry, special needs and science and reading, language learners and inquiry, language learners and reading comprehension, and misconceptions and earth science and technology, among others.

Particularly relevant journals I consulted included: The Journal of Research in Science Teaching, European Journal of Science Education, Remedial and Special Education, Journal of Learning Disabilities, Journal of Geoscience Education, Reading and Writing Quarterly, and Reading Research Quarterly. Finally, I contacted several experts in the field on a variety of topics: Dr. Jose Otero from the Universidad de Alcala de Henares, Spain, on the psychology of science text comprehension; Dr. Annemarie Sullivan Palincsar from the University of Illinois, on reciprocal teaching; Dr. Kathleen Metz from the University of California at Berkeley, on using inquiry science with young students; Dr. Ana Miranda from the Universitat de Valencia, on reading and students with attention deficit disorders; and Dr. P. David Pearson from the University of California at Berkeley on the connection of reading and science.

Many of the challenges dual language learners with and without disabilities endure in today’s classrooms are in the content areas. Interconnecting literacy with science is of particular importance for these students as teachers adopt inquiry-based methods, which require more language and exposure to higher order skills.
A growing body of evidence indicates a strong relationship between inquiry-based science instruction and improved achievement not only in science, but across content areas (Amaral, Garrison & Klentschy, 2002). However, the relationship between inquiry-based methods, literacy in the content areas (particularly math and science), and challenges faced by bilingual special education students is an area in great need of theory and research. In addition, technology and accessible Internet resources offer potential for literacy support for dual language students with cognitive special needs in inquiry-based instruction.

Currently, although research has been conducted in all of the areas touched on above, very little has been done on the interconnections of these issues for students who have linguistic and cognitive special needs. Therefore, as stated above, the integration of these important areas of research is crucial to providing the necessary grounding for continuing study of learners with both linguistic and cognitive special needs.

The literature review covers eight major topics: (a) content reading comprehension, (b) cognitive strategies in reading and in science, (c) text variables, (d) constructivism and social construction of knowledge, (e) the generative model of teaching, (f) interdependence and relationship of strategies in science and reading, (g) the importance of students’ prior knowledge and issues related to vocabulary, and (h) technology and learning. To describe explicitly the chain of reasoning which has shaped this thesis, a summary of the literature review is presented at the end of the review. Partial summaries are also provided throughout the review where necessary to help explain how concepts are integrated.
Content Reading Comprehension

Many local school districts have targeted improvement in reading as their highest priority. The national attention to reading, however, focuses predominately on early reading instruction, such as phonological awareness, decoding, and word identification instruction (Snow et al., 1998). Early reading instruction has historically been emphasized with the understanding, that if effective, the number of struggling readers should diminish. Furthermore, it is commonly believed that instruction on early reading skills, such as decoding and word identification skills must precede instruction in comprehension (Gersten & Baker, 1998). A brief history of the research in content reading comprehension followed.

In 1976 the National Institute of Education Reading Research issued a Request for Proposal (RFP) to establish a Center for the Study of Reading for the purpose of conducting research in reading comprehension. The RFP’s proposal included the following three assumptions (Durkin, 1978):

1. Reading comprehension can be taught.
2. Reading comprehension is being taught.
3. Current teaching of comprehension must be improved if reading problems are to be reduced.

In 1978, Dolores Durkin’s study of classroom reading instruction found that teachers taught comprehension less than one percent of the time. Since then research on comprehension instruction has proliferated. Twenty years later, Pressley, Wharton-McDonald, Hampson, and Echevarria (1998) revealed that despite all the research,
comprehension instruction in classrooms remained inadequate. A consistent finding in the reading comprehension studies is that teachers most frequently used comprehension practice is teacher questioning: In other words, the teacher, not the students, was in charge of monitoring comprehension (Holmes, 2000).

Since 1975, the two main streams of research on comprehension have been: (a) processes used by proficient readers, and (b) instructional strategies that improve students’ comprehension (Asselin, 2002). The major contributions of both streams follow.

**Research on processes used by proficient readers.** Reading research looking at comprehension processes evolved through three information-processing theories to explain what now seems obvious to us, how readers’ background or prior knowledge affects comprehension (Asselin, 2002). The three theories are (a) the bottom-up, (b) the top-down, and (c) the interactive model. This thesis is rooted in the top-down and interactive information-processing theories.

The bottom-up, or text-based theory (Gough, 1985; LaBerge & Samuels, 1985), describes information processing as a series of discrete stages proceeding from letter identification to meaning. According to this model, the reader’s role is passive, and the only knowledge needed to learn to read is knowledge of sound-symbol correspondences (Kamil & Pearson, 1979). In contrast, the top-down, or knowledge-based processing theory (Goodman, 1970; Smith, 1978), describes the reading process as a search for meaning in which the reader plays an active role. Top-down theorizing is widely used in traditional psychology and is behind single-subject designs, which are used to explore the
nature of behavior and develop theories from the data collected. As will be explained at a
later in this review, this study includes a single-subject design. Finally, the interactive
model contends that both bottom-up and top-down processing occur simultaneously as
the reader searches for meaning (Rumelhart, 1985). The interactive model provides
justification for direct instruction of the content knowledge that students are asked to read
and learn.

Theorists who emphasize the reader’s knowledge are called schema theorists and
they base their models on those of the cognitive psychologists (Holmes, 2000).
According to this view, the process of understanding is under the control of a guiding
schema (Schank & Abelson, 1977) that provides a control structure to regulate
comprehension processes from the top down (Kintsch, 1998).

Barlett (1932) was the first psychologist to use the term schema and he focused
his work on the effects that time, interest, and prior knowledge had on story recall. In a
study on the oral recall of an Indian folktale with 20 subjects, he found that after long
periods of time the subjects simplified the passage by omitting or changing troublesome
elements of the story that did not fit their schema. He referred to memory as a
reconstructive process where information is altered as changes in schemata occur due to
time and the input of new information.

Schema theory has taken many forms over the years, but according to Kintsch
(1998) it has problems. He explains that because human comprehension is incredibly
flexible and context sensitive, it cannot be modeled solely with fixed control structures
like schemas. The outcome of comprehension is certainly a coherent model, but the
process can be conceived as a loosely structured, bottom-up process that is highly sensitive to context and that adjusts easily to shifts in the environment. Therefore, comprehension can be very chaotic in its early stages, becoming orderly only when it reaches consciousness; according to this theory, then it is difficult to model that such a process with fixed control structures like schemas. The process can only be modeled in an associative, bottom-up manner that is followed by a satisfaction process in the form of an activation mechanism that yields the coherence and order we experience. This model is what Kintsch (1998) called the construction-integration model.

The theory of development and learning elaborated by Vygotsky (1978) aims to explain that learning is a journey from outer to inner control. Learning does not evolve naturally in isolation and independence, but is shaped by social processes, occurring as one interacts with experts in problem-solving situations. However, it is not simply this social action alone that leads to learning, but the very speech itself that is used in this social interaction and is taken over by the child and internalized. Brown, Palincsar, and Armbruster (1994) explained that “development progresses from social to individual cognitive processing” (p. 758), that is, from social speech to inner speech. An important Vygoskian idea is that of the zone of proximal development (ZPD), which describes what the child is able to do with help from a more capable other. The ZPD offers opportunity—opportunity to teach and to learn. Teaching in the ZPD requires that an expert first model how to complete a task for him or herself and then provide assistance as the child tries out that task on his own. The expert then gradually removes support and the child eventually learns to complete the task independently. As I will explain later in
this review, the instructional method for reading comprehension strategies called Reciprocal Teaching (Palincsar & Brown, 1984) is consistent with this approach. Although both the schema and the construction-integration models emphasize the need for explicit instruction of comprehension processes, they also imply the Vygoskian-based idea that comprehension is a complex and very individualized process for which there are no miracle recipes that work for all. The variety of students in today’s classrooms means an organized and planned curriculum must account for differences in preferences for materials, in engagement, and in strategies (Blachowicz & Ogle, 2001). The instructional sequence in this investigation models and facilitates students’ use of cognitive strategies, but ultimately it is the students’ personal construction of these strategies that will help them improve their understanding of scientific texts. Common to both schema and the construction-integration models is the characterization of reading comprehension as an active complex process that places the reader in a responsible position of constructing meaning from text. Active comprehension involves self-monitoring and student questioning that then lead to independent comprehension building, a conclusion that is consistent with the findings from my 2006 pilot study based on student’s interviews. During these interviews, although students were able to name many strategies, they did not use them while reading to help them improve their comprehension (Martínez, 2006). These findings indicate that students need to have the opportunity to use strategies after modeling and adapt them to their own needs. Only then will the strategies do what they were designed to do: help students better comprehend scientific texts.
According to Palincsar and Brown (1984), it is generally agreed that if a student has a reasonable facility with decoding, then reading comprehension will be the product of three main factors: (1) considerate texts, (2) compatibility of reader knowledge and text content, and (3) the active strategies the reader employs to enhance understanding and retention and to circumvent comprehension failures. The next section gives a general description of instructional strategies for reading comprehension as they relate to these factors.

*Instructional strategies that improve students’ comprehension.* The second major body of research on comprehension instruction focuses on instructional constructs. *Instructional framework* is how Boatright (2005) terms the components that make up the learning process. He explains that, although flexible, the instructional framework can be used by teachers as a planning guide, and students can utilize it as a learning guide. When examining the instructional components of a quality reading program, key issues are the consideration of the constructive nature of comprehension, the importance of comprehension instruction, and the direct instruction of strategies. Although these components are important considerations for regular classroom instruction, they become imperative when designing programs for struggling readers (Diehl, 2005). Due to the relevance and the importance of cognitive strategies in this research study, I will address the research on these in depth as well as their significance in reading and in science in a separate section.

*Summary of the research on content reading comprehension.* This section of the Literature review dealt with issues of science text reading comprehension. This historical
overview covered how the position on reading comprehension took a 180 degree turn: early research framed reading comprehension as a skill arising naturally from the knowledge of how to decode; the education community now sees it as one that needs to be taught.

Two major streams of research about comprehension were discussed next: the first covered the process used by proficient readers (including the schema theory and ZPD) and the second looked at instructional strategies that improve students’ comprehension. The last topic of the section on content reading comprehension introduced the research on cognitive strategies, which is addressed in the next section.

*Cognitive Strategies in Reading Comprehension*

According to Garner (1987), reading strategies, which she operationally defines as “generally deliberate, planful activities undertaken by active learners, many times to remedy perceived cognitive failure” (p.50), facilitate reading comprehension and may be teachable. Studies on strategy training have found that when strategies are modeled for students and when students have an opportunity to practice the strategy, their reading comprehension improves (Palincsar & Brown, 1984; Wittrock, 1991). Garner (1994) concurred with Paris and Myers (1981) that reading strategies can and should be learned to the point of automaticity. They explain that once the strategies are automatic, they become skills, and that learners need to learn not only the strategies to use, but also when, where, and how to use them.

According to the text processing model of Kintsch and van Dijk (1978), forming a macrostructure is an integral part of normal text comprehension. It does not occur merely
in response to special task demands, such as instructions to summarize the text, but is an automatic component of the process of comprehension that cannot be separated from it.

The concept of strategies, as used in developmental research, is general and global, rather than domain specific (Chi, 1987). At the same time, the more general term of metacognition, discussed later in this review, is often regarded as referring to general and flexible knowledge that is not domain specific (Greeno & Riley, 1987).

According to Chi (1987) a strategy has four properties: (a) it is general and domain-independent, (b) has a goal, (c) can have several components, and (d) the total number of strategies in memory must be finite. The author enumerates a number of findings from the literature, which are relevant to this thesis. First, for the purpose of generalization from one task situation to another, strategy training has been unsuccessful. Next, younger children can often learn to use a strategy, but unless explicitly told to do so, will not apply it. Additionally Chi (1987) found that whenever an instructional approach is used to teach strategies, older children often will learn and adopt them more readily than young children. This finding is significant here because it suggests that earlier exposure to the strategies might facilitate their generalizability.

The next section covers ideas and research related to the two strategies, self-monitoring and questioning, taught and used in the intervention described in this study. .

Self-monitoring and metacognition in reading. Metacognitions are second-order cognitions: Thoughts about thoughts, knowledge about knowledge, or reflections about actions (Weinert & Kluwe, 1987). A simpler definition is offered by Jacobs and Paris (1987) metacognition refers to thinking about thinking. Metamemory is a specific type of
metacognition generally defined as: the knowledge one has about memory in general; including a system of skills for planning, directing, monitoring, and evaluating one’s behavior during learning and remembering (Weinert & Kluwe, 1987). Just as Chi (1987) explained that strategies are general and global, metacognition is often regarded as referring to general and flexible knowledge that is not domain specific (Greeno and Riley, 1987). Metacognition addresses the fundamental issues of concern to information-processing theorists, i.e., the active role of learners in directing their own processes for learning, and the extent to which individuals are able to transfer what they have learned to different settings. Metacognitive theorists assert that it is the person’s metacognitive knowledge which permits him to perform as an independent learner with the ability to adapt cognitive activity to different settings (Gavelek & Raphael, 1985).

Flavell (1979) first used the term Metamemory in cognition with his memory studies in the 1970’s. According to Flavell (1979), cognition involves processes such as perceiving, remembering, and comprehending. Metacognition involves processes such as metaperception, Metamemory, and metacomprehension. Flavell (1981) differentiated between metacognitive experiences which students may have, metacognitive strategies, which are discussed at different points throughout this section, and metacognitive knowledge, which refers to knowledge of what variables act in what ways to affect a person’s cognitive performance. Flavell (1981) distinguishes among three categories of such variables: (a) knowledge about ourselves (persons), which refers to knowledge about our abilities and limitations in learning situations; (b) knowledge about tasks, which refers to knowledge about the relative difficulty of processing different types of
information; (c) knowledge about strategies, which refers to knowledge about various goal-directed actions one can voluntarily use to facilitate comprehension. These three variables are highly interactive and interdependent.

Harris, Kruithof, Terwogt, and Visser (1981) distinguished between two main components of comprehension monitoring: Active constructive processing, which requires the child to integrate the material actively (usually measured in relation to the difference in time the reader needs to comprehend a sentence), and checking of such processing or specifically comprehension monitoring, which has been measured as the ability of the reader to identify incongruent sentences within a text in relation to other sentences. Students at times check each sentence for its possible falsehood, rather than for its consistency with other sentences, and in that case they are failing to effectively monitor their comprehension. These authors conducted two experiments looking at students of different ages and both of these components of comprehension monitoring, and concluded that correlational measures indicated a weak relationship between constructive processes as indexed by reading time and the detection of anomaly (comprehension monitoring). They also conducted an anomalous sentence recall and a text recall to further check other hypothesis. Their findings suggested that eight-year-olds may have been able handle the recall task but have failed to tag that line as problematic, thereby creating difficulties in the comprehension monitoring task. These findings suggest an important direction for future research, namely to investigate the relationship between comprehension processes and comprehension monitoring. Since this study
includes a recall and a comprehension monitoring component, this area of need will be addressed.

One of the metacognitive strategies is monitoring. Monitoring is a form of Metamemory, which is related to the awareness of what one’s knows and what one doesn’t. Monitoring requires knowing which of the different parts to be learned require more attention and effort (Chi, 1987). Comprehension monitoring is an important metacognitive skill that enables individuals to evaluate and alter their performance (Pressley & Ghatala, 1990). Therefore, there is a hierarchical relationship between the terms ”metacognition”, “cognitive monitoring”, and “comprehension monitoring”. The superordinate term is “metacognition”. “Metacognition” and “cognitive monitoring” refer to knowledge about cognition in general.

Metacognitive theorists and researchers maintain that we can teach students to use a flexible repertoire of comprehension strategies that will serve the dual purpose of enabling them to focus simultaneously on the material they are reading and on themselves as learners. Studies have shown that strategies which enable students to maintain this split mental focus while reading will help the inefficient learner meet the demands of learning from texts (Paris & Myers, 1981). Next, I present the research on metacognition and the strategy of monitoring.

Baker (2004) explains that effective text comprehension requires an important metacognitive control component known as comprehension monitoring. He adds that comprehension monitoring involves deciding whether or not we understand something (evaluation) and taking appropriate steps to correct whatever comprehension problems
we detect (regulation). Research has shown that students of all ages are often surprisingly poor at monitoring their understanding of text (Baker, 1989). This is included in this thesis study because these difficulties are most apparent when students are asked to read information text, such as science books (Otero, 1998).

A promising area of research related to the process of noticing and fixing comprehension difficulties, is that of creating a cognitive dissonance. Festinger (as cited in Otero, 2002) refers to the theory of cognitive dissonance, which is one of the oldest theories of regulation processes. Dissonance is defined as “a negative drive state which occurs whenever an individual simultaneously holds two cognitions (ideas, beliefs, opinions) which are psychologically inconsistent” (Aronson, 1968, p. 5 as cited in Otero, 2002). Research has been conducted on the methods used by individuals to reduce states of dissonance (Abelson, 1959 as cited in Otero, 2002). Also regulation has been studied by researchers interested in the way readers modify situation models (e.g. Kintsch, 1998). Finally, regulation has been investigated in research on comprehension monitoring, within the framework of the contradiction paradigm (Otero, 2002). In this framework, subjects read manipulated texts that contain contradictions. Detecting a contradiction is taken as a sign of adequate monitoring of comprehension.

The potential of strategies to be transferred has already been mentioned in this review as one of the essential topics in relation to this study. The general monitoring skill hypothesis is related to this idea. Schraw, Dunkle, Bendixen, and Roeder (1995) conducted two experimental designs in order to clarify whether monitoring is best construed as a domain-specific or domain-general phenomenon. The findings obtained
by Schraw (1994) with college students also indicated that monitoring accuracy in one domain was related to accuracy in other domains. This idea introduced at the beginning of this section is what they called the general monitoring skill hypothesis. Their findings were consistent with the domain-general assumption that performance and monitoring are governed in part by general processes that transcend domain boundaries.

Schraw and Nietfeld (1998) conducted a study to test the general monitoring skill hypothesis proposed by Schraw, Dunkle, Bendixen & Roeder (1995) and they found that individuals use a similar heuristic for texts that share similar demands, even when those texts differ widely with respect to content and difficulty. These findings are most compatible with the domain-general theory, which states that skilled learners construct a limited set of general monitoring skills that enable them to self-regulate with a high degree of proficiency in any domain. These ideas, which are supported by the research, suggest that students will be able to use their monitoring skills across reading and science. This is significant in the present study because I am investigating whether or not students can be taught to realize the parallelism among processes and strategies across science and reading.

Specifically, metacognitive reading skills include the following activities: Establishing the purpose for reading; modifications in reading due to variations in purpose; identifying important ideas; activating prior knowledge; evaluation of the text for clarity, completeness, and consistency; compensation for failures to understand; and assessing one’s level of comprehension (Baker & Brown, 1981). It is clear that these activities strategic reading activities were recognize well before the emergence of the
term metacognition (Brown, 1987). Thus, there is considerable historical agreement that reading and learning from texts involve metacognitive skills (Brown, 1987).

As I mentioned earlier, it is well-known that active self-regulation strategies such as elaboration, critical thinking, and organization of information influence learning (Weinstein & Mayer, 1985; Paris & Myers, 1981). Monitoring one’s comprehension is also a part of the strategies that play a key role in self-regulated learning (Zimmermann, 1990). However, Brown (1987) explains that it is important to notice that self-correction and regulation can proceed below the level of consciousness (self-regulation). Piaget’s mature stage of reflected abstraction is distinguished by the “transcendence of action by conceptualization”; understanding comes “out of the realm of successes into the realm of reason” (1978, p. 218). Thus, Piaget distinguishes between self-regulation, which is age-dependent, and metacognition, which is late developing, and is the keystone of formal operational thought. This is significant for this thesis study because it suggests there is an instructional component to metacognition. Next, I present the research on instructional research on metacognition.

Around 1970, when metacognition work was beginning to appear, there was an increase in the amount of instructional research being conducted (Campione, 1987). Reports of relevant research began to appear in the mid 1970’s showing that retarded children failed to produce the kind of strategies necessary for a variety of tasks. By now, metacognitive deficiencies have been cited as a factor in poor academic performance (Campione, 1987). In fact, there are a number of studies that demonstrated that unskilled readers have lower metacognitive skills.
Paris and Myers (1981) compared good and poor fourth graders readers and observed that good readers knew more about reading strategies, detected errors more often while reading, and had better memory for text than did poor readers. Canney and Winograd (1979) found that young and poor readers attended more to decoding, whereas proficient readers knew that making sense was the goal of reading. Kobasigawa, Ransom, and Holland (1980) observed that 10-year-olds had only a rudimentary understanding of skimming, whereas 14-year-olds could describe and use skimming as a strategy to aid comprehension. One last study which demonstrates the relationship between metacognitive awareness and reading ability was conducted by Paris and Jacobs (1984). They found that children with high awareness about reading based on their metacognitive scores consistently scored higher than other children on standardized reading tests, cloze tasks, and error detection tests. They used an interview to uncover students’ awareness and demonstrated that interview measures can yield information about metacognition. However, Garner (1987) reported eight criticisms of verbal report data on children’s reading. His criticisms included that some cognitive processes are tacit and inaccessible, and that children may lack the language and verbal facility to discuss mental events. The important idea of these findings is that researchers agree that awareness and monitoring of one’s comprehension processes are critically important aspects of skilled reading and self-monitoring is a factor in poor academic performance. As mentioned earlier, such awareness and monitoring are often referred to in the literature as metacognition (Mokhtari & Reichard, 2002). In addition, Paris and Winograd (1990) maintained that metacognition can promote academic learning and motivation.
Students can enhance their learning by becoming aware of their own thinking as they read and engage in science at school. This consciousness-raising presents a double benefit (Paris and Winograd, 1990): “(a) it transfers responsibility for monitoring learning from teachers to students themselves, and (b) it promotes positive self-perceptions, affect, and motivation among students. In this manner, metacognition provides personal insights into one’s own thinking and fosters independent learning” (p. 15). The third reason that metacognition has become popular is that it offers a tangible alternative to unsatisfied teachers who have used the term metacognition to create instruction that fosters thinking strategies and complements traditional methods.

Many articles written for teacher educators and curriculum supervisors have enthusiastically endorsed metacognition as a key ingredient for cognitive instruction that leads to independent learning (e.g. Costa, 1986). According to Jacobs and Paris (1987), this enthusiastic acceptance of the importance of metacognition can be traced to several factors. First, metacognition emphasizes active participation by the reader in task analysis and strategic reading. Second, children are often confused about what to do when they confront an unknown word, why skimming text can be useful or how rereading might facilitate understanding. This is particularly true among unskilled readers. However, some reading educators believe that an emphasis on reflection, planning, and cognitive strategies will lead to practice on cognitive skills removed from the context of reading (Jacobs and Paris, 1987). More research is needed in order to find appropriate measures of metacognition and to test the value of the construct in helping students read better.
There are many different kinds of knowledge and processes subsumed under the term of metacognition. Campione (1987) explains this distinction. On the most general level, the topic of metacognition includes knowledge concerning, understanding of, and access to cognition and cognitive resources. There are two distinct referents involved in this definition: Knowledge about the cognitive system and its contents (e.g. Knowing that immediate memory span is limited and that some kinds of information like a list of organized items are easier to remember than others); and self-regulatory mechanisms, which include checking, planning, monitoring, selecting, revising, etc. (Brown, 1987).

Two phases may be distinguished in comprehension monitoring; evaluation and regulation of comprehension (Otero, 1996). The author explains that evaluation refers to the identification of a comprehension problem. Students at the elementary level, for instance, frequently overlook apparently clear inconsistencies that exist between information found in a text and their knowledge (Markman, 1979). Regulation consists of the actions undertaken to solve the problem, after students have detected it. This research study focuses on helping students identify when understanding is not occurring and at the same time provide students with tools to help them bring the understanding back.

Paris and Winograd (1990) caution that “metacognition should not be regarded as a final objective for learning or instruction”. Instead, it should be an opportunity to “provide students with knowledge and confidence that enables them to manage their own learning and empowers them to be inquisitive and zealous in their pursuits” (Paris & Winograd, 1990, p. 22). Campione (1987) concludes that the most effective teaching plan would attend to providing knowledge about the domain (domain-specific), specific
procedures for operating within that domain (reading and science in this case), and more
general regulatory processes that are task independent. The research shows that slow
learners experience problems in all three areas. He explains that incorporating all three
areas would be expected to yield truly impressive results.

Summary of metacognition and self-monitoring in reading. This section of the
review started with the definition, origin, and categories of the term metacognition. The
research presented indicates that students can learn to use a flexible repertoire of
comprehension strategies to enable them to focus simultaneously on the material they are
reading and on themselves as readers. The general monitoring skill hypothesis proposed
by Schraw et al. (1995), which supports the domain-general theory, was discussed. In
general, this review of metacognition and self-monitoring in reading, supports the idea
that the cognitive strategy of self-monitoring can be learned in any one context, and can
then potentially be transferred to other contexts (such as science and reading). Next, the
research on the cognitive strategy of questioning is presented.

Questioning in reading. An active learner has been described as someone who
asks a substantial number of questions (Graesser et al., 1994). In reading, student
questioning is represented as a strategy that helps foster active comprehension (e.g., NRP,
2000). Instruction in generating questions has been shown to help elementary students
improve their comprehension of expository and narrative texts (e.g., King & Rosenshine,
1993). As a reading strategy, student questioning is supported by strong empirical
evidence pointing to the benefits that instruction of question-generation during reading
can bring to reading comprehension (NRP). Research reviewed by the National Reading
Panel reveals that there are 16 categories of instruction. Out of the 16 categories of instruction only 7 strategies appeared to be effective and promising for classroom instruction. Of these 7 strategies, the effectiveness of having readers generate questions during reading (NRP) has the strongest support from scientific evidence.

With regard to informational texts, higher order inferential questions induce more thorough processing of the text and enhance attention to its macrostructure (Davey & McBride, 1986). In fact, it has been suggested that students who tend to ask lower level questions struggle with identifying the overall hierarchical structure of texts and the major interrelationships among the concepts within texts in a knowledge domain (Taboada & Guthrie, 2006).

Questioning and metacognition are related. As mentioned in the section reviewing the research on metacognition in reading, two phases may be distinguished in comprehension monitoring: evaluation and regulation of comprehension (Otero, 1996). This research study focuses on helping students identify when understanding is not occurring (evaluation) and at the same time provide students with tools to help them bring the understanding back (regulation). One appropriate regulation action is asking questions about problematic information to be processed (Costa et al., 2000).

Costa et al., (2000) conducted a study focused on questions asked to correct declarative knowledge deficits while readers were processing science texts explaining natural phenomena. The researchers wanted to find out first, what kind of questions are asked by students who read these texts and, second, how task demand influences the quantity of questions formulated. Their results showed that students were able to ask
many questions when given an opportunity to do so. Their study also proved that students are capable of generating a large volume of causal-antecedent questions relative to these types of texts. However, because these results came from work with 8th-, 10th-, and 12th-graders in a study that was not linked to any intervention, it is not known whether the same results would hold true if students at the upper elementary level were asked to formulate questions and encouraged to use of questioning to help them self-regulate their comprehension. Next, I will present the most significant research conducted on two instructional methods which focus on the cognitive strategy of learning to improve reading comprehension of informational text—Reciprocal Teaching and collaborative strategic reading. Following that section, I briefly describe research conducted on bilingual cognitive strategies.

**Reciprocal teaching.** Reciprocal Teaching is a dialogic instructional procedure originally designed to enhance students’ reading comprehension ability through the use of four cognitive reading strategies (predicting, questioning, clarifying, and summarizing). This procedure, developed by Palincsar and Brown (1984), was selected to be used in this study because it is widely supported in the literature and its strategies parallel those used in inquiry-based science.

Reciprocal Teaching is based on the top-down and interactive information-processing theories. As was explained earlier in this review, these processing theories acknowledge the significance of the principles set forth by the schema theorists, which are rooted in the theoretical positions of metacognitive theory. Reciprocal Teaching makes all these theories accessible for use in the learning environment in the frame of
social-learning theory. The Reciprocal Teaching procedure was designed to provide dynamic cooperative learning situations and to create a zone of proximal development for learners (Palincsar & Brown, 1986). The goal of Reciprocal Teaching is to prepare students to direct and control their own learning.

Reciprocal Teaching procedures involve students in mediated learning with the teacher initially acting as expert. The teacher models four comprehension-fostering and monitoring activities: summarizing, questioning, clarifying, and predicting. In a cooperative learning group, an adult teacher and the students take turns assuming the role of leader and facilitating an interactive dialogue on silently read text that they are jointly attempting to understand. The teacher acts as a mediator, offering feedback and guidance. As students improve their use of the strategies, the bar is raised so that students are increasingly challenged and, consequently, more able to become independent leaders.

The findings of an impressive collection of studies support Reciprocal Teaching; the most important research is summarized here. Reciprocal Teaching began in 1981 and, in the two original experiments (Palincsar, 1982; Palincsar & Brown, 1984), the subjects were seventh-grade students who were average decoders, but lower comprehenders. Once their reading levels were assessed, students participated in a baseline phase, followed by a treatment phase in which they read daily passages and answered comprehension questions. The analysis of the second study included both single subject graphs, and statistical analyses with a control group who was taught a strategy called locating information (Raphael, 1980). The results of these 20-day interventions were positive and students comprehension assessment scores improved. Students in the Reciprocal
Teaching group also increased scores in verbal behavior and the ability to summarize and generate. A measure designed to determine students’ improvement on a standardized test of reading comprehension showed a 20-month gain in comprehension scores by the Reciprocal Teaching group.

Given the positive results obtained in the above studies, additional studies were conducted to test the instructional feasibility of Reciprocal Teaching (Palincsar & Brown, 1985). Students in this study worked in larger groups. A modified Reciprocal Teaching procedure was designed to be implemented in an entire class (Palincsar & Brown, 1985). Students and teachers read silently and students wrote summaries, questions, clarifications, and predictions after each paragraph. After several segments, students shared their work. As a result, they began to rely on modeling and feedback from the teacher and from each other. The results showed that even the students who had low comprehension improved rapidly in only 5 days.

The Reciprocal Teaching procedure has been used to teach in other areas, such as arithmetic reasoning (e.g., Brown, Campione, Reeves, Ferrara, & Palincsar, in press) listening comprehension (Palincsar & Brown, 1986), and to teach students with a wide range of abilities: gifted third-graders, learning disabled college students, students with and without reading problems, and students with normal IQ scores at the low end of normal (Brown & Palincsar, 1987). All of these studies resulted in improvement in comprehension and standardized test scores and maintenance, transfer.

As an instructional method for teaching cognitive strategies, Reciprocal Teaching has been shown to be effective with diverse populations when working in small groups.
There have been a few studies looking at the effect of Reciprocal Teaching with diverse populations in larger and more natural learning settings. For example, Padrón (1992) conducted a study with 89 third-, fourth- and fifth-grade Hispanic bilingual students. Students in this study were randomly assigned to one of four groups: (a) the Reciprocal Teaching group, (b) the question-answer relationships group, (c) control group 1, and (d) control group 2. The two control groups were used to assess whether or not extra tutoring in general rather than specific tutoring on cognitive strategies affected students’ use of strategies. Students received instruction for 30 minutes a day for a month. Students’ scores on the Reading Strategy Questionnaire (Waxman & Padrón, 1987) showed that those who participated in the Reciprocal Teaching groups did better than the other groups on producing self-generated questions and summarizing (Padrón, 1992a).

These findings have been more recently replicated in other countries. For example, in Croatia, an experimental-control design was conducted on 57 students in three fifth-grade classes, who were divided into one experimental and two control groups (Kolic-Vehovec, 2004). The three groups were initially similar in their understanding of texts, summarizing, and questioning. Reciprocal Teaching was practiced in 12 sessions over a 4 week period. One of the control groups read the same texts and answered the same questions about the texts as students in the experimental group. The second control group received no comprehension practice and took only pre and postassessments. Testing at the end of the treatment revealed significantly better results in the experimental
group than in both control groups; the former was the only group with significant improvements in summarizing abilities between the two testing periods.

Another control group-experiment group design was conducted in Finland with students with specific language impairments (SLI) in a self-contained setting with fourth- and sixth-graders (Takala, 2006). In this case, lessons in general science and history that varied in length from 10 to 15 sessions were used as the context for the Reciprocal Teaching intervention. The analysis of the results from pre-post retention tests showed that positive development could also be noticed with students with SLI. During posttreatment interviews, participants explained they were pleased to have had the opportunity to go through the interventions and to learn a new method of improving reading comprehension.

A 2005 study examined the effectiveness of the teaching strategy in elementary school science lessons on electric circuits (Takagaki, 2005). The purposes of the study were to induce conceptual change through reciprocal teaching, and to analyze variables that might be affecting change. Thirty students in a fourth-grade class participated in the study. The results suggest that, in the course of reciprocal teaching, when maximum conceptual conflict was induced and discussions reached deadlock, a strategy incorporating thinking guidance for coordinating the predictions and theories to the results properly facilitated conceptual change.

In one final study conducted in Israel, Alfassi (2004) reported results of two sequential studies examining the efficacy of combining Reciprocal Teaching and direct explanation at the high school level. Findings suggest that combined strategy instruction
may be beneficial in providing students with tools that will enable them to apply higher
order cognitive processes while they learn from text.

Although some research has been conducted in a whole class setting, past and
recent studies have confirmed that Reciprocal Teaching works most effectively in a small
group setting. Looking for a version of Reciprocal Teaching that would be more effective
in a whole group setting, Kim (2002) proposed collaborative strategic reading, which will
be discussed next.

Collaborative strategic reading. Collaborative strategic reading is an adaptation
of Reciprocal Teaching (Palincsar & Brown, 1984) and it includes many features
associated with effective instruction (e.g., collaborative group work, interactive dialogue,
and clearly specified procedures). According to this method, the teacher presents the
strategies to the whole class using modeling and think alouds. After students have
developed proficiency using the strategies, they are divided into collaborative groups, in
which each student performs a defined role to implement the strategies collaboratively
while learning from expository text. Collaborative strategic reading was selected for this
review because it can be used with the whole class of diverse students rather than in small
groups (Kim et al., 2006).

Bilingual strategies for reading. In addition to Reciprocal Teaching and
collaborative strategic reading, there is research looking at the strategies bilingual
children use when reading which indicate that there are individual differences in the use
of cognitive reading strategies (Padrón, 1992a). Furthermore, some research has been
conducted in examining the strategies used in reading by bilingual students while reading
in their second language (e.g., Padrón, Knight, & Waxman, 1986). Padrón et al found that bilingual students use fewer strategies and different types of reading strategies than English monolingual students. Little research, however, has been conducted that examines the effects of cognitive strategy instruction on the strategies that bilingual students use in reading text written in their second language (Padrón, 1992a).

The literature indicates that successful bilingual readers possess a special awareness of the relationship between the languages they know. This special awareness leads them to use the bilingual strategies of searching for cognates, transferring, and translating (Jiménez et al., 1996). This research suggests that these three specific strategies could help all bilingual learners better comprehend scientific text.

This study is investigating the impact of parallel instruction in the content and in the use of cognitive strategies in both reading and science; therefore, I will next present the research on cognitive strategies in inquiry-based science.

**Cognitive Strategies in Inquiry-Based Science**

Inquiry has become a sacred word in education circles. Many scholars and educational researchers recognize it as important. According to the National Research Council (1996), inquiry into authentic questions generated from students’ experiences is a central strategy for teaching science. Much more needs to be done, however, to inform the day-to-day practice of inquiry teaching at any level, particularly under the Department of Education’s new No Child Left Behind legislation (2002). With the advent of this law (U.S. Department of Education), reading and mathematics have assumed a critical importance to standardized tests. Rice et al. (2004), explain that in the wake of the
standardized testing movement, science has all but disappeared from the curricula in many elementary schools.

Continuing with the idea that science is at risk, Saul (2004a), in his book *Crossing Borders*, discusses the fact that educators across the United States are feeling the pressure of standards, assessment, and accountability. He explains that, on one hand, time is increasingly squeezed from the instructional day in an attempt to strengthen student achievement in reading, language arts, and mathematics. However, Rice et al., (2004) explain that, on the other hand, content areas such as science are becoming integral parts of the ever increasing battery of standardized tests that students take. With this shift, elementary teachers will become more and more accountable for students’ science achievement, and every child, including English language learners, will need appropriate instruction. In fact, a growing body of evidence indicates a strong relationship between inquiry-based science instruction and improved achievement not only in science, but also in reading, language arts, and mathematics (Jorgenson & Vanosdall, 2002).

Addressing the issue of whether or not inquiry-based methods are appropriate for all learners, Zohar (2004) explains how the goal of teaching thinking is seen as appropriate for high achieving students. Low achieving students, however, who have trouble with mastering even basic facts and skills, are thought to be unable to deal with tasks that require thinking. This belief may have enormous instructional consequences, depriving low achieving students precisely of those tasks requiring higher order thinking that are so crucial for their development. Zohar (2004) concludes that since such beliefs are likely to influence teachers to expose high achieving students to tasks requiring
higher order thinking skills more than low achieving students, the gap between low and high achieving students will only grow.

Rivard (2004) powerfully makes the case for the need of more activities involving language and higher order thinking skills in the diverse science class. He developed a quantitative and qualitative study aiming to determine the effect of using various classroom tasks involving talking and writing about science learning involving problem solving tasks for low, average, and high achievers. The results were indicative of the benefits of engaging all students in more activities involving practice of language skills and higher order thinking skills in the diverse science class. Two strategies on which this study are based, self-monitoring and questioning, are discussed next in the context of science.

**Self-monitoring and metacognition in science.** Experimental work in the latter part of this century has provided several reasons for the young child’s difficulty in situations that require effortful learning (Brown, Campione, Metz, & Ash, 1997). Initially, it was thought that the young children simply had less learning or memory capacity, but during the 1970s it became clear that what this age group lacks is the ability to make strategic use of the capacity they do have (e.g., Chi, 1987). However, even when children were trained to use strategies, they were not using the strategies unless prompted by an instructor (Brown, et al., 1997). The problem was that children had little insight into their own ability to learn intentionally, that is, their metacognition. Specifically, children did not monitor their own learning activities, by, for example overseeing or revising their own efforts at intentional learning (Brown, et al., 1983).
Metacognition in science can be considered as reflection-in-action involving real-time thinking about a task, while the task is being performed, to improve the execution of that task (Yore, et al., 2006). Metacognition involves knowledge about and executive control of the task. It serves as a superordinate interface between theoretical and practical knowledge stores and task performance that becomes a deliberate function to manage subroutines, adjust effort, and seek alternative actions when the cognitive task becomes difficult (Yore et al.).

Metacognition has been used to refer to widely different levels of cognitive activity, ranging from simple forms of planning and self-regulation, up through complex reflective practices including the reflective abstraction that make up the formal operations in Piagetian theory (Brown, et al., 1997). Metacognition has also been used to refer to students’ knowledge about the nature of knowing itself. According to Brown, et al., (1983), the term loses its explanatory value if given a multiplicity of meanings. Therefore, in this study, metacognition in science refers to intentional learning coupled with reflection, the type of behavior required for the learning of school science (Brown, et al.).

Some of the interpretations of Piaget’s theory have had an important impact on the design of grade (primary) school education in the US and to some extent in Europe (Brown, et al. 1997). However, a simplistic interpretation of Piagetian theory led to an underestimation of elementary students’ capabilities (Brown, et al.). In fact, there is a body of research that has successfully scaffolded the inquiry process for students as young as those in second grade (Metz, 2004). In this study, students were able to conduct
their own investigations to answer student-generated questions and the results indicated that most children developed a rich understanding of how uncertainty enters into scientific inquiry (Metz, 2004).

This ends the section on metacognition on science that is complemented by information presented earlier in this review on the research on metacognition in science. The research on questioning in science is covered next.

**Questioning in science.** According to The National Science Education Standard’s definition of *inquiry*, when students generate questions for the purpose of finding “answers to questions derived from curiosity about everyday experiences,” they are participating in scientific inquiry (NRC, 1996, p. 22). This self-questioning is also guided from a textual content (Alvermann, 2004). The current wave of science education reform literature emphasizes learning science as inquiry (Keys, 1998). For example, in the United States, authors of the National Science Education Standards assert that, “Inquiry into authentic questions generated from student experience is the central strategy for teaching science” (NRC, 1996, p. 31). This statement reflects the view of a majority of science educators, who believe that students should build on their own knowledge, explore questions that are of interest to them, and learn to use inquiry strategies to build conceptual understandings (Keys).

However, Keys (1998) explains that there is relatively little research on how young students respond when they are asked to pose their own questions and design investigations to answer those questions. Keys conducted a study to investigate the reasoning strategies of urban students at the sixth-grade level involved in creating their
own questions and plans for scientific investigations. The instruction was based on the
generative model of teaching primary science (Harlen & Osborne, 1985), which includes
exploration, investigation, and reflection. (This method is described after this section in
more detail.) The results of this study indicated that students pursued two major avenues
for question generation, varying the teacher directed exploration activity and inventing
questions from their own imaginations. Students designed investigations that were both
experimental and descriptive in nature.

Keys (1998) suggests that more research is needed to support the statements made
in current science education reform documents promoting student generated inquiry.
Some specific avenues she mentions, which are relevant for this thesis, are bridging the
gap between students’ investigation ideas and those deemed appropriate by scientists,
teachers, and science educators. For example, looking at how teachers and students may
generate, evaluate, and select questions for doing descriptive studies are needed, as well
as determining the potential learning outcomes of this form of instruction. The most
important of her recommendations for the purposes of this study is that more research on
the potential of children creating variations of teacher-deigned experiments is needed.
Creating variations of teacher-designed experiments would provide students with
scaffolding towards a full investigation design cycle. This recommendation is important
because of the key role of modeling throughout the intervention I am proposing.

Another study with young students was conducted by Metz (2004). Her research
study involved 21 second-graders, 15 fourth-graders and 16 fifth-graders in two different
phases. During Phase I the whole class worked on developing background knowledge in
animal behavior and botany through texts and analysis of video. During Phase II pairs conducted their own trials of common, collaboratively refined investigations. In this study the whole class and the teacher were responsible for determining the most appropriate tools to use in answering the research questions.

At the end of the treatment Metz (2004) conducted interviews with each group of students. She analyzed the data by looking at how students conceptualized the spheres of uncertainty. The spheres of uncertainty used for the analysis of data arose from the concept of problematic versus unproblematic conceptualization of science.

The results of the study show that children were keenly interested in their research projects and sustained an intense engagement. Students at the elementary level who participated in this intervention effectively took on the challenging task of designing and implementing an empirical study to investigate their own questions. Specifically, 52% of the students conceptualized two or three spheres of uncertainty, and additionally, had knowledge of how to improve their study, thus indicating that children’s thinking can transcend naïve realism. These results challenge the assumption that educators need to decompose scientific inquiry to bring it within reach of the elementary school child. Since this study did not include any children with special needs and it was conducted using a relatively well known science topic, questions remain as to whether or not the same results could be replicated if the study had included diverse learners and other less well known science topics.

Other studies show the importance of questioning in science. According to Alvermann (2004), out of the 450 text comprehension studies that members of the
National Reading Panel (National Institute of Child Health and Human Development [NICHD], 2000) identified as meeting their criteria for scientific analysis, 27 involved studies of self-questioning in grades 3 through 9. The Panel’s report explained, “There was stronger evidence for near transfer than for generalized effects” (p. 4-45). The Panel concluded that, “Question generation may be best used as a part of a multiple strategy instruction program” (p. 4-45). However, Alvermann explains that the Panel did not address issues specific to English-language learners or to scientific literacy, nor did it include studies using qualitative research. Members of the RAND Reading Study Group (2002) pointed out the need to consider the characteristics of the reader involved. In relation to diverse learners, they explained that:

> Sometimes this explicit instruction is helpful for low-achieving students but is superfluous for normal readers. Explicit instruction generates the immediate use of comprehension strategies, but there is less evidence that students continue to use the strategies in the classroom and outside of school after instruction ends. (p. 33)

This statement suggests the need for more research in the area of questioning in science, with diverse students.

The most relevant literature on diverse learners and inquiry in science is addressed in the next section of this review.

*Cognitive Strategies and Language Learners*

The U.S. Department of Education (2002) stresses the importance of effective second language acquisition strategies and challenging academic programs built on the
cultural and linguistic strengths of the students. However, students with limited English proficiency, are generally deprived from instruction on higher-level skills until the student has mastered English fully because many teachers assume that students are not able to comprehend until they can speak the language well (Garcia & Pearson, 1991). Despite positive findings on the effects of strategy instruction on student outcomes (e.g., Padrón, 1992a), few studies have investigated the use of this procedure with culturally and linguistically diverse students (Waxman, Padrón, & Knight, 1991). The studies that have focused on strategy instruction with diverse students show that bilingual students can benefit from instruction in cognitive strategy use (e.g., Padrón, 1992a). Further, studies have indicate that English as a second language students’ perceptions of the cognitive strategies that they use have predictive validity with students’ reading comprehension (Padrón & Waxman, 1988; Padrón, 1992a).

Other findings indicate that participating in cognitive strategies instruction interventions may decrease the use of weaker strategies (Padrón, 1992b). This finding supports the idea of strategy training for bilingual students as does previous research that has found the use of weaker strategies to be negatively related to students’ gain in reading comprehension (Padrón & Waxman). Finally, it has been suggested by the literature on strategy teaching with diverse learners that teaching one or two strategies over several weeks may be the most beneficial practice (Pressley & Harris, 1990) and that a student’s motivational should be addressed (Padrón, 1992b).

The importance of incorporating student populations who have traditionally been underserved in science has been emphasized by organizations such as the American
Association for the Advancement of Science [(AAAS), 1989]. A key aspect of national science education reform efforts involve making science for all Americans (AAAS, 1989) a reality that includes students from culturally and linguistically diverse backgrounds. Therefore, in science, classroom activities should focus on developing scientific literacy skills with every student. Yet teachers often do not pose higher level questions to English language learners, consequently depriving them of learning opportunities (Verplaetse, 1998). However, traditionally, disciplinary knowledge and student diversity have constituted separate research directions (Lee, Deaktor, Hart, Cuevas, & Enders, 2005). The use of cognitive strategies influences science performance. Studies on cognitive strategies have been a major research area in science education (e.g., Lee & Anderson, 1993). These studies have usually examined the frequency of strategy use or the relationship between cognitive strategies and science performance with monolingual English students (Lee, Fradd, & Sutman, 1995). Considering that cognitive strategies are products of learning within contexts, the frequency and the effectiveness of deep-processing or surface level processing strategies vary among diverse language and culture groups (Chamot & O’Malley, 1987).

In science education, reform documents highlight science for all, but do not provide strategies for achieving a coherent conception of equity (e.g., Lee, 1999). In multicultural education and bilingual education the focus has been on students’ cultural and linguistic diversity, with only limited attention given to subject area instruction such as science (August & Hakuta, 1997). Effacing the difference in academic achievement (traditionally called a gap) that exists among different groups of students while
simultaneously improving the science achievement, of all students constitute the dual goals of science education in the nation (Lee et al., 2005).

The literature on cultural congruence suggests that when teachers engage in communication and interaction patterns that are familiar and intelligible to students, students more actively engage in classroom tasks (e.g., Villegas & Lucas, 2002). In addition, the literature emphasizes the importance of utilizing children’s home-language resources in teaching and learning (Moll, Diaz, et al., 1992).

Emerging research on cultural congruence and culturally relevant pedagogy (Gay, 2002; Ladson-Billings, 1994, 1995; Osborne, 1996; Villegas & Lucas) employs the framework of instructional congruence (Lee, 2002, 2003, 2004; Lee & Fradd, 1998). This framework highlights the importance of developing congruence not only between students’ cultural expectations and classroom interactional norms, but also between academic disciplines and students’ cultural and linguistic experiences. This research focuses on adapting academic disciplines with students’ cultural and linguistic experience to develop congruence between the two domains. Thus, instructional congruence emphasizes the role of instruction (educational interventions) as teachers explore the relationship between academic disciplines and students’ cultural and linguistic knowledge and devise ways to link the two. English language proficiency includes knowledge of various subregisters representing specific disciplines (Chamot & O’Malley, 1994; Schkeppegrell & Achugar, 2003), and consequently, for an English as a second language learner, language and literacy development are integral to subject area instruction, such as science (e.g., Hampton & Rodriguez, 2001).
In addition, it has been suggested by the literature in bilingual education, that students who speak more than one language have an enhanced awareness of different linguistic codes, which translates into cognitive flexibility (Cummins, 2001). The instructional congruence framework (i.e., the integration of science, the student’s home language and culture, and English language and literacy) serves as a conceptual and practical guideline for development, for classroom practices, for teacher change, and for student achievement.

A review of the literature on student diversity in science education during the last two decades indicates that most of the studies in this field have been small-scale and descriptive; only a small number have been intervention-based (Lee et al., 2005). However, some studies have begun to focus on bilingual students and students learning English as a new language. For example Chamot, Dale, O’Malley, and Spanos (1992) contrasted the ways bilingual Hispanic students used cognitive strategies and process information with their monolingual English peers. These studies provide steps in understanding learning differences (Lee, Fradd, & Sutman, 1995). Moreover, studies reporting English language learners’ outcomes in both science and literacy are rare (Lee, Deaktor, Hart, Cuevas, & Enders, 2005). There are two large-scale studies that looked at both science and literacy progress with English language learners. The first was conducted by Amaral et al. (2002) who examined the impact of a district-wide intervention program on the science and literacy achievement of elementary students functioning at different levels of English proficiency.
The second large scale study was conducted by Lee et al., (2005). This study involved third- and fourth-grade teachers and their students at six elementary schools. The study aimed to promote both science and literacy achievement among culturally and linguistically diverse elementary students who were working on two science units. Their framework was based on the idea that instructional congruence with English as a second language learners involves promoting English language and literacy development as part of subject area instruction. The research examined three areas: (a) overall science and literacy achievement, (b) achievement gaps among demographic groups, and (c) comparison of results with national and international samples. Their results show statistically significant gains and large effect magnitudes (Cohen’s d) on all measures of science and literacy achievement at the end of one school year. When examining the results according to demographic groups, their results indicated that achievement gaps widened with the third graders at the end of the school year, whereas the gaps narrowed with the fourth graders. The authors explained that using their written assessment tests to measure the dependent variables was a limitation of the study. Although they encouraged teachers to make accommodations, such as reading the test questions for English as a second language learners and allowing responses in the home language of the student, they had no control over the degree to which each teacher implemented the accommodations. Future recommendations for research included using a control or comparison group to establish the causality of the intervention on student outcomes and the differential impact of each domain of the intervention (i.e., science, English language and literacy, and home language and culture). Studies on cognitive strategies in which
not only students’ self-report is used, but also observations of the actual use of strategies during science performance are needed (Lee et al.1995).

*Cognitive Strategies and Struggling Students*

Explanations of the difficulties experienced by students with learning problems in the context of science instruction vary and suggest different forms of intervention (Palincsar et al., 2001). Special educators historically have been skeptical about the effectiveness of discovery, inquiry, or constructivist methods for students with disabilities (Mastropieri et al., 1997). In fact, Woodward and Noell (1992) argued that there is little evidence suggesting that an inductive style of instruction is effective for these students. However, Kessen (1984) pointed out that a good part of what we call cognitive development is dependent on the selection by caretakers of possible lines of development in children (p. 427). Metz (1997) explains that the findings of developmental studies involve some unknown cultural and instructional components.

Differences in the academic achievement of high and low achieving students may be explained by the latter having no opportunity to learn higher level thinking skills (e.g., Coley & Hoffman, 1990). Gersten and Baker (1998) have argued that students with learning disabilities must become “fluent with essential factual and conceptual knowledge” (p. 24) before they can profitably engage in inquiry-based instruction. Furthermore, Woodward and Noell (1991) and Mastropieri and Scruggs (1992) submit that students with learning disabilities require significant coaching to engage productively in the kinds of reasoning that are typically associated with inquiry-based approaches to science instruction. Questions remain as to whether or not the combination of an
inductive style of instruction and comprehension-fostering strategies will help students with learning disabilities better comprehend and learn scientific content in written form.

**Summary of the Research on Cognitive Strategies**

This section has presented the relevant pieces of literature in the topic of cognitive strategies. Specifically, after a general introduction to cognitive strategies, I reviewed the research on cognitive strategies in reading comprehension, focusing on metacognition and self-monitoring and questioning. The section describing the cognitive strategies in reading also included work on specific instructional methods, namely Reciprocal Teaching, collaborative strategic reading, and bilingual strategies.

I then summarized research on cognitive strategies in inquiry-based science, organizing the information into the two main strategies this research has focused on, metacognition and self-monitoring, and questioning. I concluded with a discussion of cognitive strategies in science with second language learners and with struggling students.

In general, the review indicates that a combination of modeling strategies and opportunities for active learning has been shown to foster understanding and transformation of learning (Scardamalia & Bereiter, 1987). Additionally, integration in content areas rewards knowledge transformation in the study of different topics and promotes the acquisition of a meaningful knowledge base (Lipson, Valencia, Wixson, & Peters, 1993). Much more research is needed to understand how instruction on the cognitive strategies of self-monitoring and questioning can better serve diverse students.
Impact of Type of Text on Reading Proficiency

This section covers two main topics: the first is the use of culturally sensitive texts and the second is the importance of authentic texts presented in authentic settings. The importance of using texts that include some form of cultural sensitivity, which makes the text seem familiar to minority students, cannot be overemphasized. According to Ladson-Billings (1992) the terms *culturally appropriate, culturally congruent, culturally responsive,* and *culturally compatible* have all been used to describe efforts in the classroom to match school culture more closely with student culture to promote academic success.

In this thesis study, the term used to describe these efforts is *culturally sensitive context.* In general, children who are struggling to read, for whatever reason, often appear disengaged by the learning process (Pinkard, 2000, 2001). The task of the instructor is to find new ways to engage these students in the process of learning to read. According to (Pinkard) (2000, 2001), a direct link is assumed from cultural responsiveness through engagement to learning. Pinkard (1999) developed two computer-based learning environments for reading lyrics to help African-American boys and girls who were in the beginning stages of learning to read. African-American students obtained a higher gain in sight vocabulary from pre to posttest than the European-American students. These results suggest that studies using culturally responsive texts for other cultural groups could obtain similar findings. The GoInquire system echoes Pinkard’s (1999) use of common cultural knowledge through the display of images of the school. Students’ shared cultural
knowledge is brought to the surface by looking at these pictures of locations that are familiar to all.

It can be anticipated that students will be more engaged if they recognize the context of their educational materials. Another important factor characteristic of an effective text is its authenticity.

According to Yano, Long, and Ross (1994) linguistically simplified texts constitute less realistic models of the target language. They found that elaborative modification, in which the main ideas are clearly stated and additional features are added to unfamiliar concepts, effectively increases nonnative comprehension and has other advantages over linguistic simplification. Moreover, they found the idea that linguistically simplified texts’ input can negatively affect learner output and language acquisition. As part of a larger study, Parker and Chaudron (1987) found that university English as a second language students’ comprehension of a passage that had undergone elaborative modification correlated more closely with independent measures of their reading proficiency than did their comprehension of a simplified passage. Another study (Yano et al.,) with undergraduates showed that second language readers performed no better on a short simplified version of a text than did those reading an elaborated version in a test of reading comprehension. Yano et al. also found that when looking at the type of questions students asked, students reading the elaborated version performed significantly better than those reading the simplified version in the inference items, when compared to the replication and synthesis items. These results suggest that elaborative modification of texts serves to provide semantic detail essential for second-language readers to make
inferences about the text they read. Although this literature emphasizes the importance of using authentic language material for reading, the relevance to the present study is not clear as little is known about whether similar results hold for second language learners in a dual immersion program at the upper elementary level reading longer pieces of scientific text.

To end the section on content reading comprehension it is important to emphasize that authentic texts must also be presented in an authentic context. The intervention proposed in this study (INSCIREAD) is based on the idea that combined instruction in science content and reading comprehension is more efficient and authentic than separate instruction in these areas as isolated school subjects. This view is consistent with an integrated language arts perspective. This perspective is based on the belief that reading and writing are functional tools not to be mastered in isolation, but to be used in authentic activities (McGinley & Tierney, 1989). The content areas provide learning contexts in which reading and writing are used for a purpose (Morrow, Presley, Smith, & Smith, 1997). Theoretical support for the proponents of the integrated language arts approach suggests that it will simultaneously increase students’ literacy abilities and knowledge of content (Pappas, 1995). Before fully discussing the research on cognitive strategies, an introduction follows.

Relevance of Scientific Text Reading Comprehension

One of the instructional components of a quality reading program is a consideration of the importance of comprehension instruction. Students need help to become better critical readers of scientific text (Otero, León, & Graesser, 2002). In fact,
there is evidence to suggest that when reading popularized reports of scientific research, some of the well-educated members of the general public (high school students with backgrounds in science and university students) have difficulty differentiating among information functions in a scientific argument, recognizing generalizations, considering the socio-historical context and related research, and adopting a critical stance (Otero, et al.). These difficulties when approaching scientific text give urgency to the need to develop skills earlier, allowing time for these skills to become more sophisticated, and thus permitting our students to become successful and critical readers of scientific text (Coté, Goldman, & Saul, 1998).

It has been shown that while linguistically diverse students are learning a second language, they can indeed read scientific information to formulate understandings (Bernhardt & Kamil, 1995). The research has indicated that children are capable of understanding texts in a language they do not completely control. In fact, there is evidence from the literature to suggest that children can learn both school subjects and nonnative languages simultaneously without any measurable detriment to either (Harley et al., 1990). However, the role of literacy materials may be undervalued in second language science instruction (Bernhardt & Kamil); however, due to the paucity of research in that area, the implications of such instruction are not clear (Saul, 2004a). Research into second language science instruction is also needed to identify principles for teaching that can appropriately serve all second language learners (Bernhardt & Kamil,). As I discuss in the next section of this review, experimentally based research shows that self-questioning that it is one of seven types of instructional strategies deemed effective
in improving students’ comprehension of traditional print texts (NICHD, 2000). The last essential key component of a quality reading program is the direct instruction of strategies; the next section discusses the research in this area.

Constructivism and Social Construction of Knowledge

When examining the instructional components of reading, an important issue is the constructive nature of comprehension. Constructivism is increasingly appropriated by science educators as well as serving as the basis for research and curricular recommendations (O’Loughlin, 1992). The constructive nature of comprehension entails three concepts: (a) activation of prior knowledge, (b) active engagement with the text, and (c) strategic processing. The intervention in this study takes these concepts into consideration by building on students’ limited prior knowledge in slow geomorphological changes, modeling and promoting active engagement with the texts and the content students are learning, and teaching cognitive strategies in that context. The research related to these three concepts is included at a later point in this review.

Despite the appeal of the notion that learners construct their understanding, O’Loughlin (1992) argues the following:

Constructivism is problematic because it ignores the subjectivity of the learner and the socially and historically situated nature of knowing; it denies the essentially collaborative and social nature of meaning making; and it privileges only one form of knowledge, namely, the technical rational. (p. 791)

However, O’Loughlin (1992) explains that among the proponents of constructivism, there is also lack of agreement. Some constructivist educators follow a
Piagetian line (e.g., Sigel, 1978). Others focus more on the pedagogical implications of the child as an active learner (Donaldson, 1978; National Association for the Education of Young Children [NAEYC], 1988). Still others, follow von Glasersfeld (1987) and identify with radical constructivism, which is also behind Piaget’s theory (von Glasersfeld, 1984). While there is lack of agreement, it is clear that Piaget’s theory has influenced constructivists’ pedagogical approaches, and therefore it is important to clarify Piagetian views and critically interrogate its assumptions.

Piaget’s theory is based on the idea that we begin to learn by developing operations to act on our world, and eventually, by the stage of formal operations, we develop to acquire abstract reasoning capacities that allow us to detach from the object world to reason about it in strictly logical terms (O’Loughlin, 1992). Piaget’s theory is premised on the biological assumption of self-regulation, equilibrium, assimilation, and decentering. As stated by Piaget (1970):

> The gradually emerging equilibration between assimilation and accommodation is the result of successive decenterations, which make it possible for the subject to take the points of view of other subjects or objects themselves. We formerly described this process merely in terms of egocentrism and socialization. But it is far more general and more fundamental to knowledge in all its forms. For cognitive progress is not only assimilation of information; it entails a systematic decenteration process which is a necessary condition of objectivity itself. (p. 710)

Piaget (1970) explains that in the process of self-regulation, the organism constantly strives to reduce conflict in order to gain equilibrium. Equilibrium is
established through the dialectical interplay of assimilation and accommodation; the end result of this process of adaptation is an increasing ability to view knowledge objectively, a skill which Piaget (1970) called *decentering*.

Venn and Walkerdine (1977) note that Piaget focused only on the general principles of human reasoning and excluded from consideration particularities such as the social and historical context of reasoning and the experiences of the individuals he studied: “The subject of these constructions is thus only an epistemic subject who abstracts from experience logical schemes and discards the experiences themselves as empty shells” (p. 70). Difficulties arise when constructivists appropriate this universalist theory to deal with classroom learning processes that are inherently constrained by sociocultural and contextual factors (O’Loughlin, 1992).

Constructivist approaches, which attempt to adapt Piagetian theory to the real classroom, are significant for this study. Specifically Sigel (1978) advocates the application of constructivism to teaching by combining Piaget’s work and Kelly’s (1958) personal construct theory, arguing for the necessity of considering each individual as a scientist. For Siegel the key issue is the development of mental representations of reality. He argues that to develop abstract representations we need to detach ourselves from our own reality, and to increase the accuracy and the complexity of our representations we need to be confronted with contradictions and discrepancies that induce cognitive conflict. Based on these two premises Sigel and Cocking (1977) argue for a mode of teaching by questioning, known as *distancing education*, that is designed both to distance students from their own perspectives and to induce cognitive conflict. Distancing occurs
via a set of inquiry and questioning strategies that are designed to cause a “cognitive separation between the individual and the immediate present” and which demand “active engagement” (p. 212).

A version of constructivism that is more common in science is described by Donaldson (1978) and Duckworth (1987), who began to look at the process of schooling from the learner’s perspective. They both explain the importance of understanding how learners make sense of the world. These authors also address thoughtfulness in classrooms and the importance of helping students feel comfortable enough to talk in class, so they can reach their own tentative understandings through the confusion and messiness of the process of constructing personal meaning.

Kelly (1958), Sigel (1978), Donaldson (1978), and Duckworth (1987), are all sensitive to the necessity for students to be actively engaged in the construction of their own understanding in the classroom. This emphasis on personal construction of knowledge provides a rationale for a student-centered pedagogy in schools; however, as the next section details, this idea is of limited value in providing the foundation for a radically reformed science education (O’Loughlin, 1992).

Beyond Piaget

A considerable critical literature has emerged surrounding Piaget’s theory. Much of this is reviewed in the five critical essays by Broughton (1981a, 1981b, 1981c, 1981d, 1981e) that were published in Human Development. In summary, critics of Piaget’s theory argue that knowledge is socially constructed. However, the kind of abstract formalisms described in Piaget’s theory is accompanied by individualism. According to
Sampson (1981) “the individualist approach reduces reality to the acts of the individual’s constitution; objects of reality are seen as products of individual cognitive operations rather than as products of social and historical constitution” (p. 731). Piaget’s model is conservative, critiques of the model defend that the idea knowing is a process of examining current reality critically and constructing critical visions of present reality and of other possible realities (O’Loughlin, 1992). A major weakness in Piaget’s theory is the absence of any consideration of human subjectivity in the process of construction (O’Loughlin). Finally, some critics (e.g., Riegel, 1979) argue that the subjectivism and individualism of Piaget’s theory and the primacy of assimilation over accommodation point to the essentially nondialectical nature of thinking in Piaget’s scheme (Riegel):

Although Piaget’s theory is founded on a dialectical basis, it fails to make the transition from the formal intellectualism of Kant to the concrete dialecticism of Hegel. Thus, his theory is not only incapable of interpreting mature thinking but also fails to give sufficient emphasis to their dialectical character and the creative features of children’s cognitions. (p. 50)

Constructivism in this form detaches people from their reality, teaching them to intellectualize their relationship with the world, rather than to come to grips with the possibilities for personal and social transformation (O’Loughlin, 1992). Student-centered pedagogy, which emerged from constructivists beliefs, has also aroused ardent criticisms.

**Beyond Student-Centered Pedagogy**

Student-centered pedagogy stresses play and spontaneous activity as sources of learning and delimits a set of stages within which certain concepts ought to or ought not
to be. Conceptions of child-centered pedagogy are framed in terms of individualist concepts from developmental psychology (O’Loughlin, 1992). The studies by Edwards and Mercer (1987) were designed to investigate the extent to which there was a relationship “between practical activity and principled understanding” (p. 94) in a series of explicitly child-centered activity elementary classrooms in England. They present numerous examples from their response protocols indicating that many of the students seemed to have gained a very limited grasp of the underlying principles that the activities were intended to establish. Instead of striving for genuine understanding, students typically made judgments and offered opinions that were in accord with what they perceives to be the teacher’s expectations (Edwards & Mercer). In fact, the authors explain, “The freedom of pupils to introduce their own ideas was largely illusory; the teacher retained a strict control over what was said and done, what decisions were reached, and what interpretations were put upon experience” (p. 156).

For the purpose of this research study what is most important is Delpit’s (1986) argument that this kind of environment may have particularly deleterious effects on the learning potential of students from cultural groups other than the white middle class. Delpit (1988) supports the combination of instruction in both language and content areas and the importance of helping students develop better content reading and writing skills as the following statement demonstrates.

I suggest that students must be taught the codes needed to participate fully in the mainstream of American life, not by being forced to attend to hollow, inane, decontextualized subskills but rather within the context of meaningful
communicative endeavors; that they must be allowed the resources of the teacher’
expert knowledge, while being helped to acknowledge their own expertness as
well; and that even while students are assisted in learning the culture of power,
they must also be helped to learn about the arbitrariness of those codes and about
the power relationships they represent (Delpit, p. 296).

In this sense, students are encouraged to truly engage in their own construction of
meaning in a social context. For sociocultural theorists such as Delpit (1988), the answer
to the balanced relationship among thought, action, and the person in his or her setting is
in the notion of dialectical interaction.

*Summary of Constructivism and Social Construction of Knowledge*

The three key concepts of the constructive nature of comprehension opened this
section: (a) activation of prior knowledge, (b) active engagement with the text, and (c)
strategic processing. The main body of this section dealt with the theory of
constructivism and student-centered pedagogy, which evolved from the principles of
Piagetian ideas. This review explained that according to Piaget’s (1970) theory, cognitive
progress is not only assimilation of information, but also an increasing ability to view
knowledge objectively (which Piaget called decentration), a necessary condition of
objectivity itself. Further, it was discussed that Piaget (1970) explained that in the process
of self-regulation, the organism constantly strives toward the reduction of conflict to gain
equilibrium. Equilibrium is established through the dialectical interplay of assimilation
and accommodation, and the end result of this process of adaptation was, in Piaget’s
view, decentration.
Kelly (1958), Sigel (1978), Donaldson (1978), and Duckworth (1987) and the belief that students need to be actively engaged in the construction of their own understanding in the classroom was presented were discussed yet. This emphasis on personal construction of knowledge provided a rationale for a student-centered pedagogy in schools; however, critics see many problems in Piaget’s theory and student-centered pedagogy which were discussed in the last two sections of the review on the constructive nature of reading and science.

Critics of Piaget’s theory argue that knowledge is socially constructed and that education should aid students in coming to grips with the possibilities for personal and social transformation (O’Loughlin, 1992), instead of compelling them to learn the teacher’s or school district’s versions of truth. Similar criticisms assailed student-centered pedagogy, which emerged from constructivists beliefs. Delpit reinforced the need presented earlier to help students become critical readers of scientific text and provides support for teaching and learning environments in which students attempt to answer their own questions. Ultimately, students would seek answers not only through experiments and learning centers, but also through exposure to modeling from teachers and peers, group discussions, readings, and other modes of dialogic inquiry, which situate learning in a context and help all learners make sense of the information they encounter. These modes allow students to try and fail, to be playful, and to experiment as they attempt to come to tentative understandings through the confusion and messiness of the process of constructing personal meaning.
In conclusion, I would argue that the information presented provides support for an inquiry-based approach, in which language and content are integrated in an authentic manner, and in which students and teachers engage in a dialectical interaction between activity, setting, and the person learning as explained by sociocultural theorists.

**Generative Learning and Reading Comprehension**

The model of generative learning maintains that teaching can be understood only by knowing what it catalyzes in learners when they are learning. In Wittrock’s model of generative learning (1974, 1978, 1980, 1981a), reading comprehension occurs when readers build relationships between the text and their knowledge and experience, and among the different parts of the text. The generation of associations and relations can be taught in a variety of ways. Keys (1998) in her study on the reasoning strategies of urban students at the sixth-grade level, discussed in the prior section, based her instructional model on the generative model of teaching primary science (Harlen & Osborne, 1985).

The model Keys followed includes a sequence of three phases: exploration, investigation, and reflection. Through these three stages teacher help students generate associations and relations. Ways in which these three phases can be done include, for example, inducing the learners to generate text-relevant summary sentences and inference, or the readers can be taught to construct imaginal representations such as pictures, images, illustrations, or diagrams (Kaplan, 1971). In fact, 10 years old students construct more text relevant generations and, as a result, comprehend text better when teaching proceeds from imaginal to verbal generative activities, rather than the opposite (Linden & Wittock,
1981). Imagery probably makes learning specific and is a preferred mode of knowledge storage for children at this age (e.g., Paivio, 1970).

Studies with school children and adults support the utility of this model of generative learning for reading comprehension and fact retention in the laboratory or in the classroom (e.g., Bull & Wittrock, 1973; Doctrow, Wittrock, & Marks, 1978). However, these earlier studies were not designed to approximate the complexity of a sequence of several days of classroom teaching. Later studies have looked at the instructional sequence and have obtained similar encouraging results. Linden and Wittrock (1981) implemented an instructional sequence derived from Wittrock’s model of generative learning to determine the utility of the generation of associations for the text. Their findings confirm that text related associations, either from imaginal to verbal or from verbal to imaginal produced during learning, led to increases in fact retention and text comprehension (Linden & Wittrock, 1981).

**Science and Generative Learning**

Studies of school children and adults support the utility of this model of generative learning for reading comprehension and fact retention in the laboratory or in the classroom (e.g., Bull & Wittrock, 1973; Doctrow et al., 1978). The generative learning model is consistent with cognitive approaches to learning (Wittrock & Lumsdaine, 1977) and research on the brain (Wittrock, 1980). The essence of the generative learning model (e.g., Wittrock, 1974) is that the brain is not passive, but rather it actively constructs its own interpretations and draws inferences from the information it receives. Osborne and Wittrock (2007) maintain that generation is a fundamental
cognitive process in comprehension. As with reading, generations facilitate
comprehension, generations in science will also help the learner actively construct
meaning. People retrieve information from long-term memory and use their information
processing strategies to generate meaning from the incoming information and to store it
in long-term memory (Osborne and Wittrock). Larkin (1980) exemplified this process
with research where learners attempted to construct meaning from difficult textbook
information. Tentative links were made and tentative meanings constructed prior to the
final construction of meaning.

Children acquire considerable knowledge about the world from their contact with
their social and physical surroundings (Ausubel, 1968; Kelly, 1969). In fact children’s
views are parts of conceptual structures that provide a sensitive and coherent
understanding of the world from the child’s point of view (e.g., Bell, 1981). Recent
studies of children understandings show that although children’s ideas can be amazingly
resistant to change, they can be changed by science teaching, in ways sometimes quite
different from those intended. For example, Bell showed that the proportion of children
who considered worms and spiders to be animals decreased significantly from ages 5 to
11. In these and similar cases, however, it was reported that 16- to 17-year olds tended to
be more congruent with those of scientists than those of 15-year olds. In conclusion, the
research indicates that children’s ideas actually regress before improving. The work of
Tasker (1981) suggests that science teaching has not been as effective as we might have
thought for several reasons. For example, students tend to consider each lesson as an
isolated event while the teacher assumes that the children are aware of the connecting
links between learning experiences. Additionally, students knowledge structures were frequently not the structures the teacher assumed them to be.

Findings show that while children frequently pass tests, they often do not really change their ideas of how and why things behave as they do (Osborne & Wittrock, 2007). This result is consistent with the findings from my single subject pilot study (Martínez, 2006b), in which students’ responses during posttreatment interviews revealed that they were not making the connection between the two conditions I was implementing (GoInquire and the Reciprocal Teaching conditions). Osborne and Wittrock proposed that children develop ideas about their world, develop meanings for words used in science, and develop strategies to obtain explanations for how and why things behave as they do, long before they are formally taught science. In an attempt to acquire what is considered by the learner to be appropriate sensory information from an experience and in an attempt to use information from long-term memory to construct meaning from the incoming information, links are often made to scientifically inappropriate aspects of memory store (Osborne and Wittrock).

The authors conclude that teaching needs to take full account of children’s perceptions and viewpoints and, where appropriate, to attempt to modify or build on children’s ideas (Osborne & Wittrock, 2007). In fact, they explain that the nature of much experimental work and typical assessment procedures in science classrooms are such that children are not really encouraged to find links between knowledge in long-term memory and incoming information, to construct meaning, and to critically evaluate this meaning against both knowledge structures and external experiences. In terms of the generative
learning model, learning science is something only the learner can do. In summary, the generative learning model defends students’ knowledge, logic, and experience to parts of the statement or explanation, and the construction of meaning (Wittrock, 1981).

Interdependence/Relationship of Processes/Strategies in Science/Reading

Saul (2004a) wrote that “perhaps the cognitive strategies shared between reading and science could be taught directly, in coordination with each other” (p. 243). An interest in the relationship between science and reading can be traced to writing from the 1980s and early 1990s examining the overlap of the cognitive demands of science and literacy. For example, Padilla, Ruth, and Padilla (1991) suggest that discovery science and reading emphasize a shared set of intellectual processes (e.g., observing, classifying, inferring, predicting, and communicating) and that the very same problem solving processes are used “whether [students are] conducting science experiments or reading assigned science texts” (Padilla, et al.). The majority of the literature from this decade is more conceptual and theoretical than empirical or pedagogical in orientation and consists largely of insights into the shared demands and processes of thinking in science and literacy (Cervetti, Pearson, Bravo, & Barber, 2005).

More recently researchers have started to realize that the language arts (talking, listening, viewing, interpreting, reading, and writing) are important abilities for scientists as they seek research funds, make sense out of their experiences, and present their research questions, experimental procedures, knowledge claims, and evidence to inform and persuade other scientists and laypeople about their work. Each of these functional roles places different demands on the form and use of language by scientists (Yore, et al.,
Building on the work of others who have examined the benefits to students’ conceptual knowledge of an integrated approach to science and literacy is essential (Guthrie & Ozgungor, 2002; Palincsar & Magnusson, 2001).

Yore et al. (2006) conducted a long-term case study of two scientists who served as informants and coauthors. In their discussion the researchers explain that because of their personal goals and the nature of their disciplines, they both belonged to several discourse communities, which ranged from the general public to very large groups of scientists and to a very small group of specialists. The study revealed that each scientist had to develop writing and communication strategies that addressed the needs, traditions, and conventions of the different audiences.

Osborne (2002) has placed special emphasis on the discourse of argumentation as central to scientific pursuit. While literacy researchers were the first to seek out the potential benefits of integrating science and literacy (Guthrie et al, 1999; Padilla et al, 1991), educators, too are paying more attention to these potential benefits (Pearson, 2006). In addition, science educators recognize the advantages of a Trojan horse strategy: disguising science as literacy addresses the need to find space for science in the congested elementary curriculum in an era almost completely dominated by literacy and mathematics (Dillon, O’Brien, & Heilman, 2000; Jorgenson & Vanosdall, 2002). A literature review about integrating language arts with content area instruction show that there are few investigations that involve empirical, controlled, experimental evaluations of language arts and science integration or integration of language arts with other content areas (Morrow et al., 1997). Smith, Monson, and Dobson (1992) studied the effects of
using historical novels in an integrated language arts approach to social studies and literacy instruction. Their results showed students in the treatment groups recalled more information than students in control groups.

Finally, Morrow et al., (1997) conducted a study looking at students’ reading and science achievements in a literary-based intervention in both literacy and science programs. Their findings suggest that the integration of literature and language arts activities into science instruction enhanced performance in the language arts more than when the integration into a content area did not exist. These results are encouraging given that the authors did not incorporate a work-like-a-scientist philosophy. However, the study did not look at students’ existing knowledge and the impact that the content integration had on it. The authors noted that more studies on the benefits of integrating literature-based programs in literacy and content areas are needed. To summarize, the content areas provide learning contexts in which reading and writing are used for a purpose.

A curriculum based on the relationship between science and reading was developed by a team at the University of California, Berkeley's Lawrence Hall of Science. The development effort of this curriculum was led by Jacqueline Barber at Lawrence Hall of Science (the public science education center at the University of California at Berkeley) and P. David Pearson at the Graduate School of Education at the University of California at Berkeley. The curriculum is called Seeds of Science/Roots of Reading (University of California, Berkeley’s Lawrence Hall of Science & Graduate School of Education, 2007b) and it was funded by the National Science Foundation and
published and distributed by Delta Education. The team working on this project from Berkeley University is the same team that created the *Great Explorations in Math and Science* (GEMS) series (University of California, Berkeley’s Lawrence Hall of Science, 2007a). GEMS was developed at the Lawrence Hall of Science and tested in thousands of classrooms nationwide. The main difference between GEMS and *Seeds of Science/Roots of Reading* is that the *Seeds of Science/Roots of Reading* curriculum focuses on the relationship between science and reading (University of California, Berkeley’s Lawrence Hall of Science & Graduate School of Education, 2007b). The explorations proposed in both curriculums provide a range of supplementary learning experiences for preschoolers through eighth graders. Activities presented in this research study, like those in the *Seeds of Science/Roots of Reading* curriculum, engage students in direct experience and experimentation to introduce essential, standards-based principles and concepts.

Positive results have already been documented at the elementary level when implementing this type of curriculum. For example, Barber et al. (2006) in a presentation at the AERA 2006 conference reported the results of three consecutive studies using the science and reading curriculum. Data from these studies show that the combined science/literacy approach, as embodied in three different 8-week units, was effective in promoting science content acquisition in second–third-grade students. The results were based on pre and post tests designed to gauge growth in the understanding of a subset of the unit’s targeted knowledge of the science content domain (earth science, life science, and physical science). Students in the combined approach outperformed students in a science-only curriculum.
Although encouraging, these findings are not easy to replicate. An 8-week unit is difficult to implement in the regular classroom. Shorter investigations exploring the benefits of a combined approach for science and reading are needed. In addition, studies integrating English as a second language learners and children with special needs are needed. This is the end of the section on the generative model of teaching, which I discussed in the context of reading comprehension and of science. The next section covers the research on cognitive strategies shared by science and reading.

*Cognitive Strategies Shared by Science and Reading*

The progression toward inquiry-based instruction and integration of appropriate text-based materials to improve reading comprehension of science instruction represent two nationally significant challenges for teachers (NRC, 2000). Many commonalities exist in the recommendations for promoting reading comprehension and science inquiry (Baker, 2004). The content areas provide learning contexts in which reading and writing are used for a purpose. In addition, according to Saul (2004a), the process and reasoning used to reach explanations in science and in reading is similar.

It is well known that active self-regulation strategies such as elaboration, critical thinking, and organization of information influence learning (Weinstein & Mayer, 1985; Paris, et al., 1983). Connections of strategies that students activate while working in science and those they use when reading are particularly evident in cognitive strategies. The concept of scientific literacy involves, among other things, encouraging students to ask their own questions about their everyday experiences in the world (NRC, 1996). Students who generate questions and engage in some form of finding answers are
participating in scientific inquiry (Alvermann, 2004). It has been suggested in the literature that question generation may be best used as part of a multiple-strategy instruction program (NICHD, 2000); however, there is some indication that explicit instruction is helpful for low-achieving students but not as effective for other students (RAND Reading Study Group, 2002).

Another important strategy in both science and reading is self-monitoring, which is related to metacognitive control (Baker, 2004). In reading, comprehension monitoring involves deciding whether or not we understand something (Baker, 2004). As students engage in scientific inquiry, they develop an appreciation of how we know in science (NRC, 1996). Researchers are calling for additional studies on the implementation of inquiry processes and also how these processes may intersect with appropriate science reading strategies (Palincsar & Magnusson, 2001).

It is now well accepted that metacognition should be fostered in comprehension instruction (e.g., Block & Pressley, 2001). Instruction in monitoring comprehension also helps students improve their comprehension (Baker, 2004). Children have been taught by teacher modeling and guided practice to use self-instruction or think-alouds to monitor their own comprehension during reading (Baker, 2004). In science, metacognition does not enjoy such a prominent role in the reports of national science panels, but statements like, “Engaging students in inquiry helps students develop an appreciation of how we know what we know in science” (NRC, 1996, p. 105), underline the central role metacognitive thinking has in science.
Because of its importance to this study, it bears repeating that social interaction plays an important role in the development of metacognition (Baker, 2004). Dewey helped us understand that the reflective process of thinking is essentially a dynamic relationship between a student and his/her own thinking (1933). Dewey also realized that communication between an individual child and his/her classmates and teacher is a building block of knowledge (Dewey, 1944). Cognitive theorists have long argued that acquisition of knowledge is embedded in social interactions (Piaget, 1963; Vygotsky, 1978). Many theorists believe that a metacognitive skill starts from expert-novice interactions (Baker, 2004), a view that originates in the social interaction theory of Vygotsky. Therefore, modeling, dialogue, feedback, and many opportunities for practice need to be introduced into the classroom to help students learn through an inductive approach.

Prior Knowledge and its Relation to Reading Comprehension

The first thing good readers do is to activate their prior knowledge. Prior knowledge is a critical ingredient in the process of comprehending text (Anderson, 1994; Dole et al., 1991) and learning from it. According to Kendeou and van den Broek (2005), much of the learning that takes place in and out of schools is based on successful comprehension of texts. As readers interact with the text, explicit efforts are required to relate what is being read to prior knowledge. The powerful effects of prior knowledge on a reader’s comprehension were documented early on (Barlett, 1932). Later studies confirmed the decisive role of prior knowledge in text comprehension (e.g., Afflerbach, 2002), indicating that prior knowledge increases memory of texts of readers (e.g., Recht...
& Leslie, 1988). In a sense, prior knowledge filters text material, resulting in personal interpretations and variations in meaning. Simply put, students with extensive knowledge of the world are better readers.

Two types of knowledge have been found to affect text comprehension and memory (Kintsch & Frankz, 1995): general knowledge, which is defined as knowledge that the individual shares with members of a culture, and specific knowledge, which varies among people, depending on their exposure to a topic. Kintsch and Frankz used a news story as their main material in an activity that required their participants to have both general and specific knowledge for maximum comprehension. General knowledge in this case was information about war, warfare, armies, government, and other such topics. Specific knowledge was knowledge about the civil war in Sri Lanka. This specific knowledge is what this intervention attempts to provide to all learners. The researchers explain that the effects of background knowledge on the ability to recall expository texts are quite complex (Kintsch & Franzke). In a study to explore how subjects at the college level with various degrees of special background knowledge were able to recall a news story, the researchers found that the total amount of reproductive and elaborative recall produced by a subject in a full versus a partial or no-knowledge condition was not widely different in the three background conditions (Kintsch & Franzke). The difference was in what they recalled. While subjects who lacked the necessary background fabricated information that did not fit the situation described in the text, their elaborations of the subjects with background information did.
The theory of text comprehension developed by Kintsch (1988, 1992; van Dijk & Kintsch, 1983) describes the text base and the situation model as two different types of representations generated during comprehension. This theory offers a framework that helps explain the relationship between background knowledge and its effects on the recall of expository texts. The text base is the representation of the meaning and structure of the text itself (readers can generate an adequate text base, even with minimal domain knowledge), whereas the situation model represents the content of the text, and what is already known about it. The authors clarify that both representations depend on one another. The analysis the researchers conducted of the text recalls in the study on the news story, revealed that subjects who had the least background knowledge missed some of the intricacies and implications in the information transmitted, but had no trouble getting the main point and even a lot of the detail (Kintsch & Franzke, 1995). As part of the study, the authors gave certain subjects impoverished texts to read. They found that subjects with less prior knowledge recalled much less from that text and the subjects with no background information generally disregarded it.

What happened is that without specific information on the topic, readers were not able to form an adequate text base for the impoverished part of the text because they could not fall back on their general knowledge. Means and Voss (1985) reported comprehension differences as a function of the quality of readers’ knowledge schemata. In the example provided by the Kintsch and Franzke (1995) study, the readers’ schema of the impoverished texts was sufficient to understand one part of the text, at least superficially, but the schema they created was useless by itself and needed to be
combined with specific information to support comprehension. This finding extends the Means and Voss explanation. Although at times the reader can create a text base without constructing an adequate situation model, in the present study control group’s lack of knowledge of the relevant subjects was so extreme that the limits of purely text-based understanding are clear (e.g., Mannes & Kintsch, 1987).

Mannes and Kintsch, (1987) describe reading comprehension as the construction of a mental representation of text. They postulate that comprehension involves the use of a combination of both general and specific knowledge. Similarly, Kendeou and van den Broek (2005) explain that readers actively construct a memory representation of the text that critically depends on their interpretation of the information they are reading in light of prior knowledge.

Kendeou and van den Broek (2005) investigated the effects of readers’ misconceptions on the cognitive processes of science text comprehension. They obtained both online (think-aloud, reading times) and offline (recall) measures. They found that readers with misconceptions recalled less textual information after reading than did readers with no misconceptions (after controlling for reading comprehension differences), but that the online processes all readers engage in during reading do not differ. Therefore, differences in the amount of information recalled among students who have equivalent reading comprehension levels is directly related to their misconceptions/prior knowledge of the content of the text. The authors explain that student-generated questions or self-explanation reading training will help readers’ inferences as they read.
As presented earlier in this review, research in reading and science education has shown consistently that readers with misconceptions are relatively unaware of conflicts between their knowledge and the information in traditional expository texts. If readers realize that their explanations actually contradict the to-be-explained text, one solution would be for them to engage in deeper processing in an attempt to establish coherence. In fact, when average readers generate explanatory inferences they have a tendency to do so in a relatively shallow fashion (Otero, 1998). This is consistent with the research on knowledge incorporation versus compartmentalization. Incorporation is the integration of new information from the text with the reader’s existing body of knowledge, whereas compartmentalization is the isolation of new information from the text from prior knowledge. The evidence provided by Kendeou and van den Broek (2005) suggests that readers engaged in knowledge compartmentalization failed to incorporate textual information into their prior knowledge.

My personal experience as a teacher supports this idea as well. I conducted a naturalistic investigation with fifth-grade students with learning disabilities (Martínez, 2006a) and found similar results when students failed to realize (after reading the text) that their predictions were totally incorrect. However with teacher intervention and metacognitive-fostering prompts, students were able to modify their ideas and incorporate new, more accurate ones. Students’ difficulty to realize their predictions are incorrect presents the important educational problem of how to foster incorporation rather than compartmentalization. Kendeou and van den Broek (2005) suggest that readers must
first become aware that there are inconsistencies between their prior knowledge and textual information.

This review included information on the schema theory (Andersson, 1986) which suggests that an individual’s knowledge of the world is stored in organized, cognitive frameworks called schemata. Readers apply relevant schemata to interpret text information, thereby building a coherent mental model of the text. The activation of schemata results in a personal response and understanding of meaning as each reader uses appropriate schemata to construct meaning. Additionally, a reader’s schema plays other roles. First, it provides a structure for assimilation of new text information with current knowledge. Additionally, because the stored knowledge is organized, more efficient memory searches are possible. Therefore, it becomes even more apparent that meaning is not a simple matter of adding up the words (Andersson). Through the activation of schema, readers construct meaning.

A related issue, which has already been touched upon several times in this research study, is that learning, especially in young students, is influenced by cognitive development (Barton & Jordan, 2001). All students do not arrive at school with the same set of knowledge and skills, particularly when these students are from a variety of socioeconomic backgrounds. These differences might become highly significant later on in life. In fact, in science, knowledge of relevant content domains may help account for individual differences in reader engagement, a potentially important factor in accounting both for what types of science articles are read and what for types of mental representations are constructed during reading in everyday contexts (Otero et al., 2002).
Providing sufficient background knowledge and opportunities to develop thinking skills of a higher order are some of the ways teachers can compensate for a student’s lack of knowledge and skills. The role of inaccurate prior knowledge, however, has received far less attention (Kendeou & van den Broek, 2005).

Prior Knowledge and Its Relation to Science

Individuals construct different mental models to explain concepts and processes in the physical world (Kendeou & van den Broek, 2005). In fact, young children do so even before receiving formal instruction on those concepts (Carey, 1985). One principal result is that their conceptions prior being taught are markedly different from the concepts of the teaching program, and according to Andersson (1986), these concepts develop only to a minor extent as a result of teaching. In fact, these prior concepts have been found to be very resistant to change (Ausubel, 1968) and to hinder learning from text (e.g., Alvermann et al., 1985). Depending on the investigator’s starting point, different names are given to the students’ conceptions (Andersson). Some of the names include alternative framework (Driver, 1983), children’s science (Osborne, Bell, & Hilbert, 1983), everyday physical and chemical conceptions (Andersson) and misconceptions (e.g., Helm & Novak, 1983). In this research study, the term misconceptions has been adopted. Inaccurate ideas in science, also called misconceptions, have been found to interfere in the process of acquiring new knowledge (e.g., Alvermann et al., 1985).

Up to this point, this review has covered issues related to the importance of teaching cognitive strategies, such as adopting a more culturally sensitive context and considering prior knowledge. The review of this information suggests that these factors
could help second language learners improve their ability to comprehend scientific text: (a) building up prior knowledge, (b) helping students learn and use cognitive strategies that are effective in both science and reading, and (c) using more linguistically and culturally sensitive contexts. Next, I will discuss vocabulary, which is closely related to general knowledge.

Importance of Vocabulary

There is no doubt that vocabulary is a critical factor in building proficiency in reading. Researchers have long been aware of the key role of vocabulary in reading. Whipple (1964), for example, said, “Growth in reading power means, therefore, continuous enriching and enlarging of the reading vocabulary and increasing clarity of discrimination in appreciation of word values” (p. 76).

Written texts complicate language comprehension by introducing students to words that they will not necessarily have encountered in everyday oral discourse. The silver lining in this cloud of difficulty introduced by written texts is that these texts also provide a rich resource for expanding vocabulary, particularly by elaborating on the set of words that can be used to name a given concept (e.g., adding gorgeous, stunning, and dazzling to the description of a painting). Not only are students expected to understand words in texts, but they are also introduced to many new words. The degree to which the vocabulary used in educational texts handicaps American school children in their reading is difficult to establish since the effects of vocabulary are often difficult to separate from reasoning in assessments. However, according to the National Assessment of Educational Progress (Donahue, Finnegan, Lutkus, Allen, & Campbell, 2001), a fairly consistent
number of American fourth-graders—around 40%—fail to comprehend a grade-level text at a basic level; approximately one in four comprehends at a proficient level. The profile of the National Assessment of Educational Progress on science is quite similar. Closer examination of these data indicates that traditionally marginalized students (i.e., low-income students or those who are in a racial or linguistic minority students) are more likely to perform at below the basic level and less likely to perform at the proficient level or higher in either reading comprehension or science achievement. This discrepancy deserves particular consideration in a content area such as science where the performance of Hispanic students is substantially different from that of their peers, whose first language is English.

As a content area, science is unforgiving in terms of the constant need to build knowledge and to learn the terminology needed to express that knowledge. Native Spanish speaking students need to use every resource available to them to make meaning and build control over science vocabulary and conceptual knowledge; cognates seem to be a ripe area for exploitation as a fundamental building block. Science texts deal with aspects of the world that students may encounter daily but that have never consciously analyzed or addressed. Science texts involve many words used in the three most difficult word-learning tasks that Taylor, Graves, and van den Broek (2000) describe: (a) words that are synonyms for concepts that students already have, (b) words that students know at some level but that have multiple meanings, and (c) words that represent new concepts for students.
Another aspect of science vocabulary that makes comprehension and science learning difficult is that a new topic typically involves a number of unknown concepts and vocabulary. In science texts, new words come in groups since complex concepts are situated in a semantic network that includes related words (Bravo, Hiebert, & Pearson, 2005). Gaining active control of these words is achieved when students know where the word fits in relation to other words. Finally, there are few contexts other than the school lesson in which the technical scientific vocabulary is used or heard (Bravo et al., 2005).

Latin-based words in English come from science (a source shared with most modern languages). Because of the use of Latin among scholars and the clergy from the middle ages on, because scholars wrote and spoke in Latin, the early language of science was Latin. The tradition of attaching Latin names (and Greek, as well) to new discoveries in science has continued up to the present (Bravo et al., 2005). Words for science and technical vocabulary of Latin origin are similar in English and Spanish. Since written language typically employs more formal vocabulary than spoken, these Latin-origin words are often found in literary and academic texts. Bravo et al. explain that Spanish speakers trying to learn English, particularly scientific English have an advantage because there are many words which are cognates in both languages. Students from homes and communities with languages and cultures that differ from than the language and culture of school are frequently evaluated on their inadequacies, rather than on their strengths (Allington, 2000). This perception has too often led to lowered academic expectations for these students, which in turn lead to lower academic performance (Moll & Ruiz, 2002).
The “funds of knowledge” perspective of Moll and his colleagues (Moll, Amanti, Neff, & Gonzalez, 1992) directs attention to the intellectual resources that students, particularly culturally or linguistically diverse students, bring to school. These funds of knowledge pertain to the bodies of knowledge that are essential to a household's functioning and well-being. Spanish-English cognates can also be regarded as a fund of knowledge that can be used to build a bridge between community and classroom way of knowing. As the discussed above, academic English contains vocabulary has close connections with some vocabulary in Romance language such as Spanish. To date, researchers have examined the transfer value of these cognates, but whether interventions that capitalize on this resource deliver benefits for learning English.

The importance of vocabulary for fluent reading has been documented (e.g., Allington, 2000; NRP, 2000). In general, individuals with poor vocabulary have difficulty understanding written text. Therefore, research-based vocabulary instruction was reviewed to guide the approach to vocabulary instruction in this research study. Most of the words that students learn are learned in context, and a few are learned through direct instruction (Beck & McKeown, 1991). It has been documented that from the fourth grade on, most words are learned incidentally through books and stories (Fielding, Wilson, & Anderson, 1984). The Matthew Effect describes the reality that students with robust vocabularies read more, comprehend better, and thus read more still, improving their vocabularies. This phenomenon is also described as the rich get richer and the poor get poorer (Stanovich, 1986; Walberg & Tsai, 1983). Rupley and Nichols (2005) report that, at present, vocabulary is often taught by having students look for dictionary
definitions. However, effective instruction requires more (Beck, McKeown, & Kucan, 2001). As opposed to associative, rote-memory, dictionary-based instruction, meaning-based approaches to learning vocabulary have been found to be more effective, resulting in more lasting memory and better understanding (Beck et al.).

There have also been studies that show that word origin or etymology can also make learning words both meaningful and interesting (e.g., Moats, 2000; Venezky, 1999). This finding is important here because the literature indicates that successful bilingual readers search for cognates, transfer, and translate (Jiménez et al., 1996); this attention to the word origins can enable students to identify potential cognates.

*Earth Science*

Learning about landforms, an important component of earth science instruction in the elementary grades, has been identified as needing improvement (Rule, Grahan, Kowalski, & Harris, 2006). Students need to know the terms for landforms and how they are formed and means of facilitating the acquiring of such information” (Twidale, 1999). Nelson-Herber (1986) suggested the problem is not that students lack reading skills to assimilate the new vocabulary, but that they lack the prior conceptual knowledge to construct meaning for the new terms. The National Science Education Standards (NRC, 1996) *Air and Space Science Content Standard D for grades K-4, Changes in Earth and Sky*, addressed landform processes by stating, “The surface of the earth changes. Some changes are due to slow processes, such as erosion and weathering, and some changes are due to rapid processes.” Similarly, chapter 4, “The Physical Setting,” of the *Benchmarks*
for Science Literacy states that children in grades three through five should learn about surface features of the Earth.

The thematic concept of “evidence, models, and explanations” has been used effectively in elementary school science investigations. Rule, Young, and Fox (2003) conducted an investigation of driftwood with third-grade students using this unifying concept. The cycle of exploration, explanation, and expansion phases (Karplus & Lawson, 1974) supports constructivist learning, which has its foundations in the work of Piaget, who believed that learners interact with the world to construct knowledge actively from their existing conceptual frameworks. For students to learn new ideas, they must recognize that their current understandings of how the world works do not adequately explain the new ideas they confront (Rule et al., 2006). If students do recognize the discrepancy between current ideas and new ideas, the authors explain that the students will experience a disequilibrium and a readiness for new learning. This disequilibrium and self-questioning allow students to change their framework and learn. Constructivist approaches are accepted as best practice in science teaching by the National Research Council and the American Association for the Advancement of Science.

Using data from the Learning in Science Project (Osborne & Freyberg, 1985) Happs (e.g., 1982a, 1982b) reported exhaustively on students’ views of earth science phenomena. From interviews and sorting tasks, Happs (1982a) concluded that children’s approaches to constructing categories for rock and mineral samples contrasted sharply with the approach likely for earth scientists. In reference to students’ grasp of mountain-building processes, Happs (1982b) found that two-thirds of his sample of 37 had no
awareness that a dormant volcano might erupt again. With regard to soils, Happs (1982c, 1984) concluded that students had little sense of soil-formation processes or dynamic environmental factors related to soil change with time. Common to all these examples is children’s generally sound thinking with respect to the classification schemes for earth science phenomena that suit their purposes. Difficulties arise when the meanings their teachers ascribe to geological terms differ from those held by children, and the children do not yet recognize the alternative purposes served by the scientific meaning. Lemke (1990) explains that the child and the teacher are simply not “talking science” and as mentioned earlier, researchers refer to this mismatch as a misconception.

Continuing with earth science, Cohen (1968) used a “mudpile mountain” to probe upper elementary grade children’s grasp of fluvial processes. Before instruction, students’ predictions on the future of water running down a dirt pile varied widely, but afterwards students were able to grasp the principle of transport, that is, water carries smaller particles farther from the slope than larger ones.

Research with young children suggests that logical reasoning improves when the question makes intentional sense to the child (Donaldson, 1982). Ault (1994) explained that without a common purpose (or without recognition of another’s purpose), a shared meaning of concepts is unlikely. Ault’s reasoning supports the assessment of identifications of misconceptions in this study. Once the misconceptions and students’ understanding of the basic terms involved have been identified, teachers can purposefully present students with situations that will challenge their erroneous prior ideas. Ault (1982) also explained that children’s concepts about time present no barrier to
understanding the geologic past; however, their lack of familiarity with and knowledge about geologic objects and events leads to confused and contradictory thinking. Teaching aimed at bringing about understanding of complex systems involves probing student surface errors for possible deeper misconceptions, then guiding instruction according to correction strategies (Ault 1994). According to Stevens and Collins (1980) such uncovering of students’ ideas requires: (a) a knowledge of common student errors and the relationship of such errors to misconceptions, (b) an understanding of the types of real-world, experiential knowledge students use to comprehend novel problems, and (c) an understanding of various ways to apply such real-world knowledge.

Sometimes textbooks are misleading, as in the case of cross-sectional diagrams depicting underground water as a stripe of pure blue (Ault, 1994). Direct observation is seldom possible for underground water, but small-scale experiments may help (Ault, 1994). Finally, field oriented, on-site problems are natural to the earth science curriculum, but their use demands extra teaching effort (Kern & Carpenter, 1984).

Technology and Diverse Learners

Technology can help teachers implement effective instructional practices for all. For example, integrated and used thoughtfully and well, technology in English as a second language can mobilize children to active involvement in the content, contexts, and discourses of school (Meskill, 2005). In fact, learning language through academic content has been found to be greatly facilitated when teachers include computer use as part of instruction (Adamson, Herron, & Kaess, 1995). Computer technology holds unprecedented promise for students with disabilities to grow and learn alongside their
peers. The literature contains a number of examples of assistive technology applications found successful when used with students with learning disabilities (Lewis, Graves, Ashton, & Kieley, 1998; MacArthur, 2000; Raskind & Higgins, 1995; Thompson, Bethea, Rizer, & Hutto, 1998), but inclusive classrooms were not usually where the research took place. As a result, students with disabilities are unintentionally denied the opportunity to participate as full and equal collaborators because online resources are designed without regard for accessibility. Ultimately, insurmountable barriers keep students with disabilities from using computer technology at school.

A study by Neuman and Celano (2006) looked at how having equal access to resources impacted the knowledge gap. This gap refers to the differentials in information acquired and retained by individuals (Neuman & Celano). “Leveling the playing field” is the theory of action that underlies this idea that equalizing resources has a causal effect on equalizing opportunity. Interestingly, it has been found that inequality in resources had little to do with achievement inequity. Coleman’s report of educational inequity (Coleman et al., 1996), explained that family characteristics and socioeconomic status contributed more to learning than did the schools. Neuman and Celano used an initiative, starting in 1996, to renovate neighborhood branch libraries in Philadelphia to investigate how technology and greater resources impacted the gap. Renovations included, among others, additional computers linked to the internet, and a collection of 1,000 new books plus software programs for each library. Contrary to expectations, studies indicated heavy library use across neighborhoods, and socioeconomic status. However, they explain that the quality of time spent in the libraries varied substantially by socioeconomic status. In
addition, these quality differentials appeared at all grade levels prior to, immediately after, and stronger still following technology renovations. Neuman and Celano concluded that technology and greater resources did not close the gap, but actually exacerbated it. In other words, equal resources did not translate to equal educational experiences.

These findings are significant because economically disadvantaged individuals tend to be information-poor, which can lead to difficulties in learning to read and also in acquiring new knowledge (Neuman and Celano, 2006). It is clear that providing equal resources is not sufficient to level the playing field and that additional targeted instructional strategies are needed as well. In this study, an attempt is made to level the playing field by providing all students with rich prior knowledge in the content and using resources with which all students are familiar.

The GoInquire System

GoInquire is a web-based system developed by Dr. Bannan-Ritland and a team of researchers. GoInquire aims to develop students’ prior knowledge on slow geomorphologic processes and improve their reading comprehension, using a collaborative inquiry-based science approach. The development of the system involved elementary science teachers in an intensive one-year experience in which they reviewed the research available, conducted their own research with their students, and created prototypes that the current system was based on.

The system aims to enhance students’ ability to observe in a more geomorphological way and to acquire the background knowledge they need in the topic of slow landform change (erosion, deposition, and transportation) while at the same time
developing their reading comprehension skills of scientific text in an authentic and inquiry based setting. The strategies used throughout the GoInquire system parallel those used in Reciprocal Teaching (Palincsar & Brown, 1984). The advantage of the GoInquire system is that it allows teachers to adapt the content, the sequence, and the questions to their particular groups of students. The system encourages collective rather than individual construction of meaning from texts and has been proven to be highly motivating for students as they construct their own meaning of the content and the texts they are reading. In addition, the analysis of postintervention interviews from the pilot study I conducted at the beginning of the 2006-7 school year, showed that students were very motivated by familiar pictures and by seeing other’s responses. Researchers have found that motivation for reading predicts reading achievement on standardized tests (Gottfried, 1985) and school grades (Sweet, Guthrie, & Ng, 1998), especially for students in grades 3 through 5. In a study on the influences of stimulating tasks on reading motivation and comprehension, researchers used hands-on science observations and experiments to increase situational interest (Guthrie et al., 2006). Their results show that students’ motivation predicted their level of reading comprehension after controlling for initial comprehension. The authors asserted that stimulating tasks in reading increased situational interest, which in turn increased longer term intrinsic motivation and reading comprehension (Guthrie et al.)

Following this review is the Methods section with a description of the study’s design. The participants in this research project were a group of diverse fourth-grade students. This project examined their understanding of scientific inquiry through their
conceptualization of uncertainty in plans they developed and tested with a partner to solve real life problems. These student-regulated plans followed an intervention focused on building up diverse students’ prior knowledge in the area of slow geomorphological changes caused by water and reinforcing the parallel use of cognitive strategies in reading and science. The ultimate goal of this intervention was for students to use this ability to move towards a better understanding of the nature of science. The focus was on teaching both comprehension-fostering and monitoring strategies that can be used in reading and science, via inquiry-based instruction on the specific science content they were reading about.

According to Palincsar and Brown (1984), it is generally agreed that given reasonable facility with decoding, reading comprehension is the product of three main factors: (a) considerate texts, (b) the compatibility of the reader’s knowledge and the content of the text, and (c) the active strategies the reader employs to enhance understanding and retention, and to circumvent comprehension failures. Therefore, this study aims to, given appropriate texts, increase diverse reader’s knowledge of scientific text content and comprehension-fostering strategies, which can be used in a wide range of situations. There is ample evidence that helping students become critical readers of scientific text is an area of need (Otero et al., 2002). Second language science research is needed as well to understand fully the implications of instruction in science and in reading and science in student outcomes and for student success (Saul, 2004a).
Summary of Literature Review in the Context of this Proposal

Below I summarize the ideas and findings most relevant to this study. This discussion leads into the Methods section.

This research study describes and sets the context for an instructional model designed for upper elementary dual language students, which is be based on the parallel use of similar cognitive strategies in both inquiry-based science (geomorphology) and reading comprehension. The core theme presented in the Literature review, that using inquiry-based instruction and appropriate text-based materials to improve reading comprehension of scientific texts represent two nationally significant challenges for teachers nationwide (NRC, 2000), is reflected throughout the INSCIREAD model and is indicative of the significance and timeliness of this study.

The topic selected as a context for implementation of the proposed model is slow geomorphological change caused by water. This context is an area of need addressed in the standards. For example, chapter 4, “The Physical Setting,” of the *Benchmarks for Science Literacy* states that children in grades three through five should learn about surface features of the Earth.

In addition, the participants of the proposed study are all dual language learners, who are learning in English and in Spanish, students with special needs. Due to the challenges presented when having language learners and students with special needs in the same classroom, the Literature review has explicitly addressed research conducted with these populations as well. There is little evidence suggesting that an inductive style of instruction is effective for students with disabilities (Woodward & Noell, 1992). The
literature, however, reports that differences in the academic achievement between high and low achieving students may be that lower achieving students are often denied effective exposure to higher level thinking skills (e.g., Coley & Hoffman, 1990). Recommendations from research include helping these students become “fluent with essential factual and conceptual knowledge” (Gersten & Baker, 1998, p. 24) before they engage in inquiry-based instruction, and providing significant coaching (Woodward & Noell; Mastropieri & Scruggs, 1992). These two recommendations take the form of modeling and presenting multiple opportunities for practicing new information during the proposed instructional sequence.

In relation to the linguistically diverse population included in this research study, it is important to point out that the instructional model proposed here is based on the idea that culturally or linguistically diverse students bring intellectual resources to school which can be utilized in the classroom. The Spanish-English cognates are a fund of knowledge that can be used to bridge community with classroom ways of knowing; the use of this resource was explored during the intervention. In addition, the literature in bilingual education suggests that students who speak more than one language have an enhanced awareness of different linguistic codes, which translates into cognitive flexibility (Cummins, 2001).

Research Questions

To collect evidence on whether or not the instructional model is, in fact, successful at helping students’ develop their awareness of the relationship between science and reading, and improve students’ comprehension of
scientific text and their knowledge of science I have proposed a series of questions. The Matrix at a Glance included as Appendix A, give an overview of the hypotheses, research questions, methodology, data collection measures, scoring system, and data analysis approach.

This investigation includes two studies, a mixed-methods quasi-experimental: Study 1 and a single subject: Study 2. Research Question 1A is answered in both studies and Research Question 5 is answered as part of Study 2 only. Data from students with special needs are presented as part of Study 2.

Quantitative Research Questions and Hypotheses for Study 1

Research Question and Hypothesis 1A: Does explicit instruction of scientific text content and comprehension-fostering cognitive based strategies (questioning and self-monitoring)—INSCIREAD—have an effect on fourth-grade children’s science text recall? It is hypothesized that students exposed to INSCIREAD will achieve higher text recall scores than the control group.

Research Question and Hypothesis 1B: Does INSCIREAD have an effect on the level of questions fourth-grade children generate? It is hypothesized that students exposed to INSCIREAD will use a higher level of generated questions in the posttest than in the pretest.

Research Question and Hypothesis 1C: Does INSCIREAD have an effect on the ability of fourth-grade children to monitor their comprehension as measured by their ability to detect incongruent sentences, before and after controlling for guessing? It is
hypothesized that students exposed to INSCIREAD will demonstrate a greater ability to monitor their comprehension than the control group.

Research Question and Hypothesis 1D: Does INSCIREAD have an effect on fourth-grade children’s ability to summarize and rate importance? It is hypothesized that students exposed to INSCIREAD will demonstrate a greater ability to summarize and rate importance than the control group.

Research Question and Hypothesis 2: Does INSCIREAD have an effect on the number of misconceptions fourth-grade children identify, as shown by descriptions and illustrations they create to answer open-ended questions? It is hypothesized that students exposed to INSCIREAD will hold fewer misconceptions after the intervention than before.

Research Question and Hypothesis 3: Does INSCIREAD have an effect on the awareness fourth-grade children have of the parallelism and the interdependence of science and reading, as shown by the number of connections they are able to make on a science and reading concept map? It is hypothesized that students exposed to INSCIREAD will make more connections on a science and reading concept map than control group.

Qualitative Research Questions and Hypotheses for Study 1

Research question 4 is: How does INSCIREAD impact fourth-grade children’s use of the online cognitive strategies of questioning and self-monitoring as shown by a think-aloud protocol using texts with anomalous sentences?
Quantitative Research Question and Hypothesis for Study 2

Research Question and Hypothesis 1A are does explicit instruction of scientific text content and comprehension-fostering cognitive based strategies (questioning and self-monitoring)—INSCIREAD—have an effect on fourth-grade children’s science text recall? It is hypothesized that students exposed to INSCIREAD will improve their text recall scores as the intervention is implemented, as shown by visual analyses and randomization tests.

Qualitative Research Question and Hypothesis for Study 2

Research Question 5: Does INSCIREAD have an effect on fourth-grade children’s awareness of the parallelism and the interdependence of science and reading, as shown by their answers to interview questions?

I anticipate that the combination of data collected via quantitative and qualitative methods will provide strong support to the idea that the INSCIREAD intervention provides strong positive effects in the different dependent variables in the classroom. This dialogic approach across different methodologies is best addressed by the paradigm of critical realism, which has defined the data collection and analysis used in this research study.

Pilot Study

Results from the 2006 pilot study and the overall general research designs and procedures are described next.
3. Method

This chapter presents the pilot study conducted prior to this investigation. It then covers the method for the mixed-methods quasi-experimental: Study 1 and the method for the single subject: Study 2.

Participants

The participants of this pilot study were 24 fifth-grade students who received science instruction in Spanish: 14 students, including 4 with learning disabilities, received the intervention; 10 were in the control group.

Measures

Students in the treatment group completed a text recall protocol daily. Students would read and interact with a text for as long as they wanted and then write everything they could remember from the text. Students in the treatment group read and wrote what they could remember from a total of 12 texts. Students read one text each day. The control group completed only the text recalls for the pretest (Texts 3, 4, and 5) and the text recalls for the postassessment (Texts 11 and 12).

The questions addressed in this pilot study were (a) will a sequential implementation of first, science content and then, reading strategies help students improve their ability to recall information from a science text? (b) will students who participate in the intervention improve more than those in the control group?
Description of the Intervention

The experimental design consisted of a multiple baseline across groups, combined with a changing condition. The two conditions were exposure to inquiry-based instruction using the GoInquire web-based system, and direct instruction on comprehension-fostering and monitoring strategies that can be used in reading and science (Palincsar & Brown, 1984).

Procedures

The 6-day intervention during the pilot study was similar to that of the INSCIREAD instructional model (see Appendix I). Whereas during INSCIREAD the researcher presented the two conditions and a whole group discussion to make the relationship between the two conditions more clear, during the pilot study the researcher presented students with two distinct conditions without explicitly discussing their relationship. The first condition was instruction in science content related to geomorphology using the technology system GoInquire. The second condition was instruction in reading strategies. Each condition was implemented for three consecutive days. Each day of the baseline and the intervention students read part of a science text and then wrote everything they could remember from memory.

Design

A multiple baseline across groups, combined with a changing condition design (GoInquire and Reading Strategies) was used to analyze the effects of intervention on learners’ ability to comprehend scientific text. After three baseline recalls had been collected, students in group 1 received the GoInquire condition during three sessions.
while students in group 2 remained in baseline. After group 1 had finished the GoInquire condition, both groups simultaneously moved onto the Reading Strategies condition for three consecutive sessions. Finally, after the Reading Strategies condition was completed, students in group 2 changed conditions and received instruction with the GoInquire system, while students in group 1 continued the recall protocols with no treatment.

Twelve recalls were collected for every student. Students in the control group remained in their regular science and reading classes and received no intervention.

Results and Discussion

As shown in Figures 1 and 2, students who participated in the intervention improved their ability to recall text more than those who did not. The results for students with special needs showed high variability and only moderate improvement from baseline to intervention. However, I observed that students with special needs did make progress during the intervention. Specifically, these students were observed applying the strategies while working in groups and generating more questions. Therefore, the results of the pilot study suggest that an additional type of data was needed to improve documentation for the progress of students with special needs. Data from the text recalls supported the hypothesis that a combined approach rather than a sequential implementation of the two conditions could be expected to produce the best results. In addition, I used this pilot study to help determine appropriate materials for future data collection, and to improve the general design of the study. Changes and adaptations arising from the pilot study that were included in this study were (a) closer consideration of students’ inferences and illustrations when scoring the text recalls, (b) consideration of
the measurement of students’ online comprehension processes, (c) more explicit establishment of the relationship between science and reading more explicit during the intervention; (d) collection of both quantitative and qualitative data, and (e) incorporation of whole group discussions at the end of every session to promote reflection and communicate learning. The modified version of the teaching sequence from the pilot study resulted in a combined instructional intervention in science and reading, with an emphasis on questioning and self-monitoring termed INSCIREAD.

Figure 1. Comparison of students in pilot study Group 1 (GoInquire + Reciprocal Teaching) and Group 2 (Reciprocal Teaching and GoInquire) from the general education population with the students in group 1 and group 2 from the special education population with students in the control group.
To continue and improve this line of research and the conceptual model and results, this study focused on implementing a combined rather than a sequential intervention of reading and science with a larger group of students distributed among three treatment groups, instead of the two original ones. Rather than a quantitative study, the researcher conducted a mixed-method study, collecting additional quantitative and qualitative data to illustrate more effectively all students’ learning and to triangulate findings. An analysis of the misconceptions before the intervention was an element added
as a conclusion to the pilot study. This additional analysis of the misconceptions enabled an explicit analysis of students’ erroneous ideas through texts and discussions. Another difference between this study and the pilot study is the emphasis on revealing more explicitly the relationship between science and reading and the similarity of processes and strategies used, as well as measuring students’ progress in relation to this awareness.

Mixed-methods Quasi-Experimental: Study 1

The purpose of a quasi-experimental design is to test descriptive causal hypotheses about identified manipulable variables. Quasi-experiments do not traditionally employ random assignment. They share with all other experiments the purpose of testing descriptive causal hypotheses about manipulable causes, but lack random assignment (Campbell & Stanley, 1963).

Method

Participants and Setting

Fifty-two fourth-grade students initially took part in this study, but three of them did not complete all the assessments and were eliminated from all analyses. Therefore, the data from 49 students with no special needs were used as part of Study 1. In addition 21 students were included in the no-treatment control group. All students were assigned to their respective classes. The distribution of students tended towards a balance of girls and boys and of other general student characteristics, such as English and Spanish native speakers, within the same class. The researcher did not alter these existing classes for the intervention. Each class included a mean of 16 students, raging from 14 to 18 students (not counting students with special needs, whose data are included only in Study 2). The
treatment group for Study 1 and the control group did not include any students designated as having disabilities. All of the students were dual language learners (English to Spanish or Spanish to English) and spent half the school day learning in English and half learning in Spanish language. In this school science, math, and language arts instruction was conducted solely in Spanish.

This research study was conducted in an elementary school in the eastern United States, serving children in kindergarten through fifth grade. At the time of this investigation, enrollment was 609 students, 187 of whom were English language learners, and 52 of whom received special education services.

Measures

This section covers a detailed description of the seven quantitative measures used in this investigation and the qualitative measure of the think-aloud activity. The seven measures are (a) science text recall, (b) level of generated questions, (c) detecting incongruities, (d) summarizing and rating importance, (e) number of misconceptions, (f) science and reading concept map, and (g) Spanish reading level.

Science text recalls. This measure was adapted from Carlisle (1999) who conducted a study looking at free recall as a test of reading comprehension for students with learning disabilities. The purpose of the science text recalls was to measure students’ ability to comprehend written science text related to slow landform changes caused by water. This ability was measured by determining the amount of information students could recall after reading and interacting with one of the assessment passages for as long as desired. As a deliberate part of the research design, all students in the
intervention completed daily text recalls until they all had read 15 texts. Appendix B provides an example of one of the texts, its scoring, and the instructions given to raters of students’ text recalls. For the quasi-experimental part of the design, only three texts completed after the intervention (posttest: Texts 12, 13, and 14) were considered. These text recalls were completed by both treatment and control groups. The data from the posttest was used to analyze the results statistically with analysis of covariance, controlling for students’ Spanish reading levels prior to the intervention.

Text recall analysis was aligned with the method described by Johnson (1970). The original text was initially divided into pausal units (a unit where a pause occurs at its beginning and end during normally paced oral reading). The different text units were entered on an Excel spreadsheet and each clause was coded for one of three choices: (a) main idea, (b) high subordinate idea, or (c) detail level idea. A weighted analysis was then developed by having raters rank each pausal unit in terms of its salience to the message of the text. Main ideas were rated 3 points each if, when read consecutively, they formed a summary of the text. High subordinate ideas were allocated 2 points each, and finally, detail level ideas were assigned 1 point each. A total value for each assessment passage was then calculated by adding the ranks assigned to each pausal unit. The clausal and hierarchical information for each text was placed on a retelling coding sheet. (See Appendix B for an example of a scoring sheet.) The protocol also included empty lines beneath each text analysis for adding student importations and illustrations. For this investigation, importations are “text-related information, but information that is not explicit in the words of a book” (Elster, 1998, p. 54). Importations were categorized
as inferences and extensions of text, prior experience, information from other texts in the unit, or class discussion. Erroneous importations, unrelated information, and personal narratives were categorized as intrusions (Stahl, 2003) and were not counted. Drawings were considered appropriate manifestations of students’ comprehension and were given credit when they represented an idea from the text.

The retellings were scored using the scoring sheet. Each student’s recall received four scores: a) Text Free Recall (explicit-information recall), b) Importations (1 or 0 points), c) Illustrations (up to 2 points if the illustration demonstrated comprehension of the text), and d) Free Recall Total (a total score for text-based clauses, importations, and illustrations).

All text analyses were conducted by two independent raters, the investigator and a graduate assistant who was trained to divide and assign points to each pausal unit within a text. Both raters followed the instructions, which can be seen in Appendix B. Any differences in the clausal analyses were negotiated and adjusted based on discussion and mutual agreement.

Using the scoring sheets, the researcher scored all papers; 30% of the papers were also scored by a graduate student familiar with the scoring process. According to Kennedy (2005) the current convention is that 20% of observations is a minimal percent; 33% is preferable. There was an 83% interrater agreement in the scoring of the retellings, which is acceptable as it is above the minimum of 80% agreement according to the convention used in applied research (Kennedy, 2005). Importations (information related to the text, but no explicit; Elster, 1998) required additional analysis. Importations were
categorized as inferences and extensions of text, prior experience, information from other texts in the unit, or class discussion. Erroneous importations, unrelated information, and personal narratives were categorized as intrusions and were not scored (Stahl, 2003).

The text recall method emanated from the cognitive psychology approach, which is primarily interested in how readers process text and how the cognitive structures and processes which readers bring to the text to interact with it to produce comprehension. Although it cannot be assumed that what is recalled is necessarily comprehended, and what is not recalled is not comprehended, there is some kind of relationship between comprehension and recall (Hewitt, 1982). However, to triangulate and complement the data obtained through the text recalls, think-aloud and interviews were also conducted at the end of the treatment to provide information on students’ online processes and present further evidence of their reading comprehension ability.

Other researchers have used both online processes (such as think-aloud) and offline products (such as text recall) during reading to measure students’ comprehension (e.g., Kendeou & van den Broek, 2005). Offline investigation provides information about the final representation of the text, while online investigation provides information about the different types of processes readers use during actual reading (inferring, elaborating, explaining, summarizing, integrating information, and so on) (Kendeou & van den Broek, 2005). The authors explain that it is important to investigate both types of components because background knowledge, including inaccurate knowledge, influences comprehension by influencing the processes during reading (online).
As noted earlier, informal data from the pilot study suggested that students with special needs made progress in their reading comprehension and their use of the cognitive strategies (Martínez, 2006) that was not captured in the results from the text recalls. Investigating the validity of informal measures of reading comprehension for students with disabilities, Fuchs, Fuchs, and Maxwell (1988) found that oral and written recall measures correlated significantly at a moderate level with the students’ performances on a standardized reading comprehension test.

Carlisle (1999) conducted a study looking at free recall as a test of reading comprehension for students with learning disabilities. She found that these students recalled less of what they read than their peers without learning disabilities, and that these difficulties seemed to be related to receptive language comprehension, a limited fund of background knowledge, problems identifying the main ideas and summarizing, and lack of confidence (Carlisle, 1999).

Despite these difficulties, text recall was used in this study as the main measure of reading comprehension because students needed to remember the text to be able to use the information in it for science inquiry. Additionally, text recall is related to the ability to identify main ideas and summarize the text, which had an important role in this instructional sequence. To compensate for some of the areas of difficulties students with disabilities encountered when trying to demonstrate their understanding through recalls, in this study, text recall was used while students received instruction in the topic to help build up their prior knowledge. In addition, to document alternative production channels, students’ appropriate interferences from other texts or classroom experiences were scored
Students were also encouraged to use drawings to help them monitor their comprehension, and represent the main idea of the text, therefore facilitating recall.

**Level of generated questions.** Adapted from Kim et al. (2006) and used to measure students’ ability to generate high level questions. Data for this measurement were gathered immediately after three text recall protocols (Texts 3, 4, and 5) administered before launching the intervention and, again, immediately after three text recalls (Texts 12, 13, and 14) administered at the end of the intervention. All students were asked, based on the text they had read, to generate and write at least one question they would like to investigate on the topic of slow geomorphological change caused by water. Questions from Texts 3, 4 and 5 were used as the pretest data and questions from Texts 12, 13, and 14 were used as the posttest data.

To score the questions written by the students, a 5-point rubric adapted from one developed by Kim et al. (2006) was used (see Appendix C). The lowest level of this rubric was designed to include questions categorized as *others*, which included those asking for translations or directions and questions which did not fall under any of the other categories. The data ultimately did not include any questions in this category; therefore a 4-point rubric was adopted.

The first level of the final rubric was the *basic* level, with questions worth 1 point each. Questions categorized at this level were definition questions or irrelevant questions (e.g., “¿Qué es degradación?” *What is weathering?*; “¿Va a haber erosión en el futuro?” *Will there be erosion in the future*?). The next level, the *intermediate* level, included questions worth 2 points each. Questions categorized at this level were simple questions,
taken directly from the content of the text (e.g., From a text describing the observable signs of erosion, a question was “¿Qué señales puedes observar?” What signs can you observe? Or from a text explaining that erosion leaves marks on the ground, a student asked, “¿Por qué la erosión deja marcas en el suelo?” Why does erosion leave marks on the ground?). The third level, the main ideas level, included questions worth 3 points each. These questions related to the content of the text, could be answered by conducting a quick research activity or asking the teacher. For example, from a text describing erosion, the student asked, “¿Puede ser mala la erosión?” Can erosion be bad? And, “¿Cómo se para la erosión?” How can erosion be stopped? The last level was the investigative level, with questions worth 4 points each. Questions categorized at this level could be answered by planning and conducting an investigation or researching the answer by other means, such as using the internet or contacting an expert. Questions at this level indicate that a student’s thinking is moving beyond the mere content of the text. For example, “¿El agua dulce erosiona más que el agua salada?” What erodes more, fresh water or salt water? And, “Si pusieramos el agua y el viento en una competición de erosión, ¿Por cuánto tiempo ganaría el agua al viento?” If we made water and wind compete, how much faster would water erode than wind? (See Appendix C for the rubric on the questions.)

Students wrote more questions during the posttest (113) than they did during the pretest (96). To have the same number of questions to compare pre and post, a graduate research assistant randomly selected 96 questions from the 113 generated during the posttest. The main investigator scored all questions.
Detecting incongruities. This measure, adapted from Palincsar and Brown (1984), was designed to quantify students’ ability to use the strategy of self-monitoring. Students read short texts with a title and a series of related (congruent) and unrelated (incongruent) sentences. They were assigned a score based on their ability to identify the incongruent sentences. Specifically, eight passages related to slow geomorphological change were prepared. For six of the passages, one line was anomalous with the title; the remaining two passages made sense. Four of the passages, three containing anomalous lines, were presented on the pretest and the remainder on the posttest to all students in the treatment and in the control groups. Each student received a booklet on the incongruities measure containing the passages (see Appendix D for a sample text). The instructions were given orally and in writing. Students were asked on consecutive days to read one of the passages line by line and circle yes or no if the line either did or did not make sense. For any line where a student identified a line as incorrect (circled no), they were asked to explain in writing why the line did not make sense in the passage (Palincsar & Brown, 1984).

Students read 26 sentences during the pretest and 26 during the posttest, for a total of 52 sentences. Out of the 52, 23 were congruent with the rest of the text and 3 were in fact incongruent. Several analyses of the data were conducted to compare accuracy detecting congruous and incongruous sentences on the posttest for students in the treatment group versus those in the control group.

The scoring was conducted in two parts, Part A and Part B. Part A scoring was a count of the number of sentences, congruent and incongruent that students were able to
correctly identify during the pre and posttests. To obtain this score (a) each sentence correctly identified as congruent received 1 point; (b) each sentence correctly identified as incongruent with a coherent explanation of the incongruity received 1 point; and (c) each sentence correctly identified as incongruent, but with an incorrect or incoherent explanation or no explanation, received $\frac{1}{2}$ point. The total sum was rounded to the nearest whole number.

Part B consisted of a control for guessing score (Palincsar & Brown, 1984), obtained by calculating the number of sentences each student correctly identified as incongruent, and then subtracting from this number three times the percent of times a student responded *no* when evaluating if the sentences made sense in the passage. The result, expressed as a decimal, was rounded to the nearest hundredth. The scoring sheet for this measure and a sample text can be seen in Appendix D.

This measurement and its scoring were based on those used by Palincsar and Brown (1984) in their study on reciprocal teaching. The researcher scored 100% of the data.

*Summarizing and rating importance.* This measure, adapted from Palincsar and Brown (1984), was designed to measure students’ sensitivity at the end of the intervention to the main idea and to detail information by having them summarize and rate the importance of the original forms of two of the texts prepared for the incongruities measure. These texts were used as measures of sensitivity to main idea and detail information following a procedure similar to that used by Palincsar and Brown (1984). After the intervention (posttest), students were given a booklet with two texts (see
Appendix E). The booklets contained written directions which the researcher also explained orally. Students were told that the passages had to be rewritten to fit into tiny doll house books so they were to choose only the most important lines. They were told to delete $N$ lines (¼ of the text) first by crossing out the least important lines of the text with a colored pencil. Then, they were asked to highlight $N$ lines (¼ of the text) that were the most important lines for inclusion in the doll house books. Finally, students wrote a short summary covering the most important ideas from the text (Palincsar & Brown, 1984).

To score the summaries, the most important ideas from the two texts used for this measure were identified based on Johnson’s (1970) identification of pausal units. First, the texts were divided into pausal units (for more detail, refer to the description provided in the scoring discussion in the section on the text recall protocol, p. 116); next, each pausal unit was rated as 3 (very important information that should appear in some form in the text summary), 2 (moderately important information that might or might not appear in any form in the text summary), 1 (unimportant information that should not appear in any form in the text summary). Four ideas were identified with a 3 in each text. The pausal units, their corresponding scoring, and the ideal summary for each of the two texts for summarizing and rating importance are included in Appendix F.

Two raters scored students’ summary sheets and assigned points as follows: 1 point was given for each judged-important idea that the student did not erase and the the student included in the summary, and for each judged-unimportant information that the student deleted. In addition, the integration level was scored 0 points for no important ideas present, 1 point for important ideas presented in different sentences, and 2 points
for two or more important ideas combined in a single sentence (e.g., “Los glaciares, capas gruesas de hielo, cambian los accidents geográficos” which translates to *glaciars, thick layers of ice, change the landforms*” and was a combination of two ideas from Text 5, presented in Appendix E). The points for the important/unimportant ideas and those from the integration assessment were combined into a single score for the student’s summary of each text.

The researcher trained a graduate research assistant in scoring and provided written directions for the scoring of the summary sheets (see Appendix G). The two raters started by scoring the summary sheets together and discussing the disagreements. Once they reached 100% agreement for each summary sheet, they continued the scoring independently. Eight of the scoring sheets (10% of the data) were scored jointly.

*Number of misconceptions.* This measure was adapted from Osborne and Black (1993). The purpose of number of misconceptions was to measure students’ science concepts and processes closer to those held by geomorphologists. For this study, misconceptions were defined as prior concepts by which individuals explain concepts and processes in the physical world (Kendeou & van den Broek, 2005). These prior concepts are markedly different from the concepts of the teaching program, and therefore hinder learning (Alvermann, Smith, & Readence, 1985). One of the goals of the INSCIREAD intervention was to help students develop concepts and processes closer to those held by geomorphologists.

To identify and measure the students’ misconceptions, the researcher created four open-ended, general questions to stimulate students’ generation of prior ideas. The
questions were based on the content objectives related to the processes and ideas in slow changes in geomorphology. Students in the treatment group answered these four open-ended questions in any language(s) they chose, before and after the intervention: (a) “Explain how the Grand Canyon was formed”, (b) “Explain what water erosion is”, (c) “Why doesn’t the water in rivers move in straight lines, but curves as it moves”, and (d) “What’s the relationship among erosion, deposition, and transportation caused by water”. The researcher read all questions to the students before they were asked to answer them. Students were asked to write and/or draw to show their understanding of each question and their thinking.

To score the assessments for students’ misconceptions on the topic of slow geomorphological changes, the researcher used a scoring method adapted from Carey and Smith (1993). According to this method, the most common misconceptions can be identified by reviewing students’ answers. Once a list of misconceptions was generated from the review of students’ work, the information was organized in a systemic network (Bliss, Monk, & Ogborn, 1983). The systemic network was used to classify the misconceptions and to facilitate the semi-quantitative analysis of the data (Bliss et al.). To develop the systemic network, the identified misconceptions were classified by themes. The misconceptions in each of these initial themes (described below) were then further classified in a diagram, until all misconceptions were represented in the systemic network in the form of a final branch, called a terminal. The systemic network is presented in chapter 4.
Finally, using the systemic network, the number of misconceptions from both the pre and the postassessment was tallied by means of an analysis method that Osborne and Black (1993) effectively employed to organize students’ responses to questions about the nature of seeing. The investigator then assigned each assessment a score according to the number of the identified misconceptions represented in each student’s responses to the open-ended questions (Carey & Smith, 1993).

The three initial themes used to group the misconceptions were (a) misconceptions based on natural explanations, (b) misconceptions based on unnatural explanations, and (c) misconceptions based on a misunderstanding of vocabulary words. As noted above, the misconceptions classified were then further classified until all misconceptions were represented in the systemic network on a terminal. For example, under the general theme of misconceptions based on unnatural explanations were the drawings and words of a student who believed that the Grand Canyon was formed by a rock from space that fell on the earth; she drew a rock flying from outer space towards the earth and wrote “yo creo que una roca del espacio” *I think that a rock from space*. Another misconception included in this general theme was a student drawing of a person building mountain-like structures with stones. The student wrote, “Long, long ago there were people who made the Grand Canyon”. These and other similar examples served to create two branches under the theme of misconceptions based on unnatural explanations, labeled *magical explanations* and *man-made explanations*. As these two branches were at the end of the diagram and no more branches radiated from them, they were terminals.
The teacher researcher then assigned each assessment a score according to the number of the identified misconceptions represented in each student’s responses to the open-ended questions (Carey & Smith, 1993). The list contained 11 misconceptions. Students’ work reflected misconceptions about the path the river follows, for example: (a) The path the river follows was there before there was water, and (b) the path the river follows did not start from a plain. Other misconceptions were found in students’ attempts to explain how a landform came to be. For example, students’ explanations of the Grand Canyon included: (a) processes of accumulation rather than erosion; and (b) catastrophic and magical reasons. Some misconceptions grew out of various misinterpretations of the vocabulary words erosion, deposition, and transportation: (a) a non-landform context (e.g., transportation taken to mean a car transporting people), (b) a similar word with a completely different meaning (e.g., erosion as explosion), (c) a lack of defining criteria (e.g., erosion is any type of change rather than solely the movement of solid material).

There were misconceptions regarding the slow and on-going processes related to the movement of solids, students generally referred to erosion as a completed process when looking at images of the Grand Canyon. Some students’ work showed, that unless it was raining, they did not think erosion was taking place. In relation to water movement, not all students understood that water moves from high to low places, pulled by gravity. Students’ misconceptions arose when they incorrectly applied information from other topics they had studied, such as the water cycle, the rock cycle, water pressure, states of matter, plate tectonics, or other topics. Each misconception extracted from a student’s explanations was assigned a letter in alphabetic order of appearance; these alphabetic
groupings were then organized into the systemic network, and numbered consecutively from the top to the bottom of the network (see Figure 3). The systemic network should be read from left to right, starting with the three main branches and following them to their respective terminals. Each terminal (e.g., erosion as a finished process) represents misconceptions identified during the initial analysis of the data. A single statement might represent more than one misconception, in which case it will be counted twice. For example, the statement “The water from the Colorado River evaporated and then many rocks fell inside”, written by one of the participants was classified under two misconceptions. The first one was the misconception based on rapid changes of erosion as a finished process. The second one was the misconception based on slow changes of accumulation rather than erosion. Once the systemic network had been completed, it was used to analyze students’ work so that their misconceptions before and after the instructional sequence could be tallied.
Figure 3. Systemic network of students’ misconceptions about slow geomorphological changes caused by water movement.
An example of how the responses were coded can be understood by analyzing Figures 4 and 5 in combination with Figure 3. Figure 4 shows a misconception that falls under the main heading *based on natural explanations*, and then the terminal heading *based on other topics previously studied*, misconception K. Figure 5 falls under the main heading *based on understanding vocabulary words*, and then the intermediate heading *interpreting words in a non-landform context*, and finally, the terminal heading *semantic interpretations: transportation in the context of vehicles moving*, misconception G.

*Figure 4.* Student’s explanation of what water erosion is. “It is because of the water cycle”. Shows misconception K.  
*Figure 5.* Student’s explanation when asked to explain the relationship among the terms erosion, deposition, and transportation. Shows misconception G.
The main researcher scored all work; a second reviewer used the network to classify 56% of the data. According to Kennedy (2005), the current convention is that 20% of observations is a minimal percent and 33% is preferable for adequately assess the consistency of measurement. The formula of agreements/agreements + disagreements × 100 was used to calculate the percent of agreement. An 82% interobserver agreement was achieved. An interobserver agreement of a minimum of 80% is sufficient according to the convention used in applied research (Kennedy, 2005).

*Science and reading concept map.* Adapted from Anderson, Lucas, Ginns, and Dierking (2000), the *science and reading concept map* was designed to measure students’ awareness of the relationship between science and reading. For this study, awareness of the relationship between science and reading was defined as students’ ability to realize and to be able to express (verbally, with drawings, or in writing) that reading and science depend on each other. Students need this explicit understanding because the ability to read science texts and to work in science are both needed to explore and construct scientific concepts and also there exists because reading and science share a set of cognitive strategies. Helping students develop an awareness of the relationship between science and reading was an objective of the *INSCIREAD* instructional model.

So the students’ awareness of this relationship could be measured, student in the treatment and control groups, individually, created a concept map. Students were given a sheet of paper with *science* and *reading* written in the middle of the page. The researcher gave students oral directions asking them to show how science and reading were related
by using both drawings and words. Students started the concept map before the intervention and were asked to add to it at the end of the intervention.

The concept maps were scored by counting the number of propositions written or drawn on the concept map. In this context, a proposition consists of two concepts and their relationship (Novak & Gowin, 1984), for example, one student wrote, “En ciencias y en lectura hay que leer para aprender” *In science and in reading one has to read to learn.*

A concept map is a learning tool that is actively used in science teaching because of its high effectiveness in promoting a learner’s conceptual change (Horton et al., 1993; Ruiz-Primo & Shavelson, 1996; Yamaguchi et al, 2002). Dynamic thinking reflects a proposition that captures and represents a functional interdependency between two concepts and their relationship (Derbetseva, Safayeni, & Cañas, 2007). Given that dynamic thinking is an essential aspect of this intervention, and of scientific reasoning in general (Derbetseva et al.), dynamic thinking and the concept mapping procedures were encouraged throughout the intervention. Anderson, Lucas, Ginns, and Dierking (2000) described the use of concept maps and interview methodology to reveal the change in students’ understanding of the scientific concept of magnetism. It was anticipated that these modes of data collection would help reveal students’ conceptual change in other topics as well. In fact the use of concept maps for the evaluation of students’ knowledge has been reported by many researchers (e.g., Roberts, 1999).

*Spanish reading level.* This measure was adapted from Santoro, Jitendra, Starosta, and Sacks (2006) to provide a measure to check for significant pretest differences in the
Spanish reading level of students without disabilities in the treatment and control groups. This level was determined by administering students the letter-word identification and the text comprehension subtests of the Batería Woodcock-Muñoz Test—Revised in Spanish (Woodcock, 1998). The mean of the resulting scores from both subtests was calculated and used as the Spanish reading level.

Prior to performing the statistical analyses, the Spanish reading levels from the control and the treatment groups were compared to determine if groups’ levels differed significantly. The distribution of reading levels across all students is shown in Tables 2 through 4 (p. 136, 140, & 144) for students without disabilities in the three treatment groups, in Table 5 (p. 182) for students in the control group, and in Tables 6 (p.183) and 7 (184) for students with disabilities in two of the treatment groups. An independent-samples t-test was conducted to compare the Spanish reading level of students without disabilities in the treatment versus the control groups prior to the intervention. As shown in Table 1 there was a significant difference in Spanish reading levels for the treatment group ($M=4.31, SD=1.12$) and control group ($M=5.00, SD=1.19$), $t(68)=2.32, p=.02]$. On average, participants in the control group had higher Spanish reading levels than those without disabilities in the treatment group. This difference might be explained by the fact that this group included the students identified to receive gifted services. As the magnitude of the differences in the means was moderate ($\eta^2=.07$), controlling for Spanish reading levels prior to the intervention rather than doing a t-test analysis of covariance, was used for data analysis.
Table 1

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>21</td>
<td>5.01</td>
<td>1.20</td>
</tr>
<tr>
<td>Treatment</td>
<td>49</td>
<td>4.31</td>
<td>1.12</td>
</tr>
</tbody>
</table>

Think-aloud. The purpose of think-aloud was to investigate students’ ability to use the online cognitive strategies of questioning and self-monitoring while using the web-based GoInquire system as they read, rather than after they had read. Students’ ability to use the online cognitive strategies was measured by conducting individual think-aloud and tape-recording students as they read a text which included one incongruity and one misconception (see Appendix L for the text students read). Students were asked to explain their thinking at predetermined parts of the text and to identify the incongruities in the text and any misconceptions they had with respect to the text (for the think-aloud protocol, see Appendix H).

The think-aloud methodology was used to qualitatively and quantitatively investigate the online cognitive processes of students in the treatment group after the intervention. The quantitative component was incorporated to help triangulate data from
these other sources: the think-aloud triangulated data from the level of generated questions, the ability to detect incongruities, and the number of misconceptions.

Although the original plan called for a think-aloud protocol with all participants of the intervention; scheduling difficulties made this impossible. Ultimately, 40 students were randomly selected from the total group of 57 fourth graders (representing 70 % of the participants).

The procedure for the think-aloud was adapted from the protocols used by Kendeou and Van Den Broek (2005). The researcher presented the participants with texts containing target sentences that stated either incorrect or correct information about the science content. The content of the two texts and target sentences was selected and adapted based on data from students’ misconceptions identified prior to the intervention (see Appendix L for the text students read). The texts were also embedded in the science content students had been working on during the intervention. One target sentence related to one of the three common misconceptions about the content; the other was related to content presented during the instructional sequence. Texts were presented in an accordion-style pamphlet, in which sentences appeared one at a time in large print.

Participants could move from one sentence to the next at their own speed and could go back as desired. Asterisk at the end of the target sentences marked where students had been instructed to think-aloud about the preceding target sentence. Three of the asterisks were used for control purposes, whereas the remaining two were located at the two target sentences (the incongruity and the misconception). Qualitative analysis of the data collected was conducted following the procedures used by Kendeou and Van
Den Broek (2005) and Presseley and Afflerbach (1995). The main researcher conducted all think-aloud individually (see think-aloud protocol in Appendix H).

Students’ expressions during the think-aloud procedure were transcribed and each protocol was parsed into clauses. Initially, a graduate research assistant and the researcher read and reread the transcripts looking for possible uses of the organizational categories established prior to the think-aloud, which were adapted from Pritchard (1990). Six categories established by Pritchard (1990) were used to identify the different processes readers engaged in during reading and were used in part to analyze the think-aloud protocols. The first five categories included (a) understanding, (b) uncertainty-confusion, (c) explanations, (d) paraphrases, and (e) others. The remaining two categories used in this study, by Kendeou and van den Broek (2005), were (e) valid inferences, and (f) invalid inferences. However, once the researcher and the graduate assistant began the analysis, general themes emerged which both seemed more aligned with the research question, and better identifiers of the most meaningful data for this study. Such data were directly related to reading processes and science knowledge processes emphasized through the INSCIREAD intervention. Consensus was the governing principle during this phase of the work. Emergent themes included (a) misconceptions and problems with vocabulary (b) evidence of the use of monitoring, (c) evidence of the use of questioning, (d) use of English to make sense of the text, and (e) other strategies (initial and emerging categories are listed in Table 2). A description of the statements classified under each of these new themes follows.
Table 2

*Initial and Emerging Themes for the Qualitative Analysis of Think-aloud*

<table>
<thead>
<tr>
<th>Initial Categories</th>
<th>General Emerging Themes (Categories)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding</td>
<td>Misconceptions and Problems/Vocabulary</td>
</tr>
<tr>
<td>Uncertainty-Confusion</td>
<td>Evidence of Using Monitoring</td>
</tr>
<tr>
<td>Explanations</td>
<td>Evidence of Using Questioning</td>
</tr>
<tr>
<td>Paraphrases</td>
<td>Using English to Make Sense</td>
</tr>
<tr>
<td>Others</td>
<td>Others</td>
</tr>
<tr>
<td>Valid and Invalid Inferences</td>
<td></td>
</tr>
</tbody>
</table>

I used the systemic network I had developed (based on data on misconceptions students had prior to the intervention; see Figure 14) as a guide to classify statements under the theme of misconceptions and problems with vocabulary. Statements which showed any of the misconceptions in the network, including those related to vocabulary, as well as any attempts to clarify vocabulary, were categorized under this theme.

Monitoring was taught in three steps during the intervention, namely prediction, clarification, and synthesis. Statements classified under the theme of evidence of using monitoring included those showing understanding or lack of understanding and those expressing something learned from or an opinion about the text. Also included were those statements showing the student had detected an incongruity or a misconception or had wondered if the text was correct and congruent, had reread to clarify, and/or had synthesized several sentences. (Synthesis was defined as those statements in which the student summarized three or more sentences by explaining the main idea in fewer words than those used in the text, using information from more than one sentence in the same
Evidence of monitoring also included statements in which the student continued to search for clarification of an unclear statement, after having moved to another segment of the text, used certain parts of the text to understand others, and/or related one part to another (e.g., situations in which the student referring repeatedly to the main idea or the title to make sense of the new sentences and to uncover incongruities).

Using questioning was demonstrated by students asking a question while working through the think-aloud.

Use of English to make sense of the text was demonstrated by any word or group of words stated in English as well as requests for permission to use English.

Other strategies included statements in which students incorporated their own experiences or prior knowledge while thinking aloud, predictions, and other strategies which were not questioning or monitoring.

The themes were not mutually exclusive. When the children’s statements reflected more than one theme, multiple codes were used as the next example illustrates.

The student read the following asterisked sentence from the text of the think-aloud

“La Vida de un Río” The Life of a River,

“El nacimiento de un río se llama fuente.” * The place where a river is born is called the fountain.

The student’s response was,

“Yo estoy pensando como el nacimiento de un río es como, like, como cuando fuimos afuera y vimos como la cosa chiquita, que tenía mucho agua.”
I am thinking like where the river is born is like, like, like when we went outside and we saw like the little thing, that had much water.

This transcript was categorized under three codes: evidence of using monitoring, student uses English to make sense of the text (like), and other strategies (connection to prior experiences: “like when we went outside and we saw like the little thing, that had much water”).

These five designations, misconceptions and problems with vocabulary, evidence of using monitoring, evidence of using questioning, student uses English to make sense of the text, and other strategies, were useful for early data analysis and categorization. To understand further how students who participated in the INSCIREAD intervention used the online cognitive strategies of questioning and self-monitoring, the graduate assistant and the researcher classified statements falling under these two themes under more explicit subthemes. Namely, those statements under the evidence of using monitoring were further classified under the subthemes of evaluation and regulation. As described in the literature review of this study, comprehension monitoring has been documented to include two levels, evaluation, deciding whether a part of a text is understood or not and regulation, taking the necessary steps to make the text comprehensible (e.g., Harris, Kruithof, Terwogt, and Visser, 1981; Baker, 1984; Markman, 1979). Logically, evaluation must occur prior to regulation; consequently, any difficulty in the former activity will necessarily impair the latter (Baker, 1984). Classification under these two subthemes was helpful in determining whether the instruction sequence involved in the INSCIREAD intervention helped students achieve both components of comprehension.
Evaluation of comprehension was seen in students who made noises and/or faces, reread, and/or stated they could not understand the statements. Regulation was detected when students attempted to remedy comprehension problems by explaining problem and giving a solution, that is, stating how the text should be.

Statements coded under the theme of evidence of using questioning were further classified according to the level of questions students created, a rubric developed and used to analyze questions generated during the text recalls. The four levels are (a) basic, given for a question that is irrelevant, true or false, yes or no, or a choice (A/B); (b) intermediate, given for a question which can be answered by a single sentence contained in the text read, is not a main idea, can be answered by one or two words or with a definition, or shows attempts to clarify words/parts of the text; (c) main ideas, given for a question (expressed as a complete sentence) which can be answered using information in text, but which involves different parts or sentences and refers to a main idea of the text (e.g., synthesis); (d) advanced, given for a question which does not have an answer stated directly in the text, and which will require students to do research or to integrate their own experiences with learnings from their texts and classroom to answer. Questions in this last category might be answered by planning and conducting an investigation or researching by other means, such as in the internet or asking an expert. The final themes used for the qualitative analysis of the think-aloud are shown in Table 3.
An additional level of quantitative analysis was conducted to triangulate the data and help identify patterns which will reveal how fourth-grade students who went through the INSCIREAD intervention used the online cognitive strategies of questioning and self-monitoring. For this analysis, students’ reactions to the sentence with the incongruity and to the sentence with the misconception were extracted and coded separately. To measure students’ monitoring ability, a score was assigned to each category and each student’s scores from this analysis were summed. The categories, the subcategories, and their corresponding scorings are described below and presented in Table 4.

For this analysis, four categories were adopted: (a) students’ reactions to the incongruity, (b) students’ reactions to the misconception, (c) student’s attempts at clarification by looking back and rereading sections, and (d) student’s overall monitoring category (as described in Table 4).
The inclusion of the third category, rereading for clarification, merits further explanation. It was chosen because looking back and rereading were part of the instructional sequence and because this strategy has been shown to represent students’ awareness of a comprehension problem. For example, the early work conducted by Alessi, Anderson, and Goetz (1979) demonstrated the usefulness of reinspecting text when they instructed college freshmen to reread a text they had just read if they had questions indicative of a comprehension/memory failure. Additionally, the research conducted by Garner, Macready, and Wagoner (1984) showed a positive relationship between successful reinspection and global reading performance level.

Each of the four categories were divided into two to five subcategories (see Table 5 for a summary). For the first general category, reactions to the incongruity on page 8 of the text were analyzed. The incongruity stated, “También si la pendiente es muy poco empinada, o escarpada, o sea es casi plana, más se erosiona el terreno.” (Also, if the slope is not very steep, or craggy, or if it is almost flat, more erosion occurs). Students’ responses were assigned to three subcategories: (a) Subcategory I, which received 0 points, showing that the student failed to identify the incongruity (student ignores the incongruity, discussing the congruent information, explaining the text as if it were correct, or failing to monitor against the rest of the text); (b) Subcategory II, which received 1 point, showing that the student failed to identify the incongruity, but explained the information congruently when thinking aloud; (c) Subcategory III, which received 2 points, showing that a student identified the incongruity and explained why it was incorrect or indicated implicit knowledge of the problem.
For the second general category, reactions to the misconception on page 14 from the text were analyzed. The misconception stated “El Gran Cañón de El Colorado se formó por una explosión de un meteorito contra la tierra” (*The Grand Canyon was formed by the explosion of a meteorite against the earth*). Students’ responses were assigned to three subcategories: (a) Subcategory IV, which received 0 points, showing that a student failed to identify the misconception; (b) Subcategory V, which received 1 point, showing that a student failed to identify the misconception, explaining the correct idea, but trusting the text more than themselves; (c) Subcategory VI, which received 2 points, showing that a student identified the misconception, but only with much prompting (trusting the text first) or did not explain how the Grand Canyon was formed; and (d) Subcategory VII, which received 3 points, showing that a student identified the misconception and explained the correct idea (with an additional point awarded if the student referred back to information in the text.)

For the third general category, students’ attempts at clarifying were measured by giving 0 or 1 point, based on whether or not students reinspected the sentences immediately before the incongruity (or, in some texts, the misconception) or at neither of these places. Students’ responses were assigned to two subcategories, *yes* or *no*. Students who reread at least at one of the incongruent or misconception sentences received a yes (see pages 8 and 14 of the text for the think-aloud in Appendix L). Those who did not reread received a no.

Finally, the fourth general category was the scoring for the overall identification of incongruity/misconception; and the subcategories were as follows: (a) Subcategory A,
which received 0 points, showing that a student failed to identify the incongruity and the misconception; (b) Subcategory B, which received 1 point, showing that a student overidentified incongruities and/or misconceptions; (c) Subcategory C, which received 3 points, showing that a student identified only the misconception; (d) Subcategory D, which received 3 points, showing that a student identified only the incongruity; and (e) Subcategory F, which received 4 points showing that a student identified both the incongruity and the misconception. An additional point was awarded if the student reread at either or both of the incongruity/misconception sentence points. All these general categories and their subcategories used to quantitatively analyze the think-aloud are shown in Table 9.
Table 4

*Categories and Subcategories for Quantitative Analysis of Think-aloud*

<table>
<thead>
<tr>
<th>General Categories</th>
<th>Subcategories</th>
<th>Points</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactions to Incongruity</td>
<td>I</td>
<td>0</td>
<td>Fails to identify incongruity</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>1</td>
<td>Fails to identify, but explains the right idea orally</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>2</td>
<td>Identifies incongruity</td>
</tr>
<tr>
<td>Reactions to Misconception</td>
<td>IV</td>
<td>0</td>
<td>Fails to identify misconception</td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>1</td>
<td>Identifies the misconception, but trusts the text more</td>
</tr>
<tr>
<td></td>
<td>VI</td>
<td>2</td>
<td>Identifies misconception, but doesn’t explain</td>
</tr>
<tr>
<td></td>
<td>VII</td>
<td>3 (+1 if student refers back to the text)</td>
<td>Identifies the misconception, and explains</td>
</tr>
<tr>
<td>Looking Back/Rereading</td>
<td>No</td>
<td>0</td>
<td>No reinspection of text at incongruity/misconception</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>1</td>
<td>Reinspection of text at incongruity/misconception</td>
</tr>
<tr>
<td>Overall Self-Monitoring</td>
<td>A</td>
<td>0</td>
<td>Fails to identify incongruity and misconception</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>1</td>
<td>Overidentifies</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>3</td>
<td>Identifies only misconception</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>3</td>
<td>Identifies only incongruity</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>4 (+1 if rereads at those points)</td>
<td>Identifies both</td>
</tr>
</tbody>
</table>
The main researcher coded all the statements. A graduate research assistant coded 25% of the protocols. The current convention is that 20% of observations is a minimal percent (Kennedy, 2005). Agreement was calculated by the formula of interval agreement (Kennedy, 2005). According to this formula, the interobserver agreement is obtained dividing the total number of agreements by the sum of the agreements and the disagreements by 100%. The interobserver agreement for the 25% of the protocols resulted in 78%. Disagreements were resolved through discussion.

The flexibility of this methodology allowed the researcher to consider a variety of readers’ responses (e.g. Kendeou & Van Den Broek, 2005; Presseley & Afflerbach, 1995). Furthermore, this methodology has received extensive validation as a tool to reveal comprehension processes in reading (e.g. Afflerbach, 2002; Kendeou & Van Den Broek, 2005; Magliano & Millis, 2003).

Triangulation. Triangulation occurred within and across methods in three different pieces of data: (a) Data from the quantitative science text recall of the quasi experimental design (analyzed quantitatively in a pre-post format) were triangulated with data on the text recall collected daily for the single subject design (analyzed graphically and with randomization tests); (b) data from the level of generated questions, the detecting incongruities, and the number of misconceptions were triangulated with data from the think-aloud measure, and (c) data collected from the science and reading concept map were triangulated with data collected from the interviews (see interviews in the single subject design, p. 189).
Description of the Intervention

Technology system. The main researcher used the GoInquire technology system to guide students’ inquiry into geomorphology. The technology system facilitated students’ use of strategies in both reading and science and the collaborative construction of meaning. According to the review of the literature in chapter 2, technology can promote teachers’ implementation of effective instructional practices for all. For example, when well-integrated and used thoughtfully, technology in ESOL can mobilize children to active involvement in the content, contexts, and discourses of school (Meskill, 2005). In fact, learning language through academic content has been found to greatly facilitate teachers’ computer use as part of instruction (Adamson, Herron & Kaess, 1995).

Computer technology holds unprecedented promise for students with disabilities to grow and learn alongside their peers.

The GoInquire system and design was developed by Dr. Brenda Bannan-Ritland and a team of researchers at George Mason University. The GoInquire system aims to develop students’ prior knowledge on slow geomorphologic processes and improve their reading comprehension, using a collaborative inquiry-based science approach. The system was developed following a three phase approach, for the process of systematic development of online learning, termed the Integrative Learning Framework (ILF) (Dabbagh & Bannan-Ritland, 2005). Namely, these phases included: (a) exploration phase, during which relevant information was investigated (b) enactment phase, which consists of the implementation of effective instructional strategies online, and (c) evaluation phase, which included data collection analyses, and revision cycles. This
research study was part of the evaluation phase. As previously described, the
development of the system closely involved elementary science teachers in an intensive
one year experience in which they reviewed the research available (exploration phase),
conducted their own research with their students (enactment and evaluation), and finally
created prototypes in which the system was based on (enactment phase).

The strategies used throughout the GoInquire system parallel those used in
Reciprocal Teaching (Palincsar & Brown, 1984). The advantage of the GoInquire system
is that it allows the teacher to adapt the content, the sequence, and the questions to his or
her particular group of students. This is particular significant given the diverse population
of the participants in this study. The system was shown to be highly motivating for
students during the pilot study as they constructed their own understanding and meaning
of the content and the text. In addition the analysis of the postintervention interviews
from the pilot study demonstrated that students were very motivated by photographs of
familiar locations, and the opportunity to see other students’ responses. Researchers have
found that motivation for reading may predict reading achievement on standardized tests
(Gottfried, 1985) and school grades (Sweet, Gutherie & Ng, 1998), especially for
students in grades 3-5.

Classroom materials. The sequence proposed in the INSCRI READ instructional
model progresses through six sessions lasting for 1 and ½ each. Each session comprised
two sections. The first section consisted of the activities to learn about geomorphology
(work in the GoInquire system, the field experience, and the assembling of pictures),
while the second phase consisted of whole group discussions to facilitate the
collaborative construction of meaning. The second section also included a number of questions to stimulate students’ thinking. The researcher implemented the \textit{INSCIREAD} model in all treatment groups. The investigator, in collaboration with another researcher who participated in the development of the \textit{GoInquire}, created a list of questions targeted towards weak areas in students’ geomorphological reasoning (as shown by our prior experience in the pilot study and by students’ answers to the open-ended questions on geomorphology). These questions were asked of all groups who participated in the instructional sequence to ensure that all students received the same level of challenge.

These questions were:

- Where did the sand come from? (Transported from a higher elevation.)
- What turned the cement to sand? (Usually weathering.)
- What do the roots keep from becoming loose? (Dirt.)
- What do you mean by erodes quickly? (It takes up to thousands of years.)
- What do you mean by erodes slowly? (It takes millions of years.)
- If it rains at Key [school], where does the water end up? (At sea level.)
- What causes water to go from high to low? (Gravity.)
- What landform do you see in this photograph? (I see the ground/hill/river channel.)
- Is the hill steep or shallow? (Usually hills are steep.)

A more specific description of the intervention’s daily activities is included in the procedures section and in Appendix J.
Treatment materials. Three texts were available for general training, averaging 359 words and 5 paragraphs each in length. They were selected from the third grade science textbook adopted by the county in which the school is located (Harcourt Science). All passages were informational and represented topics related to slow geomorphological change caused by water movement. To be included in the study, the passages included at least one of the following words: erosion, deposition, transportation and/or weathering. The passages were selected after determining that they conformed to a fourth-grade level according to the Fry Readability Formula (Fry, E., 2002). This formula was used by Palincsar and Brown (1984) to determine the readability level of the texts they used for a study on the effectiveness of the comprehension-fostering and comprehension-monitoring teaching method termed reciprocal teaching. This formula consisted of randomly selecting a minimum of three 100-word samples and counting the number of sentences and syllables in each sample. The average between the sentence count and the syllable count is then entered in the chart to obtain grade level. All the training texts were presented in Spanish. The passages varied in length, but were shorter than the general instruction ones, and they conformed to a third-grade level according to the Fry Readability Formula.

Training passages also included a series of texts targeting students’ previously identified misconceptions. These passages were selected from the same textbook and were meant to produce some cognitive dissonance. In addition reading materials from the school’s library were included. The texts were directly related to the work students accomplished in the GoInquire system on the specific day the text was presented. These
texts were purposefully selected and adapted to stimulate students’ use of their self-monitoring strategies and create cognitive dissonance based on students’ priori identified misconceptions. The ultimate objective was to scaffold students’ active construction of meaning and long term learning and memory of concepts.

In addition to the training passages, a total of 27 shorter assessment passages were selected from the third and fourth grade level science textbook used for the training material. The assessment passages were informational, written at the fourth-grade readability level (according to the Fry formula), and averaged 55 words (from 50-60 words) in length. The texts were typed, doubled-spaced in the 18-point Times New Roman font. Pictures and/or photographs, and titles of reading passages (if any) were deleted so that learners were required to obtain the information for the text recalls from the text itself (Tam, Heward & Heng, 2006). The texts were randomly numbered and used in the resulting order for assessment purposes.

*Conceptual model of the intervention.* The instructional model proposed in this research study was based on the parallel use of similar cognitive strategies utilized in both inquiry-based science (geomorphology), and reading comprehension of science texts. The goals of the model were: (a) to enhance student awareness of the relationship between science and reading, (b) improve student comprehension of scientific text, and (c) help students acquire scientific concepts closer to those held by scientists (specifically geomorphologists). For simplification purposes, the model is referred to as *INSCIREAD*, short from “Instruction in Science and Reading”.

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General conceptual framework of the instructional model. The intervention proposed by the INSCIREAD model is conceptually similar to the Seeds of Science/Roots of Reading curriculum. This curriculum is a research-based, field-tested framework that integrates inquiry science with content-rich literacy instruction. This curriculum development and research project was funded by the National Science Foundation and it addresses the urgent need for materials that help students make sense of the physical world while addressing foundational dimensions of literacy (see for example, http://www.scienceandliteracy.org/curriculum/index.html).

The INSCIREAD model is grounded in the literature on constructs described thoroughly in the literature review. Namely these theoretical ideas which philosophically arise from sociocultural theory and the generative mode of teaching and are most closely based on some of the following, and are reflective of the research findings:

1. Modeling and practice allows the teacher to access students’ zone of proximal development and helps students become fluent in content knowledge (reciprocal teaching).

2. Dual language learners bring with them linguistic and cognitive resources which can be utilized for learning if students’ awareness of the power of these resources is enhanced. Utilizing students’ linguistic and cognitive resources will provide cultural congruent settings in which the teaching and learning process will be most effective (Moll, Diaz, Estrada & Lopes, 1992).
3. Active construction and engagement are necessary but not sufficient for students to develop meaningful understanding. Meaning making only takes place if additional dialectical interaction between culture and thought occurs.

4. It is better to select and focus on teaching one or two strategies.

5. Many commonalities exist in recommendations for promoting reading comprehension and science inquiry.

6. The cognitive strategies of questioning and self-monitoring can be used in both reading and science.

7. Cognitive strategies are global and therefore can be transferred across contexts (general monitoring skill hypothesis).

8. Teachers must identify students’ prior concepts and misconceptions so that these can be built upon or challenged as appropriate.

9. The inquiry process can be successfully implemented with young students if appropriate scaffolding is provided.

10. Authentic texts and culturally sensitive contexts facilitate learning and comprehension, and enhance students’ motivation.

11. Learning is socially constructed through dialogic oral and written discussions.

12. Generation is a fundamental cognitive process in comprehension and in science.

13. Meaning-based approaches to learning vocabulary are the most effective.

14. Computer technology holds unprecedented promise for students with disabilities to grow and learn alongside their peers. And for all students to learn language through academic content.
These fourteen theoretical elements of the instructional model *INSCIREAD* interact to create two different levels of learning. As shown in Figure 6, the most superficial level on top illustrates more traditional approach to teaching and learning in which the learners receive sensorial information through direct instruction. Students’ prior concepts and personal meanings for words are potentially explored and then the increased motivation may result in sustained interest. Leveling off this superficial level of instruction, students then have a difficult time getting to higher levels in which long-term learning and memory may occur.

Conversely, the bottom part of the graphic contained in a shaded oval potentially progresses the learner to a higher level of engagement through (a) engagement in group discussions, (b) presentation of contradictory information from the exploration students’ misconceptions, and (c) the practice of content and cognitive strategies in multiple contexts. At this level students are made aware of the linguistic and cognitive resources they possess and are encouraged to utilize them. This bottom level facilitates long term learning and memory through the active construction of meaning, which combined with group discussions and rich exposure to information, will potentially result in meaningful understanding and flexible thinking.
Description and sequence of the INSCIREAD instructional model. The specific intervention based on the INSCIREAD instructional model was implemented in a sequence of six consecutive sessions. During these six sessions students engaged in two distinct, but interconnected sections of instruction. The first section focused in science and required students to attempt to actively construct meaning through their work with
the online GoInquire system, field experiences, and picture assembling to inductively learn about geomorphology. Then, the second section focused on the reading strategies and consisted of a collaborative construction of meaning in the form of group discussions. During this second part of the session, students moved beyond the mere active construction of meaning by: (a) engaging in group discussions to first, learn through modeling and think-aloud about the cognitive strategies of questioning and self-monitoring; (b) practicing the strategies in both reading and science; (c) explicitly discussing their own linguistic and cognitive resources as dual language learners and the relationship between reading and science; and finally, (d) collaboratively constructing concept maps to both promote conceptual change (Horton et al., 1993; Ruiz-Primo & Shavelson, 1996; Yamaguchi et al, 2002), and providing vocabulary words for the concepts learned. Although during both sections, the children conceptually developed both science and reading skills, the focus changed from science (first section) to reading (second section) every other day. A more detailed description of these two instructional sections follows.

The first section consisted on activities to learn about geomorphology. During this first section of the intervention sessions students learned how the GoInquire system works. The system consists of a main screen (see Figure 7) with four working areas. The biggest working area on the screen is occupied by a familiar picture (taken from students’ school) which illustrates geomorphological processes. At the bottom of the photo students have two stamps with words related to the rate in which erosion, deposition, and transportation caused by water movement takes place. When a student or group of
students work in the system, they observe and then stamp the word where they think it belongs. Immediately after they stamp the word, the computer generates a metacognitive prompt asking them to provide a rationale to justify their selection. Students participating in the intervention worked in dyads and were asked to type in their answers and then click enter. As the other students entered their answers, the second area of the main screen, located to the right of the image posted the typed responses from all the teams in the classroom. Students were exposed to four different features related to water erosion: (a) high and low, (b) soft and compact, (c) loose and intact, and (d) steep and shallow.

Continuing with the description of the system, below the main screen with the picture, there are two additional working areas. The one to the left is the Super Question Bank where students can insert their questions, and answer other’s teams’ questions. The one to the right is the Super Dictionary where students can enter words, and create and/or read definitions. Students began by working in the stamping of two of the images, entering questions in the Super Question Bank, and entering terms and creating definitions for existing terms in the Super Dictionary. After students worked in two images, the system generated a page called Synthesis Page. This page presented students with a compilation of all the discussions which had taken place during their work. Students were then asked to first select the most important words from the responses and then create a summary based on those words.

Apart from students work in the system, the class also went out one day to the field to collect data and compare the images in the system with the actual place where the pictures were taken. At this point the groups of students selected areas they thought
showed the processes of erosion, deposition, and transportation in action and took pictures which were then uploaded for analysis in the system. The third activity in the first section consisted on looking at hard copies of the pictures and having students select parts of the pictures they identified as significant from a geomorphological point of view. Students then cut the pictures and explained their reasoning for the selection. This activity is directed to helping students move one step closer to observing as a geomorphologist. It is important we help students focus on specific parts of an image, which reveal geomorphological processes, while ignoring others. Selecting and cutting the photograph helped students observe in a more geomorphological way. In addition, the science activity of identifying important features of a picture paralleled well with the reading activity of identifying important parts of a text. The teacher helped students become aware of this parallelism. By cutting the pieces they selected, reassembling the photograph and explaining their decisions, students were able to more easily compare their work with that of other’s and engage in conversations about their choices. Every day at the end of the work in dyads or triads, the teacher brought the class together to discuss their learning and their use of the strategies, add words to a vocabulary wall, and work as a group on a concept map on the interdependence between science and reading.
The second section was the beyond the active construction part. This second section of the instructional sequence (every other day) consisted in a collaborative construction of meaning in the form of group discussions based on science texts. The whole group was presented with a piece of science text related to their work during the first section. During the first discussion, students followed the teacher as she implemented the strategies with the group’s help. As students became more comfortable with the strategies, they took on the role of leaders and had opportunities to practice the strategies in front of the whole group and in small group. Also, after students had been introduced to the strategies, the teacher presented the class with pieces of text with incongruent sentences and first modeled and then had students practice the use of self-
monitoring to help them identify incongruities. The group discussions included the following elements:

- Modeling of the use of the cognitive strategies and opportunities for students to practice the strategies in front of the class.
- Discussion and reflection on the interdependence of science and reading and the dual use of strategies.
- Discussions will continue to add to the word wall and to the concept map.
- Discussions on students’ learning in geomorphology.
- Discussions on students’ use of strategies, use of linguistic and cognitive resources and questions they generate during their work in dyads.
- Discussions on ways by which the student-generated questions could be addressed.
- Discussions on concepts presented in the form of text which create a cognitive dissonance.

These whole group discussions helped students make sense of the active learning experience they went through during the first part of the session. It was here when students collaboratively engaged in inquiry-based science and tried to make sense of their prior knowledge and misconceptions, and integrated them with the new ideas they had been exploring during the activity part. The elements of the specific conceptual framework of the INSPIREAD instructional model are illustrated in Figure 8.
Figure 8. Specific conceptual framework of the INSCREREAD instructional model.

Parallel use of strategies in the INSCREREAD model. The cognitive strategies of questioning and self-monitoring have been shown in the literature review to enhance students’ performance in both science and reading comprehension. According to the INSCREREAD model, students will use the strategies in the contexts of science and reading, but they will also become aware of the interdependence and parallelism of strategy and processes in science and reading. Next, it is described first how the strategies
were used in the science context, then how they were used in the reading context, and finally how they came together in both contexts.

Strategies were used in the INSCIREAD in the science context. In this context students engaged in the active science learning experiences through the GoInquire, the field experience, and the picture assembling activity. While working in science, they generated questions which they then entered in the Super Question Bank of the system. At the same time students self-monitored their work and their understanding by answering the metacognitive prompts and reading other students’ answers and trying to answer students’ questions. The Synthesis Page guided the individual dyads to identify important information in the pieces of text generated during the discussion. Identifying and attempting to clarify problematic words using the Super Dictionary was also part of self-monitoring. In addition, during the whole group discussions, students generated more questions and tried to find ways to answer them.

Strategies were also used in the INSCIREAD in the reading context. In reading, students generated two types of questions. The first type consisted of questions about the information in the text. These questions helped students monitor their understanding. On the other hand, students were also encouraged to generate questions about the content of the text, which were not answered in the text but they would like to try to answer. Students engaged in self-monitoring throughout the process of questioning. Also, they identified problematic parts of the text and attempted to clarify their understanding by asking, rereading, looking for more information, using the context, and similar strategies.
Another way in which students were engaged in self-monitoring as they read was by identifying the most relevant information by highlighting parts of the text.

*Parallelism/interdependence of strategies in the INSCIREAD.* So far, it has been described how students used questioning and self-monitoring to help them in science and reading. However, the INSCIREAD instructional model aims to help students become aware of the interdependence between both science and reading and the parallelism of processes and strategies when they work in both contexts. As illustrated in Figure 9, students generated questions during their science work in the system and the field in the First Section of the period. During the second section of the period, students, in an attempt to answer some of their questions, became conscious that they needed more information. They also discussed the idea that this information might come in the form of written text. Therefore, students felt the need to read to find out more information about the questions they had generated during their work in science. At the same time, while engaged in the system, they read pieces of texts that, if they appropriately self-monitored their comprehension, helped them make sense of their active science experiences.

On the other hand and very closely interconnected, students generated questions while reading pieces of text. In order to investigate potential answers, some of these questions needed to be addressed in science, in the form of experiments, models, or investigations with other students, internet search, or asking experts. Once students moved to science in an attempt to find ways to answer their questions, and given appropriate self-monitoring scaffolded by teacher, they needed to double check the
information they were working on by reading more texts as they monitored their comprehension to compare and contrast facts.

Through this dual use of strategies and interdependence of science and reading, students potentially advanced toward long term learning and memory and flexible use of the cognitive strategies. The whole group discussed these ideas as they worked in the concept map showing the relationship between science and reading.

Figure 9. Specific use of the strategies in the two sections of the INSCIREAD instructional model.

*Sequence of instruction.* Specifically, the sequence proposed in the INSCIREAD instructional model took place during six sessions lasting for 1 and ½ each one, and followed the order described below:
1. Day 1 (focus on science): Students were provided with explanation of the instructional model at their understanding level and they learned how to use the system. After exploring the two first images and reading the first text, students moved to the synthesis page. The first day ended with a brief discussion.

2. Day 2 (focus on reading): The whole group worked with the same piece of text. The teacher introduced the strategies before reading the text. Then, the teacher demonstrated the strategies as the class collaboratively read the text and tried to make sense of it. This whole group modeling was consistent with the instructional models of Reciprocal Teaching and collaborative strategic reading.

3. Day 3 (focus on science): Students continued to work with the technology system by moving onto two additional pictures with the stamps of hard and soft and steep and shallow. The whole group discussion helped students move towards the collaborative construction of meaning.

4. Day 4 (focus on reading): Students started in the whole group practicing the strategies. Different students took on the role of leaders for each strategy. Then, students worked in groups of four to continue their work. Two of the students were in charge of implementing and modeling the strategies.

5. Day 5 (focus on science): The class went out to the field to analyze parts of the terrain showing geomorphological processes. Students also
analyzed pictures to identify areas of erosion and cut and then reassembled the pictures.

6. Day 6: The last day of the intervention had students practice the strategies in small groups.

The sessions described previously concluded with a whole group discussion to add new information to the word wall and to the concept map showing the relationship between science and reading. The conceptual framework shows there is a relationship between developing a concept map and helping students move beyond the mere active construction of meaning to really integrate all the information they are receiving and successfully acquire more scientifically-based ideas. The step by step procedures are included in a checklist in the Appendix I.

The collaborative concept map created showed multiple terms, concepts, and connections generated during the dialogue. The concept map was essential to the success of the intervention because it challenged students’ ideas, and also facilitated students’ self-monitoring abilities. This is supported by DeLeeuw and Chi (2003), who argue that the learner encourages conceptual change by reflecting on, and externalizing, his or her understanding of a scientific concept. From this standpoint, reflection on the thinking process during the INSCIREAD intervention can support learners to become conscious of his or her undergoing conceptual change, which can, in turn, facilitate learners to change their thinking intentionally (Deguchi, Inagaki, Yamaguchi & Funaoi, 2007).

The sessions just described ended with a whole group sharing which prepared students to transition to the daily text recall protocol, which is described in detail in the
dependent measures section. During the text recall protocols students worked individually to practice the strategies, and show their ability to recall information from a science text. This was the only individual work students completed during the intervention. All other experiences were completed either in dyads, or small groups, or with a whole group discussion.

The work in the system and the discussions focused on developing conceptual understanding of the big ideas (enduring understandings) in water erosion. Following are the main enduring understanding ideas, students need to know to understand slow change processes caused by the movement of water. These ideas were generated by the main researcher and another researcher who was closely involved in the development of the GoInquire and it was based on the data from the pilot study and students’ answers to the open-ended questions on geomorphology:

- Water moves from high to low
- Water moves down, attracted by gravity.
  - Student explains that transport, or movement, of rocks is caused by water.
  - Student explains water is more common (95%) agent of erosion, than wind or ice (5%).
- Geological time: Water changes the landforms over long periods of time. We cannot appreciate these changes easily. The idea that over time water erodes and changes things is a very difficult one to understand, even for adults.
• Student observes erosion as a loss of material in a landform:
• Student explains water causes changes to the ground.

• Children and adults have a difficult time knowing what to look for when looking at a picture and trying to analyze it in a geomorphological way.

• Rivers shape the land

• The shape of the surface of the land affects erosion:
  • Student explains fast water is caused by steep hills and/or lots of rain.

• The nature of the materials on the surface of the earth is related to the rate at which erosion takes place: Hard, intact materials erode at a slower rate than soft, loose materials, speed of water:
  • Student observes that grass holds dirt in place.
  • Student explains water moving fast causes more erosion.
  • Student explains water moving slowly causes less erosion.

At the beginning stages, teacher modeled the use of the science and reading strategies of questioning and self-monitoring in a dialogic manner through think-alouds. The instructional sequence of the strategies was based on the instructional procedure of Reciprocal Teaching (Brown & Palincsar, 1982) and collaborative strategic reading (Kim et al., 2006) (described in the literature review section of this study). Following these two methods, students gradually became more capable of acting as dialogue leaders and by the second session they were given the opportunity to act as leaders for the implementation of the strategies. By the third day, students were divided into
collaborative groups, in which each student performed a defined role to implement the strategies collaboratively while learning from the science text.

In addition, the literature on bilingual readers suggests the most successful bilingual readers frequently invoke prior knowledge, tend to approach Spanish and English text using different strategies and possess an enhanced awareness of the relationship between Spanish and English (Glaser & Strauss, 1967; Jiménez et al., 1996). Therefore, these three specific strategies were modeled throughout the reading strategies lessons in this study. Finally, in order to help students ask more complex questions; they were told that each question was worth an amount of money: (a) For questions that could be answered with yes or no, the value was $5; (b) For questions which could be answered with one sentence and whose answer was directly stated in the text, but was not about a main idea, $10; (c) For questions that addressed a main idea or a synthesis question, the value was $20; And (d) for questions whose answer was not directly in the text and for which students would have needed to conduct further investigations, the value was $100 (for a rubric on the level of questions, refer to Appendix C).

To help students generate better questions, the teacher researcher first modeled the different types of questions during the whole class interactions. After that, every time a student generated a question, the class decided what its value was. The specific sequence of instruction of the INSCIREAD is included in Appendix J.

Procedures

As it has been explained, the instructional model proposed in this research study (INSCIREAD) is based on the parallel use of similar cognitive strategies in both inquiry-
based science (geomorphology), and reading comprehension of science texts. The goals of the model are: (a) to enhance students’ awareness of the relationship between science and reading, (b) improve students’ comprehension of scientific text, and (c) help students acquire scientific concepts closer to those held by scientists (specifically geomorphologists). The instructional model of the INSCIREAD was implemented in four pre-existing groups, which were distributed as follows.

Twenty-one students formed the control group and received no exposure to the INSCIREAD intervention. They remained in their normal reading class for the period of the intervention.

Students in the control group took many of the same pre-and-post assessments than students who received the treatment. Specifically, these students completed the assessments of detecting incongruities, summarizing and rating importance, number of misconceptions, and science and reading concept map. In addition, students in the control group completed the text recall assessments from three texts at the beginning of the intervention (texts 3, 4, and 5) and three texts at the end of the intervention (texts 12, 13, and 14). Students in the control group took these texts recalls on the same days that the students in the treatment groups. A total score was obtained and used to visually present the pre-and-post measurement of students’ text recall. Students in the control group matched those from the treatment groups with no disabilities in aspects such as age, grade, or academic achievement. Differences existed in the Spanish reading levels of students. The demographics for students in the control group are shown in Table 4 (p.144).
Instead of their normal reading group, the sixty students in the three treatment groups received the intervention. The characteristics of participants included in the treatment and control groups are shown in Tables 1 through 6. As explained in the section describing the participants, each one of the pre-determined groups (groups were made by the county at the beginning of the school year) included a number of students from 18 to 21. Two of the treatment groups included students with disabilities, and one of them and the control group only included students without disabilities. Students with disabilities were distributed among two of the classes. The control group did not include any students identified as having disabilities.

As described in the section on the conceptual model of the intervention, the INSCIREAD model is based upon a set of 14 theoretical ideas related to sociocultural theory and the generative mode of teaching (see page 139).

As Figure 8 reflects, these fourteen theoretical elements of the instructional model INSCIREAD interact to create two different levels of learning. The most superficial level toward the top illustrates a more traditional approach to teaching and learning, while the bottom of the graphic represents students in an active learning process, and through collaboration and group discussions, potentially may result in long term learning and memory and cognitive flexibility in the use of the strategies and the resources. Given the results from the pilot study (Martínez, 2006) a combined, rather than sequential sequence of the INSCIREAD model was implemented in this research effort.

Students in the treatment and control groups completed five text recalls before the intervention, and five after the intervention. In addition, students were asked to write a
question after each one of the first 5 and final 5 text recalls. Before and after the intervention, students completed the detecting incongruities, and the summarizing and rating importance assessments. All students completed the concept maps on the interdependence and relationship of science and reading at the end of the treatment. In addition, selected students in the treatment groups participated in the interview and a think-aloud protocol. Students in the control group did not participate in any interview or think-aloud. The order in which these data were collected can be seen in the methodological model, presented in Figure 10, on page 197.

*GoInquire system.* To increase participants’ background knowledge on slow geomorphological changes, students participated in a series of lessons based on the technology system *GoInquire*. The lessons included two sections, the science content section, and the strategies for reading section.

*First section: Science content.* During this section, students explored content on slow geomorphological changes caused by water movement while working on the *GoInquire* system, then they progressed to out to a field-based experience to collect data in their school yard, contrast and compare the visual information from the system with the actual setting, and eventually they analyzed and assembled photographs according to their geomorphological features. The instructional sequence started always in a whole group setting (introduction), then students moved to work either in dyads, or in small groups (group work), and then the teacher pull all students together to help students move beyond the active construction of meaning (meaning making).
Students’ misconceptions in geomorphology had an important role in the intervention. As explained in the discussion on the conceptual framework of the INSCRIREAD intervention (Figure 8), identification of misconceptions prior to the instructional sequence is essential. To fulfill this need, the researcher compiled a list of misconceptions from the pilot study conducted in 2006. These misconceptions included the following results of children’s ideas, observed during the pilot study:

- Students don’t realize that water beds began in a plain and the water erode the surface (think there was a mountain)
- Catastrophic events are the reason for every landform (a volcano, a rock from space)
- A catastrophic event caused water to start moving
- Relationship among water cycle, rock cycle, states of matter (rock is a solid and water is liquid), plate tectonics, and erosion
  - Important idea:
    - Student retrodicts back to rain or earlier.
    - Student retrodicts back to bedrock or earlier
    - Student makes the rain-rock connection.
- Time line, clarify: a week, thousand of years, two million years, six million years
- Role of weight of water as the main erosion agent
- Water moves in all directions
- Student’s interpretation of important terms
Transportation as the movement of a vehicle—something’s moving

Children have a better understanding of erosion that deposition and transportation

Turning

These misconceptions arose from students’ work and explanations and were challenged in the form of text and/or during the whole group discussions.

As part of the first section: Science content, there were a series of activities designed to explore content. Details on the activities to promote conceptual development during the introduction and small group work follow:

1. During the GoInquire system part of the instructional sessions, students observed as the teacher modeled the processes of erosion, transportation and deposition in the class (pouring water on solids). Modeling was an important element based on the instructional method of Reciprocal Teaching (as shown in the conceptual framework in Figure 5). Then, they worked with the system in pairs to analyze the agents that affect the rate at which these processes take place. The photographs used by the system were taken from students’ immediate environment at school. Since all students shared this common context, the use of familiar photographs facilitated the cultural connection and seemed to motivate students. Digital photographs from school provided a culturally sensitive environment, as reflected in Figure 8. Again, this was one of the sections shown in the conceptual framework visual in Figure 8. While working in the system,
students were asked a series of metacognitive prompts and as they typed their answers, they were able to see other students’ responses. The fact that students were able to see other team’s answers and to respond to them was consistent with the conceptual framework of the *INSCIREAD* model, which encouraged social dialogic meaning making over individualistic learning experiences. They were also able to add definitions and words to a dictionary tool within the system, and they wrote their questions in the Super Question Bank. Finally, students worked in the Synthesis Page to identify the most important ideas from the written class discussions. These activities replicated the use of strategies during reading. During reading, students in the whole group and in small groups generated and recorded questions, they identified unclear words, and selected the most important information in each paragraph of the text, which was eventually used to generate a verbal summary. The idea that strategies can transfer across contexts is reflected in *INSCIREAD*. Therefore, the implemented instructional activities were congruent with the *INSCIREAD* model. This assumption of the global nature of the strategies is based on the research-borne theory of the general monitoring skill hypothesis.

2. Another activity to promote students’ learning of concepts consisted of having students go into their playground (the field experience). During the field experience, students continued their interaction with the system and went outside to observe the setting where the pictures were taken and take
digital photographs they found meaningful from a geomorphological point of view (school playground and parking lot). These pictures were then uploaded in the *GoInquire* system for further analysis. This activity also reflects the collaborative versus individual meaning-making represented in the conceptual model *INSCIREAD*.

3. In the final component of the instructional exploration, students selected the most important parts of a hard copy of the photographs used in the system. They circled the most important areas of the picture, and then cut and numbered them in order of significance related to geomorphological processes. Students explained their reasoning as they cut and assembled the pieces of the image. The cutting, reassembling, and the written explanations facilitated students’ discussions on the parts they had selected, which resulted in collaborative meaning making. The teacher assisted students in developing an awareness of the parallelism of this activity with highlighting important parts of a text, an attempt was made to move students toward enhanced cognitive flexibility.

After the introduction and the small group work, the class gathered together to move beyond the active construction of knowledge onto what was called the meaning making part of the instructional sequence. During the meaning making whole group work, the discussion and activities were designed to move one step beyond the active construction of meaning included in the conceptual framework of the *INSCIREAD* experiences. This was accomplished through the children’s experiences in the system and
in the field integrating their preliminary hypotheses and conclusions with information from texts and collaboration with students. During the second section of the instructional activity sequence, the class gathered in a whole group format to discuss their learning and to encourage collaborative meaning making as they read pieces of text.

The second section of instructional activities included a number of essential questions designed to stimulate students’ thinking. These questions attempted to ensure students’ were active. The questions cognitively also attempted to direct students’ attention toward important foundational ideas in geomorphology, and attempted to ease students’ progression toward the development of more scientifically based conceptual understanding that words followed. As described in the INSCIREAD map of ideas, the concepts were presented prior to the required reading words. The same questions were asked in all treatment groups. These questions consisted of the following:

- Where did the sand come from? [Transported from a higher elevation.]
- What turned the cement to sand? [Usually weathering.]
- What do the roots keep from becoming loose? [Dirt.]
- What do you mean by erodes quickly? [It takes up to thousands of years.]
- What do you mean by erodes slowly? [It takes millions of years.]
- If it rains at Key, where does the water end up? [At sea level.]
- What causes water to go from high to low? [Gravity.]
- What landform do you see in this photograph? [I see the ground/hill/river channel.]
- Is the hill steep or shallow? [Usually hills are steep.]
A detailed specific sequence of instruction followed for this condition is included in the Appendix I.

*Second section: Strategies for reading.* On alternative days, the teacher-researcher had students focus either on science content (first section) or on the strategies for reading (second section). During this second section, the instruction also followed the introduction, small group work, and meaning making sequence.

As part of this second section, the investigator facilitated students’ learning of the reading strategies through a series of activities. For example the class engaged in questioning and self-monitoring while reading through by implementation of the following steps: (a) make a prediction, (b) read sentence by sentence and clarify. Details on the activities that were designed to promote students’ use of the reading strategies are described in Appendix I.

*Design of the Study*

This study incorporated two different, but closely connected, study designs. The intervention was employed in the same way related to both methodologies using *INSCIREAD*, but there existed differences in data collection processes, and in the way the data were analyzed.

The research questions addressed by this study required multiple methods. Two different designs were proposed in order to properly investigate the research questions (a) mixed-methods quasi-experimental: Study 1, and (b) single subject: Study 2.

Mixed methods research involves the integrated use of both quantitative and qualitative research techniques, methods, approaches, concepts, or language into a single
study (Burke & Onwuegbuzie, 2004). The goal of mixed method research design and the present study was to attempt to examine the same teaching and learning phenomena through different lenses in an effort to increase validity of the study. As described in the limitations section of chapter 5, measurement and actual meaning are distinct. Multiple data collection sources were employed to triangulate the quantitative data, and multiple methods were implemented to analyze the same data. The ultimate goal was to be able to triangulate the findings and make more powerful conclusions. Triangulation of data sources can be presumably attained across quantitative and qualitative measures (Kidder and Fine, 1987). This approach that attempts to find answers using any combination of methods may be associated with a critical realist theory paradigm (Guba, 1990). This paradigm defends the idea that the process of research-based inquiry is influenced by socio-cultural and historic influences. The main objective using a mixed methods approach to data collection and analysis in this study was to converge data sources to promote inquiry and illuminate any perceived benefit of the INSCRIBEAD intervention materials for students with disabilities. Specifically, this study followed an embedded design, in which qualitative and quantitative components answered different questions (Creswell and Plano Clark, 2007).

This study utilized a mixed method design. The concept of mixing different methods originated in 1959, when Campbell and Fiske used multiple methods to study validity of psychological traits (Creswell, 2003). Mixed methods research involves the integrated use of both quantitative and qualitative research techniques, methods, approaches, concepts, or language into a single study (Burke & Onwuegbuzie, 2004).
With the development and perceived legitimacy of both qualitative and quantitative research in the social and human sciences, mixed methods research, is expanding (Creswell, 2003). The goal of mixed method research design is to attempt to examine the same teaching and learning phenomena through different lenses in an effort to increase validity of the study. The ultimate goal of implementing a mixed method research is to be able to triangulate the findings and make more powerful conclusions. Triangulation of data sources can be presumably attained across quantitative and qualitative measures (Kidder and Fine, 1987). This approach that attempts to find answers using any combination of methods may be associated with a critical realist theory paradigm (Guba, 1990). This paradigm defends the idea that the process of research-based inquiry is influenced by socio-cultural and historic influences. Some of the challenges this form of research poses for the inquirer include the need for extensive data collection, the time involved in analyzing both text and numeric data, and the requirement for the researcher to be familiar with both quantitative and qualitative forms of research (Creswell, 2003).

Single Subject: Study 2

This study included a quasi-experimental design (Campbell & Stanley, 1963), which has just been described, in conjunction with a single subject design, with groups as the unit of analysis. Previous researchers have used single subject design to assess the reading comprehension of students (Palincsar & Brown, 1984). Single subject has been used widely with students with special needs (e.g. Santoro, Jitendra, Starosta, Sacks, 2006; Regan, Mastropieri & Scruggs, 2005). A single subject design is used to demonstrate experimental control within a small number of participants.
Method

Participants

The single subject: Study 2 included 57 fourth-grade students, and no control group. All students were assigned to their respective classes. The distribution of students tended towards a balance of girls and boys and of other general students’ characteristics within the same class. The researcher did not alter these existing groups for the intervention. Each group included approximately twenty students, ranging from classrooms with 18 to 21 students. Eight students with special needs were distributed among two of the classes. These eight students were diagnosed with disabilities and were poor comprehenders (SPED). The remainder 49 students did not have special needs (NONSPED). Students with no special needs were the same in both study 1 and study 2. All of the students were dual language learners (English to Spanish or Spanish to English) and spent their school day, half learning in the English language and half learning in the Spanish language. This research study was conducted in the same elementary school described in study 1.

The students for this study were selected as follows. The students with special needs were purposefully selected from a larger group of students with disabilities at the fourth grade level. Six of these students were designated as having a learning disability, one as having an emotional disturbance, and one as having other health impairments (attention deficit disorder). To determine the reading levels prior to the intervention of all students, the investigator administered the letter-word identification and the text comprehension subtests of the Batería Woodcock-Muñoz Test-Revised in Spanish.
(Woodcock, 1998). In order to participate in the study, students with special needs were selected based on the following criteria: (1) standardized reading decoding scores set at least at the third grade level (when rounded to the closest grade level); and (2) scores demonstrating at least a 1 grade level discrepancy between reading decoding and comprehension. The demographics for students in the treatments groups without disabilities are shown in Tables 5 through 7. Demographics for students in the control group are shown in Table 8. Finally, demographics for students with disabilities in groups 1 and 2 are shown in Tables 9 and 10. These tables present students’ gender, parental language, and their Mean Spanish Reading Level. The Mean Spanish Reading Level was calculated by obtaining the mean of the grade equivalent level students obtained in the decoding and in the comprehension sections of the *Batería Woodcock-Muñoz Test-Revised* in Spanish (Woodcock, 1998). For clarity purposes, and since this was part of the selection criteria for these students only, the Spanish decoding and comprehension grade levels are reported for students with special needs. For all other students, just the Mean Spanish Reading Level has been included. Note that although the groups appear to closely match, scoring approximately the same mean baseline comprehension assessment score, differences exist.
Table 5

Demographics for Students Without Disabilities in Treatment Group 1 (N=17)

<table>
<thead>
<tr>
<th>Subject #</th>
<th>Gender</th>
<th>Parental Language</th>
<th>Spanish Reading Level¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>English</td>
<td>3.50</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>English</td>
<td>4.15</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>English</td>
<td>4.75</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>English</td>
<td>4.25</td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>English</td>
<td>3.70</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>Spanish</td>
<td>4.05</td>
</tr>
<tr>
<td>7</td>
<td>F</td>
<td>English</td>
<td>3.60</td>
</tr>
<tr>
<td>8</td>
<td>F</td>
<td>English</td>
<td>4.60</td>
</tr>
<tr>
<td>9</td>
<td>F</td>
<td>Spanish</td>
<td>6.30</td>
</tr>
<tr>
<td>10</td>
<td>M</td>
<td>Spanish</td>
<td>6.00</td>
</tr>
<tr>
<td>11</td>
<td>F</td>
<td>Spanish</td>
<td>3.30</td>
</tr>
<tr>
<td>12</td>
<td>M</td>
<td>English</td>
<td>2.35</td>
</tr>
<tr>
<td>13</td>
<td>M</td>
<td>English</td>
<td>3.00</td>
</tr>
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<td>14</td>
<td>M</td>
<td>English</td>
<td>4.40</td>
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<td>English</td>
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<td>2.95</td>
</tr>
<tr>
<td>17</td>
<td>M</td>
<td>Spanish</td>
<td>3.55</td>
</tr>
</tbody>
</table>

Mean 9 F 8 M 13 En 4 Sp 4

¹GE = Grade Equivalent, Bateria Woodcock-Munoz Test-Revised.
Table 6

Demographics for Students Without Disabilities in Treatment Group 2 (N=14)

<table>
<thead>
<tr>
<th>Subject #</th>
<th>Gender</th>
<th>Parental Language</th>
<th>Spanish Reading Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
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<td>English</td>
<td>4.70</td>
</tr>
<tr>
<td>19</td>
<td>M</td>
<td>English</td>
<td>3.55</td>
</tr>
<tr>
<td>20</td>
<td>F</td>
<td>English</td>
<td>5.30</td>
</tr>
<tr>
<td>21</td>
<td>M</td>
<td>Spanish</td>
<td>5.40</td>
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<tr>
<td>22</td>
<td>F</td>
<td>English</td>
<td>3.95</td>
</tr>
<tr>
<td>23</td>
<td>M</td>
<td>English</td>
<td>3.10</td>
</tr>
<tr>
<td>24</td>
<td>M</td>
<td>English</td>
<td>3.35</td>
</tr>
<tr>
<td>25</td>
<td>F</td>
<td>English</td>
<td>5.20</td>
</tr>
<tr>
<td>26</td>
<td>F</td>
<td>Spanish</td>
<td>7.65</td>
</tr>
<tr>
<td>27</td>
<td>F</td>
<td>English</td>
<td>4.40</td>
</tr>
<tr>
<td>28</td>
<td>M</td>
<td>Spanish</td>
<td>2.95</td>
</tr>
<tr>
<td>29</td>
<td>F</td>
<td>Spanish</td>
<td>5.00</td>
</tr>
<tr>
<td>30</td>
<td>M</td>
<td>English</td>
<td>4.20</td>
</tr>
<tr>
<td>31</td>
<td>F</td>
<td>English</td>
<td>3.50</td>
</tr>
</tbody>
</table>

Mean 8 F 6M 10 En 4 Sp 4.45

¹GE = Grade Equivalent, *Batería Woodcock-Muñoz Test-Revised.*
Table 7

Demographics for Students Without Disabilities in Treatment Group 3 (N=18)

<table>
<thead>
<tr>
<th>Subject #</th>
<th>Gender</th>
<th>Parental Language</th>
<th>Spanish Reading Level (^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>M</td>
<td>Spanish</td>
<td>5.50</td>
</tr>
<tr>
<td>33</td>
<td>F</td>
<td>Spanish</td>
<td>4.15</td>
</tr>
<tr>
<td>34</td>
<td>F</td>
<td>English</td>
<td>4.65</td>
</tr>
<tr>
<td>35</td>
<td>M</td>
<td>Spanish</td>
<td>3.45</td>
</tr>
<tr>
<td>36</td>
<td>F</td>
<td>English</td>
<td>4.95</td>
</tr>
<tr>
<td>37</td>
<td>F</td>
<td>English</td>
<td>3.25</td>
</tr>
<tr>
<td>38</td>
<td>F</td>
<td>Spanish</td>
<td>4.20</td>
</tr>
<tr>
<td>39</td>
<td>F</td>
<td>Spanish</td>
<td>3.90</td>
</tr>
<tr>
<td>40</td>
<td>M</td>
<td>English</td>
<td>5.75</td>
</tr>
<tr>
<td>41</td>
<td>M</td>
<td>English</td>
<td>5.00</td>
</tr>
<tr>
<td>42</td>
<td>M</td>
<td>English</td>
<td>2.85</td>
</tr>
<tr>
<td>43</td>
<td>M</td>
<td>English</td>
<td>5.60</td>
</tr>
<tr>
<td>44</td>
<td>F</td>
<td>English</td>
<td>4.80</td>
</tr>
<tr>
<td>45</td>
<td>F</td>
<td>English</td>
<td>3.45</td>
</tr>
<tr>
<td>46</td>
<td>M</td>
<td>English</td>
<td>4.45</td>
</tr>
<tr>
<td>47</td>
<td>F</td>
<td>Spanish</td>
<td>7.35</td>
</tr>
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<td>48</td>
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<td>4.15</td>
</tr>
<tr>
<td>49</td>
<td>F</td>
<td>English</td>
<td>3.20</td>
</tr>
</tbody>
</table>

Mean 11 F 7 M 11En 7 Sp 4.48

\(^1\)GE = Grade Equivalent, *Bateria Woodcock-Muñoz Test-Revised.*
Table 8

Demographics for Students Without Disabilities in Control Group (N=21)

<table>
<thead>
<tr>
<th>Subject #</th>
<th>Gender</th>
<th>Parental Language</th>
<th>Spanish Reading Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>M</td>
<td>Spanish</td>
<td>4.25</td>
</tr>
<tr>
<td>51</td>
<td>M</td>
<td>English</td>
<td>6.10</td>
</tr>
<tr>
<td>52</td>
<td>F</td>
<td>English</td>
<td>5.35</td>
</tr>
<tr>
<td>53</td>
<td>M</td>
<td>English</td>
<td>5.70</td>
</tr>
<tr>
<td>54</td>
<td>F</td>
<td>Spanish</td>
<td>5.40</td>
</tr>
<tr>
<td>55</td>
<td>M</td>
<td>English</td>
<td>3.60</td>
</tr>
<tr>
<td>56</td>
<td>F</td>
<td>English</td>
<td>4.35</td>
</tr>
<tr>
<td>57</td>
<td>F</td>
<td>English</td>
<td>6.70</td>
</tr>
<tr>
<td>58</td>
<td>F</td>
<td>Spanish</td>
<td>7.90</td>
</tr>
<tr>
<td>59</td>
<td>F</td>
<td>Spanish</td>
<td>3.50</td>
</tr>
<tr>
<td>60</td>
<td>M</td>
<td>English</td>
<td>5.90</td>
</tr>
<tr>
<td>61</td>
<td>M</td>
<td>Spanish</td>
<td>5.10</td>
</tr>
<tr>
<td>62</td>
<td>M</td>
<td>Spanish</td>
<td>6.75</td>
</tr>
<tr>
<td>63</td>
<td>M</td>
<td>Spanish</td>
<td>5.00</td>
</tr>
<tr>
<td>64</td>
<td>M</td>
<td>Spanish</td>
<td>3.50</td>
</tr>
<tr>
<td>65</td>
<td>F</td>
<td>English</td>
<td>4.00</td>
</tr>
<tr>
<td>66</td>
<td>F</td>
<td>English</td>
<td>5.00</td>
</tr>
<tr>
<td>67</td>
<td>F</td>
<td>English</td>
<td>4.00</td>
</tr>
<tr>
<td>68</td>
<td>F</td>
<td>Spanish</td>
<td>5.00</td>
</tr>
<tr>
<td>69</td>
<td>M</td>
<td>Spanish</td>
<td>4.00</td>
</tr>
<tr>
<td>70</td>
<td>F</td>
<td>English</td>
<td>4.00</td>
</tr>
</tbody>
</table>

Mean 11 F 10 M 11 En 10 Sp 5

¹GE = Grade Equivalent, *Batería Woodcock-Muñoz Test-Revised.*
### Table 9

**Demographics for Students With Disabilities in Treatment Group 1 (N=4)**

<table>
<thead>
<tr>
<th>Subject #</th>
<th>Gender</th>
<th>Parental Language</th>
<th>Disability ²</th>
<th>Spanish Decoding Level</th>
<th>Spanish Comp. Level</th>
<th>Spanish Reading Level¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>71</td>
<td>F</td>
<td>Spanish</td>
<td>SLD</td>
<td>3.9</td>
<td>1.3</td>
<td>2.6</td>
</tr>
<tr>
<td>72</td>
<td>M</td>
<td>Spanish</td>
<td>ED</td>
<td>2.9</td>
<td>1.2</td>
<td>2.05</td>
</tr>
<tr>
<td>73</td>
<td>F</td>
<td>Spanish</td>
<td>SLD</td>
<td>3.0</td>
<td>1.7</td>
<td>2.35</td>
</tr>
<tr>
<td>74</td>
<td>F</td>
<td>Spanish</td>
<td>SLD</td>
<td>3.6</td>
<td>2.7</td>
<td>3.15</td>
</tr>
<tr>
<td>Mean</td>
<td>3 F 1 M</td>
<td>4 Sp</td>
<td>3 SLD 1 ED</td>
<td>3.35</td>
<td>1.73</td>
<td>2.54</td>
</tr>
</tbody>
</table>

¹GE = Grade Equivalent, *Batería Woodcock-Muñoz Test-Revised*. ²SLD = Specific Learning Disability; ED = Emotional Disturbance.

### Table 10

**Demographics for Students With Disabilities in Treatment Group 2 (N=4)**

<table>
<thead>
<tr>
<th>Subject #</th>
<th>Gender</th>
<th>Parental Language</th>
<th>Disability ²</th>
<th>Spanish Decoding Level</th>
<th>Spanish Comp. Level</th>
<th>Spanish Reading Level¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>M</td>
<td>Spanish</td>
<td>SLD</td>
<td>6.6</td>
<td>2.4</td>
<td>4.5</td>
</tr>
<tr>
<td>76</td>
<td>F</td>
<td>Spanish</td>
<td>SLD</td>
<td>3.2</td>
<td>2.0</td>
<td>2.6</td>
</tr>
<tr>
<td>77</td>
<td>M</td>
<td>Spanish</td>
<td>SLD</td>
<td>4.4</td>
<td>3.4</td>
<td>3.9</td>
</tr>
<tr>
<td>78</td>
<td>M</td>
<td>English</td>
<td>OHI</td>
<td>3.6</td>
<td>1.6</td>
<td>2.6</td>
</tr>
<tr>
<td>Mean</td>
<td>1 F 3 M</td>
<td>1 En 3 Sp</td>
<td>3 SLD 1 OHI</td>
<td>4.5</td>
<td>2.4</td>
<td>3.4</td>
</tr>
</tbody>
</table>

¹GE = Grade Equivalent, *Batería Woodcock-Muñoz Test-Revised*. ²SLD = Specific Learning Disability; OHI = Other Health Impairment (Attention Deficit).
Measures

As part of the single subject: Study 2 there were two measures. The quantitative measure, science text recall is presented first, followed by the qualitative measure, interviews.

Science text recalls. The purpose of the science text recalls was to measure students’ ability to comprehend written science text related to the topic of slow landform changes caused by water. In this study, comprehension was measured by the amount of information students could recall after reading and interacting with one of the assessment passages for an undetermined time. Related to the single subject design of this research study, text recalls were collected from all participants in the three treatment groups daily during baseline, treatment, and maintenance, until all groups had the same number of data points. The data collected were analyzed for the single subject design as follows:

1. The percent of number of words versus the total number of words within a text, obtained in text recalls for treatment group were graphed. Graphs depicting this information were created to show a different baseline point, according to the number of text recalls before baseline that were randomly assigned (see Figure 2 from pilot study for an example). Data was depicted in different graphs: (a) one set of graphs for students without disabilities (NONSPED) in each of the three groups (see Figure 20), and (b) another set of graphs for students with disabilities (SPED) in each of the two groups (see Figure 21).

2. Graphs were analyzed using visual analyses. Specifically, the level of data (see Figures 21 and 22) was used. The level of the data refers to the average of the data within a
condition and is calculated as the mean of all the data points (Kennedy, 2005). The level of data was used because, according to Kennedy (2005), attending to the level of data within a phase allows for the estimation of the central tendency of the data during a particular part of an experiment. In addition, the level of data also allows for comparison of patterns between phases.

3. Considering the random allocation procedure of the implementation of treatment a randomization test was conducted, to supplement the visual analysis of the data collected on treatment group (SPED/NONSPED). The randomization test is a nonparametric statistical test, which assumes random assignment of the intervention points, that the intervention will increase points, that the data points are independent of each other, and that all participants should have the same number of observations. The reason for conducting the randomization test is the variability of the results. In the case of lack of a stable baseline, the use of statistical analysis may be useful in determining any significant changes.

Randomization tests can be conducted if the points at which each group will enter the intervention phase have been randomly assigned. Randomization tests conducted on baseline-treatment phases complements visual inspection of data and calculates the probability that any other randomly selected arrangement of treatment initiation times would result in treatment-baseline differences of a higher value (Kazdin, 1998).

In the case of a multiple-baseline design, mean differences in absolute value across treatment and baseline phases are summed across subjects. That is, the absolute difference between the mean treatment value and the mean baseline value for group of
participants 1, group of participants 2, and so on. This total sum is then compared with
total sums calculated from 2,000 randomly selected arrangements of treatment initiation
points. The expressed probability (p-value) then is the proportion of times a value
(representing magnitude of summed baseline-treatment mean differences) based on
randomly selected treatment initiation points exceeded the presently observed value
(Todman & Dugard, 2001). According to Kazdin (1984) “statistical tests such as the
randomization test may be helpful in new areas of research or when overall treatment
effects may be expected to be somewhat less pronounced”. This is the case in the present
academic intervention and population.

In order to run the randomization test on data in this study, a macro designed by
Todman and Dugard (2001) was used. The specific design used was Design 3, AB
Multiple Baseline. This is a multiple participant, two-phase (usually baseline, followed
by treatment) design, which matches the characteristics of the present design.

*Interviews.* The purpose of the interviews was to answer question number 5 by
investigating students’ awareness of the parallelism and the interdependence of science
and reading (used for triangulation with data from science and reading concept map
measure) as well as investigating the social validity of the intervention.

Thirteen students were randomly selected from the total group of 57 students who
participated in the intervention to be interviewed. This represents a 23% of the
participants. During the interview, students were asked questions about their impressions
of the instructional experience, the *GoInquire* system and the strategies learned. Their
opinions were used to investigate the social validity of the intervention. In addition, the
students were asked about the relationship between science and reading (see questions in Appendix K). Their answers were used to address question 5. Each interview lasted for about 20 minutes and all students were asked the same questions (see Appendix K).

After reading all the interviews, the researcher identified the following themes. First, general impressions, second, ideas on the strategies (questioning, self-monitoring, and others), what students liked the most, and what they liked the least, relationships between science and reading, working in groups/pairs, and ideas in relation to knowing two languages (English and Spanish). All the responses were coded using these categories. Results from the qualitative analysis of the interviews focused on determining the social validity of the INSCIREAD intervention, and answering the qualitative question 5 on how the INSCIREAD impacted students’ understanding of the relationship between science and reading.

All the pieces of data collected for the purposes of this investigation, were collected in three phases: (a) before, (b) during, and (c) after the intervention. Figure 10 presents a visual organizer representing the order in which the data were collected in these phases. The organizer is also meant to clarify the particular pieces of data which were collected from each group.
PARALLEL SCIENCE AND READING COGNITIVE STRATEGIES INSTRUCTION: EFFECT ON STUDENTS’ MISCONCEPTIONS AND READING COMPREHENSION

Methodology Model

Data Collected Before Intervention (Pretest Data) from all Participants in Treatment

Description of Participants: 80 fourth-grade students. All students were dual language learners. Eight students with special needs (learning disabilities) distributed in two of three treatment groups. Collect scores on Woodcock-Johnson, decoding and reading comprehension in Spanish and demographics.

Number of Misconceptions Assessment: Students are asked to draw and/or write to respond to four open-ended questions.

Booklet for each student including:
1. Detecting Incongruities Assessment: Four texts, three containing anomalous lines. Students were asked on consecutive days to read one of the stories line by line and circle yes or no if the line either did or did not make sense. For any line evaluated by the student as incorrect, students were asked to explain in writing any line they evaluated as incorrect.
2. Summarizing and Rating Importance Assessment: Two of the same passages selected for the detecting incongruities measure, were used in their original form as measures of sensitivity to main idea and detail information. Students read four intact passages on consecutive days and were asked to erase the least important, and select the most important information. They then wrote the main idea for the text.

Treatment Groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7 Baseline (21 students, 4 with LD)</td>
</tr>
<tr>
<td>2</td>
<td>9 Baseline (18 students)</td>
</tr>
<tr>
<td>3</td>
<td>10 Baseline (18 students)</td>
</tr>
</tbody>
</table>

Control Group

Regular Reading and Science Instruction (21 students)

Intervention:

Science instruction using the GoInquire and cognitive strategy instruction focused on questioning and comprehension monitoring in both science and reading.

Data Collected DURING Intervention/Participants in Treatment

- All dialogues during instructional sessions were videotaped
- Daily science text recalls were collected during baseline, intervention and maintenance
Data Collected AFTER Intervention/Participants in Treatment

<table>
<thead>
<tr>
<th>Treatment Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>- Daily science text recalls</strong> during baseline, intervention and maintenance were conducted</td>
<td>Students in control group completed three text recalls (texts 12, 13, and 14)</td>
</tr>
<tr>
<td>- Students were asked to <strong>write two questions</strong> related to water erosion, deposition and transportation right after texts 2, 3 and 4 and the texts 12, 13, and 14</td>
<td></td>
</tr>
</tbody>
</table>

**Number of Misconceptions Post-assessment:** Students were asked to draw and/or write to respond to the same four open-ended questions they answered pre-intervention.

**Uncovering Misconceptions Post-assessment**

**Booklet for each student including:**

1. **Detecting Incongruities Post-assessment:** Four different stories, three containing anomalous lines were presented, following same procedures as during pre-assessment.

2. **Summarizing and Rating Importance Post-assessment:** Two of the same passages selected for the detecting incongruities post-measure, were used in their original form as measures of sensitivity to main idea and detail information, following same procedures as pre-assessment.

**Interviews with the dyads or triads:** The interview will include questions about their feelings toward the intervention, their use of cognitive strategies and their perceptions on their ability to read and understand science texts.

**Think-aloud**

Students’ comments while reading a piece of scientific text will be taped.

**All Students in Treatment and Control Groups**

**Science and Reading Concept Map on the Relationship Between Science and Reading**

*Figure 10.* Methodology model.
Description of the Intervention

The INSCIREAD intervention was employed in both the quasi-experimental and the single subject designs. Further detail is provided under the mixed methods quasi-experimental section.

Fidelity of Treatment

Assuming the teacher-researcher role in this study, the investigator implemented all sessions of the intervention to the three groups, thus eliminating any variability of instruction associated with teacher, but also limiting the possibility of generalizing these procedures. Maxwell (2005) explains that an important goal in negotiating research relationships is gaining access to the setting. This access was facilitated the researcher being a teacher at the school where the study was conducted. Maxwell further describes how “the research relationships the investigator establishes can facilitate or hinder other components of the research design, such as participant selection and data collection.” The fidelity of the treatment was also facilitated by the researcher being a teacher at the school. To ensure all groups received the same treatment, a fidelity checklist was developed for each condition. The checklist contained a list of steps for appropriate treatment implementation of the two sections described earlier, the Activities to Learn About Geomorphology section and the Beyond the Active Construction section. The researcher used the checklist implementing the intervention (see Appendix I). In addition, all sessions were tape recorded.

The INSCIREAD intervention was implemented as consistently as possible using the checklist, marking each step as it was completed with the students. In addition, all
sessions were tape-recorded and the checklist for fidelity was also completed for 50% of
the total intervention sessions (3 out of 6) by a research assistant. Comparison of these
instruments showed that all sessions in both conditions and groups were implemented
consistently during the observed lessons. Although time constraints did occasionally
cause certain parts of a session to be moved to the next session, all parts were carried out.

Procedures

Treatment groups. A prerequisite of a multiple baseline single subject design
(Kennedy, 2005) is that each group of students be assigned to a different baseline. A
prerequisite of a randomized analysis is that those baselines be randomly assigned
(Todman & Dugard, 2001). Therefore, each of the three treatment groups was assigned to
one randomly selected baseline. The baseline for this study consisted of the daily
collection of a text recall protocol, but without any intervention. The data points collected
during the baseline phase were measures of the level of behavior (the dependent variable)
as it occurred naturally, before intervention. The multiple baseline (number of text recalls
before intervention) for each group was randomly determined from a pool of 10 different
numbers, starting with 7 and ending with 16. According to the rules for randomization,
the first number of baseline data points was randomly selected and assigned to one of the
groups. Then, that number was added again to the remaining numbers and a second
number was drawn and assigned to the second group. The same procedure was followed
to determine the point in the data collection at which group 3 was to enter the
intervention. According to this method, there was a chance of two groups sharing the
same intervention starting point.
The baseline points were randomly selected, labeled either 1, 2, or 3, based on how many baseline points they were randomly assigned. The resulting points prior to the intervention and the names were: group one, 7 data points; group two, 9 data points; and group three, 10 data points. The timeline showing the duration of each phase for each group can be seen in Figure 11. All three groups received the same intervention, but beginning at different randomly assigned baseline points (number of text recalls collected from each group before the intervention). Each treatment group included from 18 to 21 participants.

To fulfill the requirements for a single subject study design, there were three phases to the study for all treatment groups: (1) Baseline, with 7 days of data collection (daily text recall protocols) for group one, 9 days for group two, and finally 10 days for group three; (2) INSCIREAD intervention for 6 consecutive days; and (3) Maintenance for students in groups one and two (to ensure all students had the same number of data collection points). Students in all treatment groups were given daily assessment passages for which they had to complete immediate written text recall protocols (see Figure 11).
Each group of students was assigned to one of three randomly selected baselines. The distribution of baselines, in the context of the whole design is shown in Figure 12.
**Design of the Study**

As explained earlier, in a single subject design, data are collected daily and are traditionally represented visually for analysis as graphs. Certain components are common to all single subject designs, such as a measure of baseline performance and at least one measure of performance under an intervention within the design. This replication allows for the assumption of a functional relationship (Alberto & Troutman, 2006).
When implementing a single subject design, the researcher does not assume
generality of research results based on a single successful intervention. When a functional
relationship is established between an independent variable (intervention) and a
dependent variable (behavior) for one individual, repeated studies of the same
intervention are conducted using different individuals and different dependent variables
(Alberto & Troutman, 2006).

The first phase of single subject design involves the collection and recording of
baseline data. Baseline data are measures of the level of behavior (the dependent
variable) as it occurs naturally, before intervention. According to Kazdin (1998) baseline
data serve two functions: (a) descriptive: When graphed, data points provide a picture of
a student’s behavior; (b) predictive: To evaluate the success of an intervention (the
independent variable), the teacher must know what student performance was like before
the intervention (Kazdin). The baseline phase continues for several sessions before the
intervention phase begins. In most instances, at least five baseline data points are
collected and plotted.

Once the baseline is stable, the independent variable (treatment or intervention) is
introduced, and its effects on the dependent variable (the students’ performance) are
measured and recorded. Trends in treatment data indicate the effectiveness of the
treatment. Specifically, this study was based on a multiple baseline design. A multiple
baseline design is the design of choice when the researcher is interested in using an
intervention with more than one individual, setting, or behavior (Alberto & Troutman,
2006).
Single subject design is used when repeated measurements of the dependent variable can be made, and when the researcher can also serve as the participants’ teacher (Regan et al., 2005). Single subject design is preferred when the focus is on individual analysis, but has been used successfully when the focus is on group analysis (Palincsar & Brown, 1984).

The single subject design with groups was used in this study as the unit of analysis to investigate the effectiveness of the INSCIREAD instructional model in students’ ability to recall the information in science texts.

*Implementation of a multiple baseline design.* A teacher using the multiple baseline design collects data on the dependent variable under baseline conditions for each student. After a stable baseline has been achieved on the first variable, the intervention for the first participant can be started while the rest of the participants remain in baseline (Alberto & Troutman, 2006). At a predetermined data point, which was randomly selected for this study, the second participant will enter the intervention, and the process continues until all participants have been through the intervention. For data collection to be complete, the same number of data points must have been collected from all participants.

*Analyses of the data in a single subject design.* The data collected in a multiple baseline design can be examined for a functional relationship between the independent and dependent variables. A functional relationship is assumed if each dependent variable in succession shows a change when, and only when, the independent variable is introduced. Visual analyses of single subject graphs are based on visual inspection of the
data and simultaneous consideration of such criteria as the level of the data (Kennedy, 2005).

The level of the data refers to the average of the data within a condition and is typically calculated as the mean or median (Kennedy, 2005). According to Kennedy, attending to the level of data within a phase allows for the estimation of the central tendency of the data during a particular part of an experiment and also allows for the comparison of patterns between phases.

*Randomization test in single subject design.* In addition to visual analyses, randomization tests can be conducted if the points at which each group enters the intervention phase have been randomly assigned. Randomization tests conducted on baseline-treatment phases complement visual inspection of data and are used to calculate the probability that any other randomly selected arrangement of treatment initiation times would result in treatment-baseline differences of a higher value (Kazdin, 1998). In the case of a multiple-baseline design, mean differences in absolute value across treatment and baseline phases are summed across subjects. That is, the absolute difference between the mean treatment value and the mean baseline value for group of participants 1, group of participants 2, and so on is calculated. This total sum is then compared with total sums calculated from 2,000 randomly selected arrangements of treatment initiation points. The expressed probability (p-value), then, is the proportion of times a value (representing the magnitude of summed baseline-treatment mean differences), based on randomly selected treatment initiation points, exceeded the presently observed value (Todman & Dugard, 2001). Statistical tests such as the randomization test may be helpful in new areas of
research or when overall treatment effects are expected to be somewhat less pronounced (Kazdin), as with the academic intervention and population in this study.

**Triangulation**

The embedded design was complemented by triangulation of data sources, which can be presumably attained across quantitative and qualitative measures (Kidder & Fine, 1987). As can be seen in Figure 13, triangulation was used in this research study to analyze the data from the level of generated questions and the think alouds both qualitatively and quantitatively. In addition, triangulation was used between the quantitative data from the level of generated questions, detecting incongruities, and the number of misconceptions, and the data from think alouds. A different kind of triangulation was conducted with the findings from both quantitative dependent measures (design 1 and design 2) looking at science text recall ability. Triangulation across and within methods, and an embedded design, were implemented as part of this design to provide a view of the results that would help lead to more powerful conclusions.
<table>
<thead>
<tr>
<th>Design</th>
<th>Quantitative Measures</th>
<th>Qualitative Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embedded Mixed Methods</td>
<td>Science Text Recall</td>
<td>Triangulation</td>
</tr>
<tr>
<td>Quasi-Experimental</td>
<td>Level of Generated Questions (Quan+Qual)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Detecting Incongruities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Summarizing and Rating Importance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of Misconceptions</td>
<td></td>
</tr>
<tr>
<td>Single Subject</td>
<td>Science and Reading Concept Map</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spanish Reading Level (Covariate)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Science Text Recall (collected daily)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Identification of broad numeric trends and patterns in an objective, numerical manner</td>
<td></td>
</tr>
<tr>
<td></td>
<td>More depth; Detailed explanations; Exploration of students’ experiences</td>
<td></td>
</tr>
</tbody>
</table>

*Figure 13. Overview of the design methods and triangulation.*

Figure 14 shows a summary of all measures and their purposes for both studies conducted as part of this investigation.
<table>
<thead>
<tr>
<th>Measure</th>
<th>Time of Collection</th>
<th>Measures/Explores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Text Recall&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Post-only</td>
<td>Ability to comprehend written science text related to the slow landform changes by water</td>
</tr>
<tr>
<td></td>
<td>(quasi-exp) Daily</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(single subject)</td>
<td></td>
</tr>
<tr>
<td>Level of Generated Questions</td>
<td>Pre-post</td>
<td>Ability to generate high level questions</td>
</tr>
<tr>
<td>Detecting Incongruities</td>
<td>Post-only</td>
<td>Ability to use self-monitoring</td>
</tr>
<tr>
<td>Summarizing and Rating Importance</td>
<td>Post-only</td>
<td>Sensitivity to main idea and detail information</td>
</tr>
<tr>
<td>Number of Misconceptions</td>
<td>Pre-post</td>
<td>Science concepts and processes closer to those held by geomorphologists</td>
</tr>
<tr>
<td>Science/Reading Concept Map</td>
<td>Post-only</td>
<td>Awareness of the relationship between science and reading</td>
</tr>
<tr>
<td>Spanish Reading Level</td>
<td>Pre-only</td>
<td>Differences in Spanish reading levels prior to the intervention</td>
</tr>
<tr>
<td>Think Aloud</td>
<td>Post-only</td>
<td>Ability to use the online cognitive strategies of questioning and self-monitoring</td>
</tr>
<tr>
<td>Interview&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Post-only</td>
<td>Awareness of the parallelism and the interdependence of science and reading</td>
</tr>
</tbody>
</table>

<sup>a</sup> Study 1 and Study 2.  <sup>b</sup> Study 2.

*Figure 14. Summary of all measures and their purposes*
4. Results

This chapter presents the results of the quantitave and the qualitative research questions within the mixed-methods quasi-experimental: Study 1 and those from the single subject: Study 2. Data from the special education population are presented as part of the single subject: Study 2.

Mixed-methods Quasi-experimental: Study 1

Research question 1A: Does explicit instruction of scientific text content and comprehension-fostering cognitive based strategies (questioning and self-monitoring), INSCIREAD, have an effect on fourth-grade children’s science text recall? It is hypothesized that students exposed to INSCIREAD will achieve higher text recall scores than the control group.

A preliminary analysis using an independent-samples $t$-test was conducted to check for preintervention differences in Spanish reading level among students in the treatment and the control groups. As shown in Table 11, the mean of students in the treatment group was 4.31, with a standard deviation of 1.12, whereas the mean of students in the control group was 5.00, with a standard deviation of 1.19.

The results of the independent-samples $t$-test showed a significant difference in Spanish reading levels for the treatment group and control group, $t(68) = 2.32, p = .023$. Thus, analysis of covariance, controlling for Spanish reading levels prior to the intervention, was used to test the hypotheses in research questions 1A, 1C, 1D, and 3.
A one-way between groups analysis of covariance was conducted on the data from students in the treatment group. The independent variable used was the group students belonged to (treatment or control) and the dependent variable used was students’ mean scores for text recalls for texts read postintervention (recalls for Texts 12, 13, and 14). Students in the control group read and wrote their text recalls at the same time students in the treatment group did, but they did not participate in the intervention. Participants’ Spanish reading levels before the intervention were used as the covariate in this analysis. As shown in Table 11, the treatment group’s mean for this dependent measure (percent obtained in the text recalls from the posttest) was 47.70, with a standard deviation of 2.86. The control group’s mean was 37.27, with a standard deviation of 4.43.

The results, adjusted for preintervention Spanish reading levels, show that there was no statistically significant difference between the treatment and the control groups on postintervention scores in the students’ mean score for text recalls for texts read postintervention (recalls for Texts 13, and 14), $F(1,67) = 3.80, p = .06$, partial $\eta^2 = .05$ (a small effect size according to Cohen’s 1988 guidelines). Therefore, the results do not support Hypothesis 1A.
Table 11

*Means and Standard Deviation for Dependent Measures*

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Treatment $N=49$</td>
<td>Control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$N=21$</td>
</tr>
<tr>
<td>Science Text Recall</td>
<td>47.7</td>
<td>37.27</td>
</tr>
<tr>
<td></td>
<td>2.86</td>
<td>4.43</td>
</tr>
<tr>
<td>Level of Generated Questions</td>
<td>Pretest 3.88</td>
<td>Posttest 4.80</td>
</tr>
<tr>
<td></td>
<td>Pretest 3.83</td>
<td>Posttest 4.10</td>
</tr>
<tr>
<td>Detecting Incongruities$^a$</td>
<td>21.72</td>
<td>20.14</td>
</tr>
<tr>
<td></td>
<td>0.43</td>
<td>0.66</td>
</tr>
<tr>
<td>Controlling for Guessing$^b$</td>
<td>1.31</td>
<td>.89</td>
</tr>
<tr>
<td></td>
<td>.12</td>
<td>.18</td>
</tr>
<tr>
<td>Summarizing and Rating Importance</td>
<td>6.75</td>
<td>4.21</td>
</tr>
<tr>
<td></td>
<td>0.31</td>
<td>0.48</td>
</tr>
<tr>
<td>Science and Reading Concept Map</td>
<td>3.36</td>
<td>2.07</td>
</tr>
<tr>
<td></td>
<td>0.20</td>
<td>0.31</td>
</tr>
<tr>
<td>Spanish Reading Level</td>
<td>4.31</td>
<td>5.00</td>
</tr>
<tr>
<td></td>
<td>1.12</td>
<td>1.19</td>
</tr>
</tbody>
</table>

$^a$Score on Total Correct Detection $N = 26$. $^b$Score on Incongruent Sentences $N = 3$ corrected for guessing.

The relationship among all quantitative measures (science text recall, level of generated questions, detecting incongruities, summarizing and rating importance, number of misconceptions, and science and reading concept map) was investigated using the point biserial correlation coefficient, which is equivalent to Pearson. The significant
correlation coefficients were analyzed in the context of the hypotheses being tested in this research study; the results are shown in Table 12.
### Table 12

*Correlations Among Science Text Recall, Level of Generated Questions, Detecting Incongruities, Summarizing and Rating Importance, Number of Misconceptions, and Science and Reading Concept Map*

<table>
<thead>
<tr>
<th>Variable</th>
<th>1A</th>
<th>1B</th>
<th>1C</th>
<th>1D</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A. Text Recall</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1B. Question Generation</td>
<td>-.33*</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1C. Detecting Incongruities</td>
<td>.26</td>
<td>-.17</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1D. Summarizing and Rating Importance</td>
<td>.40**</td>
<td>-.01</td>
<td>.08</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Number of Misconceptions</td>
<td>.03</td>
<td>.03</td>
<td>.01</td>
<td>.14</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>3. Connections on a Concept Map</td>
<td>.24</td>
<td>-.02</td>
<td>.20</td>
<td>.13</td>
<td>.20</td>
<td>1.00</td>
</tr>
</tbody>
</table>

** = Correlation is significant at the 0.01 level (2-tailed). * = Correlation is significant at the 0.05 level (2-tailed).
Research question 1B: Does INSCIREAD have an effect on the level of questions fourth-grade children generate? It is hypothesized that students exposed to INSCIREAD will use a higher level of generated questions in the posttest than in the pretest.

A paired-samples t-test was conducted to evaluate the impact of the intervention on students’ scores on the questions they generated before and after the intervention. As shown in Table 11, the students’ mean score for the questions they generated during the pretest was 3.88, with a standard deviation of 3.83. During posttest, the mean of the scores was 4.80, with a standard deviation of 4.10.

The results of the paired-samples t-test show there was a statistically significant increase in student scores for the questions they generated from the pretest to the posttest, \( t(48) = 3.29, p = .01 \).

In addition, the analysis of the results from the questions (see Table 13) shows that students wrote fewer questions at the basic and intermediate levels during the posttest (56 questions) than during the pretest (74 questions). Additionally, they wrote more questions at the main idea and investigative levels during the posttest (40 questions) than during the pretest (22 questions). The classification of the questions generated by the students can be seen in Appendix C. These results support Hypothesis 1A.
Table 13

*Questions Generated at Each Level by Treatment Groups During Pre and Posttest*

<table>
<thead>
<tr>
<th>Level of Questions</th>
<th>Pretest (96 Questions)</th>
<th>Posttest (96 Questions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1 (Basic)</td>
<td>38</td>
<td>19</td>
</tr>
<tr>
<td>Level 2 (Intermediate)</td>
<td>72</td>
<td>74</td>
</tr>
<tr>
<td>Level 3 (Main Idea)</td>
<td>24</td>
<td>54</td>
</tr>
<tr>
<td>Level 4 (Investigative)</td>
<td>56</td>
<td>88</td>
</tr>
<tr>
<td>Levels 1 and 2</td>
<td>74</td>
<td>56</td>
</tr>
<tr>
<td>Levels 3 and 4</td>
<td>22</td>
<td>40</td>
</tr>
<tr>
<td><strong>Total Points</strong></td>
<td><strong>190</strong></td>
<td><strong>235</strong></td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td><strong>1.98</strong></td>
<td><strong>2.45</strong></td>
</tr>
</tbody>
</table>

*a* = These levels are described in detail in the rubric provided in Appendix C.

The results of the point biserial correlation coefficient calculated among all quantitative measures show there was a significant negative correlation between science text recall and question generation ($r = -.33$, $p = .05$). This correlation suggests a relationship between Hypotheses 1A, which states that students exposed to *INSCIREAD* will achieve higher text recall scores than the control group, and 1B, which states that students exposed to *INSCIREAD* will use a higher level of generated questions in the posttest than in the pretest. This finding is interesting because it suggests, on one hand, that students who improve their ability to recall information from a science text, do not improve the level of questions they generate after reading that text. On the other hand, students who did not improve as much in their ability to recall science texts, generated higher level questions after reading the text. One of the possible explanations for this
negative correlation could be that those students who did not focus on remembering the text, were somehow processing the information in a different way which allowed them to generate questions at the main idea and investigative levels. Or, students who focused on remembering the text, generated questions at the basic and intermediate levels, that is, questions which were taken directly from the content of the text (e.g., After reading a text describing that erosion leaves marks that we can see on the ground, a student generated the following question “¿Por qué la erosión deja marcas en el suelo?” Why does erosion leave marks on the ground? Appendix 6 shows the rubric covering question levels.

Research Question 1C: Does INSCRI READ have an effect on the ability of fourth-grade children to monitor their comprehension as measured by their ability to detect incongruent sentences, before and after controlling for guessing? It is hypothesized that students exposed to INSCRI READ will demonstrate a greater ability to monitor their comprehension than the control group before and after controlling for guessing.

A one-way between groups analysis of covariance was conducted to compare the effectiveness of the INSCRI READ intervention on students’ ability to monitor their comprehension as measured by the total number of sentences they were able to identify correctly as congruent or incongruent (part A). The independent variable was the group students belonged to (treatment or control) and the dependent variable was student scores from the total number of sentences correctly identified in the detecting incongruities measure. Participants’ Spanish reading levels before the intervention were used as the covariate in this analysis. As shown in Table 11, the treatment group’s adjusted mean was
21.72, with a standard deviation of 0.43. The control group’s adjusted mean was 20.14, with a standard deviation of 0.66.

After adjusting for preintervention Spanish reading levels, the results show a statistically significant difference between the treatment and the control groups on postintervention scores in the total number of sentences correctly identified in the detecting incongruities measure, $F(1,67) = 5.03$, $p = .03$, partial $\eta^2 = .07$ (a moderate effect size according to Cohen’s 1988 guidelines). The adjusted mean scores are shown in Table 11. Therefore, the results support Hypothesis 1C.

The number of correct detections of incongruous sentences, corrected for guessing, was also used as a follow-up for this measure (part B). Once again one-way between groups analysis of covariance was conducted to compare the effectiveness of the INSCIREAD intervention on students’ ability to monitor their comprehension as measured by the number of correct detections of incongruous sentences, controlling for guessing. The independent variable was again the group students belonged to (treatment or control) but the dependent variable this time was the scores representing the total number of incongruent sentences correctly identified in the detecting incongruities measure, minus three times the percent of times a student said “no” when evaluating if the sentence made sense in the story (the percent was first transformed to a decimal). Participants’ Spanish reading level before the intervention was also used as the covariate in this analysis. In this case, the treatment group’s mean was 1.31, with a standard deviation of 0.12, whereas the control group’s mean was 0.89, with a standard deviation of 0.18 (see Table 11).
After adjusting for preintervention Spanish reading levels, there was no significant difference between the treatment group on postintervention scores in the total number of incongruent sentences correctly identified after controlling for guessing in the detecting incongruities measure, $F(1,67) = 3.76, p = .06. \eta^2 = .05$ (a small effect size according to Cohen’s 1988 guidelines). The results of the adjusted means are shown in Table 11 and indicate that, when controlled for guessing, they do not support Hypothesis 1C.

Research Question 1D: Does INSCIREAD have an effect on fourth-grade children’s ability to summarize and rate importance? It is hypothesized that students exposed to INSCIREAD will demonstrate a greater ability to summarize and rate importance than the control group.

A one-way between groups analysis of covariance was conducted to test this hypothesis. The independent variable was the group students belonged to (treatment or control) and the dependent variable was student scores from the summarizing and rating importance measure completed at the end of the treatment. Participants’ Spanish reading level before the intervention was used as the covariate in this analysis. As shown in Table 11, the treatment group’s mean was 6.75, with a standard deviation of 0.31, whereas the control group’s mean was 4.21, with a standard deviation of 0.48.

After adjusting for preintervention Spanish reading levels, the analysis of the results shows a statistically significant difference between the treatment and the control groups on postintervention scores for summarizing and rating importance, $F(1,67) =
18.97, \( p = .01 \), partial \( \eta^2 = .22 \) (a large effect size according to Cohen’s 1988 guidelines). These adjusted results are shown in Table 11 and support Hypothesis 1D.

The results of the point biserial correlation coefficient calculated among all quantitative measures show a significant positive correlation between science text recall and summarizing and rating importance (\( r = .40, p = .01 \)). This correlation suggests a relationship between Hypotheses 1A, which states that students exposed to INSCIREAD will show higher text recall scores than those of the control group, and 1D, which states that students exposed to INSCIREAD will demonstrate a greater ability to summarize and rate importance than the control group. Students’ improved ability to summarize and rate importance can be expected to translate into a better ability to recall the more important information (pausal units) from a text (see Table 12).

Research Question 2: Does INSCIREAD have an effect on the number of misconceptions fourth-grade children identify, as shown by descriptions and illustrations they create to answer open-ended questions? It is hypothesized that students exposed to INSCIREAD will hold fewer misconceptions after the intervention than before.

To address Research Question 2 the number of misconceptions in students’ work before and after the intervention was tallied, using the systemic network shown in Figure 15. This figure includes the results from students with special needs and with no special needs. However, data from students with special needs are discussed as part of the single subject: Study 2. The results in frequency of each misconception for students with no special needs are shown in Figure 16. Confidence intervals were used for testing differences between proportions with dependent samples.
Figure 15. Systemic network of children’s misconceptions about slow geomorphological changes caused by water movement, showing students’ scores.

* = Changes, from pre- to postelicitation stages, which are significant at $p < .05$
Those changes in the total number of each misconception identified before and after the instructional sequence, which were significant at $p < .05$ (1C, 5J, 6D, and 10G) are identified by an asterisk in Figure 15. Misconception 1C refers to the work of students who explain slow geomorphological changes based on unnatural explanations, such as magical or man-made explanations. Misconception 5J is related to ideas in which the student explains slow geomorphological changes based on natural causes, but in relation to accumulation rather than erosion for all landforms. Misconception 6D refers to the idea that forces other than gravity cause water to move. Finally, misconception 10G refers to instances where students assigned a nongeomorphological interpretation to a geomorphological term. Students significantly demonstrated that they had acquired concepts closer to those held by scientists after the intervention in these four areas of misconception. The frequencies and percents for each misconception before and after the intervention for students with no special needs are shown in Table 14. Again, the results of students with special needs are included in this Table, but the discussion appears in the Single Subject: Study 2 section.
Table 14

*Frequency and Percents of Misconceptions From NONSPED Students*

<table>
<thead>
<tr>
<th>Misconception</th>
<th>Frequency</th>
<th>Percent</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>1. C</td>
<td>14</td>
<td>2</td>
<td>29%</td>
<td>4%</td>
</tr>
<tr>
<td>2. E</td>
<td>5</td>
<td>2</td>
<td>10%</td>
<td>4%</td>
</tr>
<tr>
<td>3. H</td>
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<td>7</td>
<td>24%</td>
<td>14%</td>
</tr>
<tr>
<td>4. K</td>
<td>2</td>
<td>2</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>5. J</td>
<td>9</td>
<td>4</td>
<td>18%</td>
<td>8%</td>
</tr>
<tr>
<td>6. D</td>
<td>6</td>
<td>0</td>
<td>12%</td>
<td>0%</td>
</tr>
<tr>
<td>7. I</td>
<td>0</td>
<td>0</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>8. B</td>
<td>6</td>
<td>3</td>
<td>12%</td>
<td>6%</td>
</tr>
<tr>
<td>9. A</td>
<td>1</td>
<td>2</td>
<td>2%</td>
<td>4%</td>
</tr>
<tr>
<td>10. G</td>
<td>18</td>
<td>8</td>
<td>37%</td>
<td>16%</td>
</tr>
<tr>
<td>11. F</td>
<td>7</td>
<td>5</td>
<td>14%</td>
<td>10%</td>
</tr>
</tbody>
</table>

The comparison of the results from the pre-post elicitation stages for students without disabilities showed improvement in 8 out of the 11 misconceptions (see Table 14). The changes in the numbers of misconceptions students had after the intervention indicated that their science concepts and processes had grown more similar to those of geomorphologists.
The frequency of misconception 4K remained stable at 4%. This misconception is related to students using other topics they had learned about in the science class to explain changes caused by water movement. At the end of the intervention, 2 students continued to use the water cycle or states of matter to explain slow geomorphological changes. No students in the group with no special needs held misconception 7I (which remained stable at 0%), showing that they knew water is pulled from high to low by gravity; therefore, this misconception was not statistically analyzed. Finally, misconception 9A, which related to thinking of a river as filling out a previously existing path, was still present after the intervention and, in fact, its frequency increased slightly (from 2% to 4%). The frequency of holding misconceptions before and after the intervention of students with no special needs is shown in Figure 16. The results support Hypothesis 2 for students without disabilities.
Research Question 3: Does INSCIREAD have an effect on the awareness fourth-grade children have of the parallelism and the interdependence of science and reading, as shown by the number of connections they are able to make on a science and reading
concept map? It is hypothesized that students exposed to INSCIREAD will make more connections on a science and reading concept map than control group.

A one-way between groups analysis of covariance was conducted on the number of propositions students were able to write on the concept map. The independent variable was the group (treatment or control) and the dependent variable was the number of propositions they were able to write or draw on the concept map that showed their understanding of the relationship between science and reading. The mean of the results of the Spanish reading level subtests (letter-word identification and the text comprehension subtests) of the Batería Woodcock-Muñoz Test—Revised in Spanish (Woodcock, 1998), were used as the covariate in this analysis. As shown in Table 11, the treatment group’s mean was 3.36, with a standard deviation of 0.20. The control group’s mean was 2.07, with a standard deviation of 0.31.

After adjusting for preintervention Spanish reading levels, the results show there is a statistically significant difference between the treatment and the control groups on the number of propositions they were able to generate to show their understanding of the relationship between science and reading, $F(1,67) = 11.74$, $p = .01$, partial $\eta^2 = .15$ (a large effect size according to Cohen’s 1988 guidelines).

Qualitative Research Questions

Research Question 4 is: How does INSCIREAD impact fourth-grade children’s use of the online cognitive strategies of questioning and self-monitoring as shown by a think-aloud protocol using texts with anomalous sentences?
To address this question, themes in students’ think-aloud protocols were identified, and their statements were classified into these categories as described in chapter 3 (see Think-aloud under the Method section, p. 133). I will present the qualitative findings of the think-aloud protocol analysis using a thematic approach by discussing each of the patterns uncovered during analysis and illustrating them with examples.

As part of the qualitative analysis of the data, students’ statements were classified first under five emergent themes (a) misconceptions and problems with vocabulary, (b) evidence of using monitoring, (c) evidence of using questioning, (d) student uses English to make sense of the text, and (e) other strategies (initial and emerging categories are listed in Table 2, p. 136). A detailed description is presented in the Method section for the think alouds on page 137. The statements classified under the emerging categories of evidence of using monitoring and evidence or using questioning were further subcategorized into subthemes (see Table 3 for the list of subthemes, p. 140). The identified patterns are described below.

There were 202 statements classified as part of the self-monitoring category. Based on the classification proposed by researchers in the field (e.g., Harris et al, 1981; Baker, 1984; Markman, 1979), these statements were divided into two levels. The first level, evaluation, involves deciding whether or not we understand something. The second (more advanced) level, regulation, involves taking appropriate steps to correct whatever comprehension problems were detected.
A total of 92 statements were categorized under evaluation. Examples in this level included statements such as, “Dice hay como rocas y arena, y se las lleva, y después no entiendo tanto.” (It says there are like rocks and sand, and it takes it away, and then I do not understand much.) and “Yo no puedo ver el denomina (entender) cañón.” (I can’t understand it’s called canyon.) The function of 110 statements was classified as regulation. For example, a student recognized lack of understanding and then found a possible explanation for his confusion:

Y que yo no entiende mucho porque, well, yo si entiende pero no es como que dice la misma cosa dos veces, como yo cree que el agua lleva es casi el mismo que erosión, entonces si cuanto más cantidad de agua que lleva el río al bajar por la pendiente, más se erosiona el pendiente, entonces es como la misma cosa. (I don’t understand much because, well, I do understand but it is like it says the same thing twice, like I think that the water carries is the same thing as erosion, so if when there is more water in the river when it goes downhill, more erosion takes place, then it is the same thing.)

In another example a student engaged in self-dialogue to clarify his understanding of the text, saying,

Pero yo no creo que esta pregunta tiene que ver con la vida de un río…Está hablando de erosión, pero éste no es de agua, y este texto no quiere decir no está, no tiene que hablar de erosión de agua, pero sí tiene que ver con erosión.” (But I don’t think this question is related to the life of a river. It is talking about erosion,
but not about water, and this text does not have to be about water erosion, but has
to do with erosion.)

The results of the analysis of the statements classified under questioning follow.

A total of 27 statements were classified under the theme of evidence of using
questioning. Sixteen of the statements (59%) were categorized as intermediate level
questions, the most common type of question used during the think alouds. Examples are,
“¿Qué es empinada?” (*What is steep?*) and “Mmm, ¿Qué tiene muchas fuentes? Yo no sé,
estoy preguntando a mi cerebro cómo se ve una fuente, pero no sé.” (*What has many
springs? I am asking my brain what a spring looks like, but I don’t know.*) Four of the
questions (17%) required the student to do some type of research to answer and were
classified as investigative level questions. For example, “¿Cómo el agua del río gana
fuerza?” (*How does the water from the river get its strength?*) and “Qué le pasa al agua
cuando todo el material está en el terreno?” (*What happens to the water when all the
materials are on the ground?*) In addition, two questions (7%) asked for a synthesis of
the information presented in certain parts of the text (main idea). These questions were,
“¿Qué tienen que ver las cascadas con un río?” (*What is the relationship between
waterfalls and a river?*) and “No, porque dice que es uno de los cañones más grandes del
mundo, y si esta muy, muy grande. ¿Cómo puede ser un meteorito?” (*No, because it says
that it is one of the biggest canyons in the world and if it is very, very big, how can it be a
meteorite?*).

Finally, one question (4%) was classified as basic because it required a yes or no
answer. The question was, “¿Todo ésto está extinguido?” (*All this is extinct?*). Four
questions (17%) did not belong in any of these categories and were coded as other. For example, “How do you say valley?” and “Se puede ir adelante y atrás cuando estás diciéndolo?” (Can I move forward and back when I am talking?).

The fact that most questions were intermediate level (questions which show attempts to clarify words/parts of the text) indicates that most students formed questions to clarify and make sense of the text. It can be inferred that, only when students have been able to comprehend fully the content of the text, will they then be able to form questions at the main idea and/or investigative levels (see Appendix C for the rubric on the level of questions).

The examples of students’ use of questioning as well as the number of statements which were identified in the self-monitoring category are encouraging. The qualitative analysis of students’ statements show they were actively involved with the science text they were reading and they spontaneously engaged in cognitive strategies to help them make sense of the information.

Apart from the qualitative analysis of the data collected from the think alouds, a quantitative analysis of the emerging themes was conducted for triangulation purposes and for help in identifying patterns which reveal how fourth-grade students who went through the INSCIREAD intervention used the online cognitive strategies of questioning and self-monitoring. For the quantitative analysis, students’ reactions to the sentence with the incongruency and to the sentence with the misconception were extracted. Students’ reactions to each of these two researcher-embedded situations were coded separately. Additionally, to measure students’ monitoring ability, a score was assigned to each
category and these scores were summed. The categories, the subcategories, and their corresponding scorings are shown in Table 4 (p. 144). For more detail on the scoring, refer to the Method section.

Table 15 shows the distribution of participants with no special needs, prior to the merging of subcategories, across the categories.

Table 15
Number of Children With No Special Needs in Monitoring Categories for Think Alouds

<table>
<thead>
<tr>
<th>Categories</th>
<th>Incongruency</th>
<th>Misconception</th>
<th>Rereading</th>
<th>Overall Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>II</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>3+1ª</td>
</tr>
<tr>
<td>III</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3+1b</td>
</tr>
<tr>
<td>IV</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>V</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>0-3</td>
</tr>
<tr>
<td>VI</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>14&amp;4</td>
</tr>
<tr>
<td>VII</td>
<td>3+1ª</td>
<td>+1b</td>
<td>0</td>
<td>4-7</td>
</tr>
<tr>
<td>Overall Scoring</td>
<td>0</td>
<td>0-3</td>
<td>18</td>
<td>8-11</td>
</tr>
</tbody>
</table>

Note. Students with no special needs, N = 36
ªAn extra point was awarded to students who referred back to the information presented in the text to explain the misconception. bAn extra point was awarded to students who went back to reread at the place where the incongruency and/or misconception occurred.

To facilitate the analysis of the results, the number of children whose monitoring efforts were in subcategories I and II under incongruency (failed to identify), and subcategories IV and V under misconception (failed to identify), and subcategories VI
and VII under misconception (identified) were combined into a single category.

Additionally, the results for the overall scoring were combined to show only fewer than 3 points or more than 3 points. The number 3 was selected because > 3 points indicates that the student was able at least to identify either the incongruency or the misconception and was, therefore, able to engage in cognitive monitoring during the reading. The combined analyses demonstrate that, in general, more of the students with no special needs than not who participated in the INSCIREAD intervention were able to monitor cognitively their reading (obtain more than 3 points) than not (see Table 16, 9 versus 27). Students with no special needs were more likely to identify the misconception than the incongruency (see Table 16, 11 versus 26).

Table 16

Number of Children in Combined Categories for Think Alouds

<table>
<thead>
<tr>
<th>Category</th>
<th>Incongruency</th>
<th>Misconception</th>
<th>Overall Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I&lt;sup&gt;b&lt;/sup&gt;</td>
<td>I&lt;sup&gt;b&lt;/sup&gt;</td>
<td>V&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>11</td>
<td>10</td>
</tr>
</tbody>
</table>

*Note.* Students with no special needs *N* = 36

<sup>a</sup>An extra point was awarded to students who referred back to the information presented in the text to explain the misconception. <sup>b</sup>Subcategories I, II, IV, and V indicate failure to identify incongruency/misconception. <sup>c</sup>Subcategories III, VI, and VII indicate success at identifying incongruency/misconception.
Finally, Table 17 shows that these results are true independent of whether or not students reread at the incongruency and/or misconception.

Table 17

<table>
<thead>
<tr>
<th>Number of Children With No Special Needs Who Reread Back</th>
<th>&lt; 3 Points Rereading</th>
<th>&gt; 3 Points Rereading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>14</td>
</tr>
</tbody>
</table>

Single Subject: Study 2

This study includes a quasi-experimental design (Campbell & Stanley, 1963) combined with a single subject design, with groups as the unit of analysis. The quasi-experimental design enables a comparison of pre and posttest results, whereas the single subject design is used to compare data collected daily on the text recall protocols. The latter is particularly important for analyzing the data from the students with disabilities, because of the low number of participants.

As explained earlier, in a single subject design, data are collected daily and are generally represented in graphs for analysis. Single subject design is preferred when the focus is on individual analysis, when repeated measurements of the dependent variable can be made, and when the researcher can also be the participants’ teacher (Regan et al.,
2005). However, other researchers have successfully used this particular design when a small group is the unit of analysis to show progress in reading comprehension (Palincsar & Brown, 1984). This study partially replicated the research design used by Palincsar and Brown (1984).

In general, the first phase of single subject design involves collecting and recording baseline data. Baseline data are measures of the level of behavior (the dependent variable) as it occurs naturally, before intervention. The baseline phase continues for several sessions before the intervention phase begins. In most instances, at least 5 baseline data points are collected and plotted.

Trends in treatment data indicate the effectiveness of the multiple baseline design, which is why it was chosen for this study. This is the design of choice when the teacher is interested in using an intervention procedure with more than one individual, setting, or behavior (Alberto & Troutman, 2006).

A functional relationship is assumed if each dependent variable in succession shows a change when, and only when, the independent variable is introduced. Visual analyses of single subject graphs are based on visual inspection of the data and simultaneous consideration of such criteria as the level and trend of the data and variability (Kennedy, 2005).

**Quantitative Research Question**

The quantitative Research Question for the single subject design (Research Question 1A) was: Does explicit instruction of scientific text content and comprehension-fostering cognitive based strategies (questioning and self-monitoring)—INSCIREAD—
have an effect on fourth-grade children’s science text recall? Based on Research
Question 1A, it is hypothesized that students exposed to INSCIREAD will improve their
text recall scores as the intervention is implemented, as shown by visual analyses and
randomization tests.

To meet the requirements of the single subject multiple baseline design, I
collected data on the dependent variable (text recall protocols) under baseline conditions
(with no intervention) for each student. Predetermined data points were randomly
selected. The resulting baseline points were 7, 9, and 10. Therefore, group 1, which
included 4 students with disabilities remained in baseline for 7 data collection points (7
text recalls were collected prior to the intervention) and then started the intervention.
Group 2, which also included 4 students with disabilities, remained in baseline for 2
additional days, until the students had completed 9 text recalls protocols, at which point
they entered the intervention. Finally, group 3 remained in baseline 1 additional day and
started the intervention when group 1 was in their 4th day of the intervention, and group 2
was in their 2nd day. For the data collection to be valid, the same number of data points
had to be collected from all participants; therefore, all groups conducted text recall
protocols until they all had read 15 texts, (even though groups 1 and 2 had finished the
intervention earlier than group 3). The initial plan was for the students to read 16 texts;
however, the last one was not included in the analysis due to missing data.

As part of the single subject design, the data from the daily text recalls was
analyzed using graphs and randomization tests to address the question of whether explicit
instruction of scientific text content and comprehension fostering cognitive based
strategies (questioning and self-monitoring)—(*INSCIREAD*)—had an effect on fourth-grade children’s science text recall.

A final percent was calculated for each text and used for the graphs to allow for visual analysis. All groups went through 3 stages of data collection. The first was the baseline, with 7 days of data collection (daily text recall protocols) for group 1, 9 days for group 2, and 10 days for group 3. The second stage was the *INSCIREAD* intervention for 6 consecutive days. The last stage was maintenance for students in groups 1 and 2 (to ensure all students had the same number of data collection points). These three stages are shown in Figure 11 (p. 196).

Each student’s individual percents from each text recall were added together with those of the other participants in his/her group. The mean scores for all groups are shown in Table 18. Separate analyses were performed for students without special needs (*NONSPED* students) and those with special needs (*SPED* students). See Appendix B for an example of individual scoring.
Table 18

Mean Percents for Each Group in Daily Text Recalls

<table>
<thead>
<tr>
<th></th>
<th>Group 1 (N = 17)</th>
<th>Group 1 (N = 4)</th>
<th>Group 2 (N = 14)</th>
<th>Group 2 (N = 4)</th>
<th>Group 3 (N = 18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text</td>
<td>NONSPED Students</td>
<td>SPED Students</td>
<td>NONSPED Students</td>
<td>SPED Students</td>
<td>NONSPED Students</td>
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<tr>
<td>1</td>
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<td>14</td>
<td>30.27</td>
<td>8.15</td>
<td>26.89</td>
<td>19.88</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>30.25</td>
<td>19.80</td>
<td>30.17</td>
<td>15.90</td>
<td></td>
</tr>
</tbody>
</table>
The results shown in Table 18 were used to create the graphs for visual analysis of the results for Study 2. The graphs showing the results with the level of the data of the groups of students without special needs are presented in Figure 17, and of the groups of students with special needs in Figure 18.

Figure 17 shows the level of the data for students without special needs. The level of the data refers to the average of the data within a condition and is calculated as the mean (Kennedy, 2005). Here, the level of the data indicates that group 1 improved their mean scores by 55.20% compared to their baseline (considering the mean percent for the baseline as 100%, with an improvement of 9.60 percent points), from a baseline mean of 17.40% to a treatment mean of 27.00%. Group 2 improved their mean scores by 3.30% compared to their baseline, from a baseline mean of 9.50% to a treatment mean of 12%. Finally, group 4 improved their mean scores by 4.13% compared to their baseline, from a baseline mean of 19.40% to a treatment mean of 20.20%.

In the case of the groups with students with special needs (Figure 18), group 1 improved their mean scores for the daily text recalls by 26.32% compared to their baseline, from a baseline mean of 9.50% to a treatment mean of 12%). Group 2 improved their mean scores by 24.50% compared to their baseline, from a baseline mean of 13.90% a treatment mean of 17.30%. These data are presented in Table 19.
Table 19

*Mean Percents and Improvement From Baseline to Treatment for Each Group*

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean % Baseline</th>
<th>Mean % Treatment</th>
<th>% Improvement Relative to Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ((N = 17))</td>
<td>17.40</td>
<td>27.00</td>
<td>55.20</td>
</tr>
<tr>
<td>2 ((N = 14))</td>
<td>27.30</td>
<td>28.20</td>
<td>3.30</td>
</tr>
<tr>
<td>3 ((N = 18))</td>
<td>19.40</td>
<td>20.20</td>
<td>4.13</td>
</tr>
<tr>
<td>1 SPED ((N = 4))</td>
<td>9.50</td>
<td>12.00</td>
<td>26.32</td>
</tr>
<tr>
<td>2 SPED ((N = 4))</td>
<td>13.90</td>
<td>17.30</td>
<td>24.50</td>
</tr>
</tbody>
</table>
Figure 17. Graph of the mean percent in text recall and level of the data for students without special needs, group 1 ($N = 17$), group 2 ($N = 14$), and group 3 ($N = 18$).
Figure 18. Graph of the mean percent in text recall and level of the data for students with special needs, group 1 \((N = 4)\) and group 2 \((N = 4)\).

In the case of students with disabilities \((n = 8)\), visual analysis was used to compare the students’ pretest (mean of scores from Texts 2, 3, and 4) and posttest (mean of scores from Texts 12, 13, and 14) scores. The graphical representation is shown in Figures 19 and 20. The analysis of these graphs shows that the mean scores of the 8 students with special needs improved from a mean of 12.7 % to 17.1%.
Figure 19. Line graph showing the pre-post text recall group mean percent for students with special needs.

Figure 20. Bar graph showing the pre-post group mean percent in text recall for students with special needs.
To supplement the visual analysis of the data from the results of students without special needs, a randomization test was conducted. In a randomization test of the prediction that student scores (mean percents) for the text recalls prior to the intervention would increase after the intervention, the proportion of data divisions giving a difference in the predicted direction at least as large as the experimentally obtained difference was .37. Therefore, the difference in the combined scores of students without special needs from the baseline and from the intervention phase was not statistically significant ($p > .05$; one-tailed).

A randomization test with the results of students with special needs was also conducted to supplement the visual analysis. In a randomization test of the prediction that student scores (mean percentages) for the text recalls prior to the intervention would increase after the intervention, the proportion of data divisions giving a difference in the predicted direction at least as large as the experimentally obtained difference was .52. Therefore, the change in the combined scores of students with special needs from the baseline to the intervention phase was not statistically significant ($p > 0.05$; one-tailed).

Additional data on students with special needs were collected and analyzed to document the impact of the *INSCIREAD* intervention on the number of misconceptions students had before and after the intervention. These results show that the number of identified misconceptions decreased for 7 out of the 11 misconceptions (see Table 20). These misconceptions were: (a) misconception 1C (from 25% to 13%), (b) misconception 4K (from 25% to 0%), (c) misconception 5J (from 25% to 0%), (d) misconception 6D
(from 38% to 0%), (e) misconception 7I (from 13% to 0%), (f) misconception 9A (from 13% to 0%), and (g) misconception 10G (from 38% to 0%).

Table 20

<table>
<thead>
<tr>
<th>Misconception</th>
<th>Frequency</th>
<th>Percent</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>1C</td>
<td>2</td>
<td>1</td>
<td>25%</td>
<td>13%</td>
</tr>
<tr>
<td>2E</td>
<td>0</td>
<td>0</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>3H</td>
<td>0</td>
<td>2</td>
<td>0%</td>
<td>25%</td>
</tr>
<tr>
<td>4K</td>
<td>2</td>
<td>0</td>
<td>25%</td>
<td>0%</td>
</tr>
<tr>
<td>5J</td>
<td>2</td>
<td>0</td>
<td>25%</td>
<td>0%</td>
</tr>
<tr>
<td>6D</td>
<td>3</td>
<td>0</td>
<td>38%</td>
<td>0%</td>
</tr>
<tr>
<td>7I</td>
<td>1</td>
<td>0</td>
<td>13%</td>
<td>0%</td>
</tr>
<tr>
<td>8B</td>
<td>0</td>
<td>0</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>9A</td>
<td>1</td>
<td>0</td>
<td>13%</td>
<td>0%</td>
</tr>
<tr>
<td>10G</td>
<td>3</td>
<td>0</td>
<td>38%</td>
<td>0%</td>
</tr>
<tr>
<td>11F</td>
<td>0</td>
<td>0</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Students with special needs tended to write less than the other students when answering the four questions created to elicit students’ ideas on geomorphology, thus diminishing the possibility of their revealing any of their existing misconceptions. These limited responses may explain why these students made no statements containing...
misconceptions 2E, 8B, and 11F and may also obscure the reason for the decrease in misconceptions after the intervention. The semi-quantitative analysis of the data used here will not necessarily clarify whether students with special needs actually acquired concepts more similar to those of scientists or whether they just did not write or draw enough information for the misconceptions to be identified during the postassessment.

At the end of the intervention, misconception 3H, which was related to realizing that erosion continues to take place far beyond the time when it is raining, was present, although it had not been preintervention (from 0% to 25%). There is, then, not enough evidence to support Hypothesis 2 for students with disabilities. Figure 21 shows the frequency of each misconception’s appearance before and after the intervention for the students with special needs.

![Figure 21. SPED students’ frequency of misconceptions.](image-url)
Qualitative Research Question

Research Question 5 is: Does INSCIREAD have an effect on fourth-grade children’s awareness of the parallelism and the interdependence of science and reading, as shown by their answers to interview questions?

To investigate how INSCIREAD impacted fourth-grade children’s awareness of the parallelism and the interdependence of science and reading, 13 students were randomly selected for interviews. This number represented 23% of the total participants. Five of the students interviewed had special needs (39% of the total number of interviewees) and 8 of the students did not (62% of the total number of interviewees). As described earlier, the themes used to categorize students’ answers to the interview questions were: general impressions, ideas on the strategies (questioning, self-monitoring, and others), what students liked the most about the intervention, what they liked the least about the intervention, relationships between science and reading, working in groups/pairs, and ideas in relation to knowing two languages (English and Spanish).

Results from the theme of relationships between science and reading were used to investigate how the INSCIREAD impacted fourth-grade children’s awareness of the parallelism and the interdependence of science and reading.

As described in chapter 2 of this study, the INSCIREAD intervention included two distinct, but interconnected sections. The first section was called Activities to Learn About Geomorphology and included students’ work in the GoInquire system, field visits, taking pictures in the field, and cutting and reassembling of these pictures. Strategies were presented during this section in the science context. The second section was called
Beyond the Active Construction during which the class focused on the collaborative construction of meaning from texts presented to the whole class and the presentation and practice of the strategies in the reading context. Students also had the opportunity to work in small groups to practice using the strategies.

Children’s descriptions of the relationship between science and reading focused on specific examples connecting the two sections of the INSCIREAD intervention. Students’ answers demonstrated that they could make the connection between the first section (focusing more on science) and the second section (focusing more on reading). Students succeeded in seeing a connection across the two contexts in three areas: the content, the learning strategies, and the reading strategies.

First, students discussed how they were learning about erosion in both science and reading. They mentioned specific topics that were introduced in the GoInquire system (science) and reinforced by what they read and did in the second section (reading). This statement by one of the interviewees illustrates this understanding of the parallelism of content, “Mostré donde era alto y bajo, en el computador, y cuando fuimos fuera puedo ver donde hay alto y bajo, y en el texto dice qué es alto y qué es bajo.” (I showed where it was high and where it was low, in the computer, and when we went outside I could see where there was high and low, and in the text it said what is high and low.)

Students also mentioned the similarity of learning strategies across contexts. Students stated that they read, wrote, and could learn in both contexts from the work of others. For example, one of the students mentioned, “En los dos (ciencias y lectura) puedes comparar tus respuestas a las de otros. En el GoInquire ves las respuestas de..."
otros, y en la lectura de textos, puedes mirar pero muchas veces puedes pensar y usar los estrategias con los otros.” (In both [science and reading] you can compare your answers to those of others. In GoInquire you can see others’ answers, and in reading texts, you can look, but many times you can think and use the strategies with the others).

A final reoccurring idea was on the parallelism of strategies used in both science and reading. Students’ comments focused on questioning and self-monitoring. One student who realized questioning was being used in science and reading said, “Hay dos preguntas, como ‘Super Question Bank’ y en los textos escribe preguntas.” (There are two questions, like “Super Question Bank” and in the texts you write questions). The “Super Question Bank” is the part of GoInquire, where students inserted questions they generated as they worked on the pictures from the field and, if desired, answered others’ questions. Students also mentioned using self-monitoring in both contexts. For example, one student explained, “Autocontrolar es como leerlo y escribir todo, y después abajo explicas como no sabes algo y dices, ¡ah! ¿Por qué haces eso y qué es eso?, Y puedes saber más que puedes aprender.” (Self-monitoring is like reading it and writing everything, and then below it you explain what you don’t know and you say, ah! Why do you do that and what is that? And you can know more that you can learn).

In summary, students’ answers from the interviews show that INSCIREAD impacted fourth-grade children’s awareness of the parallelism and the interdependence of science and reading. Specifically, students made this connection in three areas, the content, the learning strategies, and the reading strategies.
Additional data on 4 of the students with special needs were collected and analyzed using think-aloud protocols. The results are shown in Table 21.

Table 21
Number of Children With Special Needs in Monitoring Categories for Think-aloud

<table>
<thead>
<tr>
<th>Incongruity Categories</th>
<th>Misconception</th>
<th>Rereading</th>
<th>Overall Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>I II III IV V VI VII</td>
<td></td>
<td>Yes No</td>
<td></td>
</tr>
<tr>
<td>0 1 2 0 1 2 3+1ª +1b</td>
<td>0 0-3 4-7 8-11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. Students with special needs, N = 4
ªAn extra point was awarded to students who referred back to the information presented in the text to explain the misconception. bAn extra point was awarded to students who went back to reread at the place where the incongruency and/or misconception occurred.

As mentioned earlier, the number of children in categories I and II for the incongruency (failed to identify), and categories IV and V (failed to identify), and categories VI and VII (identified) for the misconception were combined into a single category. Also, the results for the overall scoring were combined to show only fewer than 3 or more than 3 points. Students with more than 3 points were able to engage in
cognitive monitoring during the reading. The combined analyses shown in Table 22 demonstrate that only 1 out of the 4 students with special needs demonstrated the ability to engage spontaneously in cognitive monitoring while reading.

Table 22

<table>
<thead>
<tr>
<th>Category</th>
<th>Incongruency I, II</th>
<th>Misconception IV, V</th>
<th>Overall Scoring &lt;3</th>
<th>&gt;3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0,1</td>
<td>0,1</td>
<td>2, 3 +1ª</td>
<td></td>
</tr>
</tbody>
</table>

Note. Students with special needs N = 4
ªStudents who referred back to the information presented in the text to explain the misconception received an extra point. bCategories I, II, IV, and V indicate failure to identify incongruency/misconception. cCategories III, VI, and VII indicate success at identifying incongruency/misconception.

Finally, Table 23 shows that the student with special needs who demonstrated the ability to engage spontaneously in cognitive monitoring while reading, went back and reread the information at the misconception and/or incongruity pages.
Table 23

*Number of Children With Special Needs Who Reread Back*

<table>
<thead>
<tr>
<th>&lt; 3 Points Rereading</th>
<th>&gt; 3 Points Rereading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

*Social Validity: Interviews*

Because students are required to complete many activities and learn many new things at school, it is not sufficient to demonstrate that the use of *INSCIREAD* was successful at helping students, but it is also important to find out what the participants thought about the intervention. Therefore, students’ answers from the interviews were also analyzed to find out if (a) they liked the intervention and the strategies, (b) they would like to continue using the system and the strategies, and (c) if they thought the intervention and what they had learned had helped them improve their understanding of science texts.

Students explained that they generally enjoyed the intervention. Although they thought it was not always easy, it was worth the effort and they had learned from it. For example, one student mentioned,
Bien, me ha ayudado hacerlo. Me ha ayudado a aprender como el autocontrol, y cuando no comprendo, como trato de entender o mi compañera me ayuda a veces. Sí porque como cuando estamos en el smartboard, con los textos y tú pones como el preguntador o la autocontrol, entonces cuando tú lees es más fácil, como el primer texto era un poquito difícil, pero entonces me acostumbré a hacerlo, haciéndolo. También mucho más como vocabulario, erosión y todo eso.” (Well, it has helped me. It has helped me learn like the self-monitoring, and when I don’t understand, I try to or my partner helps me at times. Yes, because like when we were in the smartboard, with the texts and you asked someone to be the person asking questions to the person self-monitoring, then when you read it is easier, like the first text was a little harder, but then I got used to doing it, doing it. Also much more like vocabulary, erosion and all that.)

Students also talked about the strategies. All but one student expressed having had the most difficulty with understanding and using self-monitoring, for example, “Yo entendía preguntar muy bien, pero no me, en el comienzo yo no entendí autocontrolar, y después yo ya se autocontrolar.” (I understood questioning very well, but it didn’t, at the beginning I didn’t understand self-monitoring, and then, later, I knew self-monitoring.)

Most students also said they would like to continue using the strategies. For example, this student explains where he could use the strategies again, “Sí, porque preguntar y autocontrolar te ayuda a recordar las cosas más fácil, y cuando estoy haciendo un proyecto y no sé que decir, si estoy usando preguntar y autocontrolar se va a poner en mi cabeza más fácil.” (Yes, because questioning and self-monitoring help you
remember things easily, and when I am doing a project and I don’t know what to say, if I am using questioning and self-monitoring, it’s going to stay in my head easier.)

Students particularly liked generating questions, working with a partner or in small groups, working with pictures of a familiar place, using the GoInquire stamps before going out to the field, interacting with the visual part of GoInquire, and working with the computer because “¡era divertido!” (It was fun!)

An aspect of the intervention students did not like or did not find useful was using the highlighter to find the main ideas. One student explained, “A mí no me gusta hacer highlighting porque yo puedo ver unas cosas y decir, ésta es la parte importante y no es solo highlighting el text, porque yo puedo entender y mantenerlo en mi cabeza.” (I don’t like to use highlighting because I can see things and I can say, this is the important part and it is not only highlighting the text because I can understand and keep it in my head). Children also mentioned disliking the dictionary tool. One student explained, “Porque es como, es un poco aburrido porque tienes que pensar en una palabra.” (Because it is a little boring because you have to think about a word.)

In summary, the data from the interviews show that students generally enjoyed participating in the intervention and they found it useful and wanted to continue using the strategies.

Triangulation

As explained earlier, the embedded design was complemented by triangulation of data sources. Triangulation across and within methods was implemented with the intent of reaching more powerful conclusions.
Triangulation of quantitative and qualitative analyses of the data. Data from the level of generated questions and the think aloud were analyzed both quantitatively and qualitatively for triangulation purposes. The quantitative analysis of the level of generated questions was conducted with a paired-samples $t$-test. The results showed a statistically significant increase in student scores for the level of questions they generated from pretest to posttest, $t(48) = 3.29, p = .01$.

In addition, the qualitative analysis of the question level results (see Table 12, p. 212) showed that students wrote more questions at the basic and intermediate levels pretest (74 questions) than posttest (56 questions). Additionally, they were able to write more questions at the main idea and investigative levels posttest (40 questions) than pretest (22 questions). This classification of the student-generated questions is shown in Appendix C. Therefore, the quantitative results, which support the hypothesis (that students exposed to INSCIREAD will generate a higher level of questions in the posttest than in the pretest), are enhanced by the qualitative results of the specific types of questions students generated. The results from both of these analyses should be taken into account when planning classroom interventions.

Qualitative and quantitative analyses from the data of the think aloud were used to answer Research Question 4 which explored how the INSCIREAD intervention impacted fourth-grade children’s use of the online cognitive strategies of questioning and self-monitoring. The quantitative analysis showed that 27 out of the 36 students who went through the think-aloud protocol, got more than 3 points. Only 9 students got fewer than 3 points. These results demonstrate that more students were able to monitor their reading
cognitively at the end of the intervention than not. The results for students with no special needs revealed that they were more likely to identify the misconception than the incongruency. Since the incongruency was more language based than the misconception; the results may have been impacted by language development levels.

The qualitative results of the categorization of students’ questions allow for in-depth analysis of the type of questions students generated while engaged in the think-aloud protocol. The qualitative analysis showed that 16 of the statements (59%) belonged in the intermediate category. These were questions which showed attempts to clarify words/parts of the text. These results suggest that most students formulated questions to clarify and make sense of the text. It can be inferred, then, that only when students are able to comprehend fully the content of the text, will they then be able to formulate questions at the main idea and/or investigative levels.

*Triangulation across quantitative and qualitative measures.* Data from the level of generated questions, detecting incongruities, and the number of misconceptions were triangulated with data from the think alouds. The think-aloud protocols (a) provided information on students’ online level of questions, which can be triangulated with the data from the measure of the level of generated questions; (b) allowed for the investigation of students’ ability to detect incongruities in a more nonverbal and natural way which can be triangulated with the results from the detecting incongruities measure; and (c) allowed the researcher to uncover misconceptions students held after the intervention as they were reading and thinking aloud, this way of uncovering students’
misconceptions supports data from the number of misconceptions measure. These three levels of triangulation across quantitative and qualitative data are described next.

The qualitative analysis of the questions students were able to generate after reading the texts and those they were able to generate during the think alouds, shows that the questions seemed to be more reasonable and more representative of students’ curiosity (moving beyond the mere content of the text) when they arose naturally. For example, during the question generation component of the text recalls, many students focused on questions that had responses in the text they were reading, (e.g., asking after reading a text on weathering, “¿Qué es degradación? What is weathering?). These questions, which focus more on comprehending the actual text, were not present during naturally occurring situations. One explanation could be that students were no longer focused on understanding all the words in the text, so they focused their energy on creating more investigative questions. For example, a student asked the following question during one of our first visits to the field (school grounds), “¿Y si pusieramos un árbol en vez de una planta, ¿pararía más la erosión?" What if we put in a tree instead of a plant, will that stop the erosion of the soil more?

The think-aloud protocols also allowed for the investigation of students’ ability to detect incongruities in a more nonverbal and natural way. Because there were several differences between the think aloud and the detecting incongruities measures, these two sets of results can be triangulated. Data from the detecting incongruities measure were collected in written form; data from the think alouds were oral. Additionally the think alouds provided more and different data on students’ processes as they read. Students
were encouraged to speak about their processes while reading the text and not just when
the sentences did not make sense. The think-aloud methodology also enabled the
collection of nonverbal data (e.g., number of times a student went back to reread/revise
the text).

An additional level of quantitative analysis was conducted to triangulate the data
and to help identify any patterns in how fourth-grade students who participated in the
INSCIREAD intervention used the online cognitive strategies of questioning and self-
monitoring. For the quantitative analysis, students’ reactions to the sentence with the
incongruency and to the sentence with the misconception were extracted. Students’
reactions to each of these two researcher-embedded situations were coded separately.
Also, to measure students’ monitoring ability, a score was assigned to each coded
category and then all scores from each category were summed.

There were four general categories: students’ reactions to the incongruency,
students’ reactions to the misconception, rereading for clarification, and overall
monitoring. The last two categories merit additional explanation. The third category,
rereading for clarification, was chosen both because rereading was part of the
instructional sequence and because this strategy has been shown to represent students’
awareness of a comprehension problem (Alessi, et al, 1979). For the final category,
overall monitoring, each participant’s four scores (four general categories) were added
together to produce a final score representing the student’s monitoring ability. These
general categories and their subcategories are presented in Table 4 and in Table 9 (see
Methods section for more detailed information).
The results of the quantitative analyses of students’ statements while detecting incongruities support the statistically significant results from the detecting incongruities measure. The combination of the data analyses from these measures shows that students improved their ability to detect incongruities as a result of the INSCIREAD intervention.

Finally, the results of the number-of-misconceptions measure are also supported by the think-aloud protocols. The results of the misconceptions measure show students without special needs were able to improve in 8 out of the 11 misconceptions. The results of the quantitative analysis of the think-aloud protocol show 18 out of 36 students (50%) were able to identify the misconception embedded within the text. The triangulation of the results suggests students did develop an understanding of geomorphological concepts more similar to those held by scientists.

*Triangulation of the results of science text recall from Study 1 and Study 2.* The results of the analyses from both designs address the question of whether or not explicit instruction of scientific text content and comprehension-fostering cognitive based strategies (questioning and self-monitoring)—INSCIREAD—have an effect on fourth-grade children’s science text recall (Research Question 1A).

Although it cannot be assumed that what is recalled is necessarily comprehended, and what is not recalled is not comprehended, some kind of relationship does exist between comprehension and recall (Hewitt, 1982). Therefore, improvement in reading comprehension ability can best be inferred from the triangulation of the data across studies.
The first part of Research Question 1A was addressed using two sources of data analysis. One source came from the quasi-experimental part of the study (Study 1), and the second from the analysis of data from the single subject study (Study 2). The quasi-experimental part of the study used a one-way between groups analysis of covariance to find out whether explicit instruction of scientific text content and comprehension-fostering cognitive based strategies (questioning and self-monitoring)—INSCIREAD—had an effect on fourth-grade children’s science text recall. After adjusting for preintervention Spanish reading levels, the results showed there was no statistically significant difference between the treatment and the control groups on post-intervention scores (recalls for Texts 13, and 14), \(F(1,67) = 3.80, p = .06\), partial \(\eta^2 = .05\) (a small effect size according to Cohen’s 1988 guidelines).

The same question was further addressed by the single subject portion of the study. The visual analyses of the single subject graphs indicated that for students without special needs (see Figure 17, p. 238), students in group 1 improved their mean scores by 9.60% points, students in group 2 improved by about 1% points, and students in group 3 improved by less than 1% points from baseline to treatment. In the case of the groups with students with special needs (see Figure 18, p. 239), students in group 1 improved their mean scores by 2.50% points, students in group 2 improved their mean scores by 3.20%. The combination of the results of the ANCOVA analysis and the randomization tests for both groups of students without and with special needs demonstrated that the overall differences were not statistically significant. These results combined with the visual analyses support the lack of significant differences.
However, although the results were not significant, there were students who generally improved their ability to understand science text, as measured by text recall protocols. This is particularly true in group 1 for students without disabilities (55.2% improvement), and students with disabilities in groups 1 (26% improvement) and 2 (23% improvement). Given the nature of strategy training and the development of text comprehension skills, the results are encouraging. Interventions longer than 6 days could yield statistically significant results.

Summary of the Findings

This chapter described the project design, the integrity of the intervention across groups, scoring and reliability, and the data results of the research study. The study focused on upper elementary dual language students and was designed to document the impact of the INSCIREAD intervention on enhancing their awareness of the relationship between science and reading and improving comprehension of scientific text and content knowledge. The INSCIREAD intervention is based on the parallel use of similar cognitive strategies in both inquiry-based science (geomorphology), and reading comprehension. Sixty fourth-grade students took part in this study, including 8 students with disabilities. Three of the 60 students did not fully complete the assessments and/or missed part of the intervention, and their results were, therefore, not included in the analysis. The results of the assessments of a total of 57 students were used for the analyses (49 students without special needs and 8 with special needs). In addition there were 21 students who were in the no-treatment control group. As described in chapter 3, a mixed-methods quasi-experimental design, combined with a single subject design was used to assess the
efficacy of the INSCIREAD intervention. INSCIREAD was used in both studies, but there were differences in the data collected and in the data analysis.

The results of the different assessments and the data analyses showed that students significantly improved in all areas except for their ability to recall parts of science texts. Pre-post test analysis also yielded nonsignificant differences for the measure of detection of incongruities (monitoring ability), when controlling for guessing. A summary of the findings follows.

As mentioned in the triangulation section of this chapter, Research Question 1A was addressed using two sources of data analysis, one from the quasi-experimental study, the other from the single subject study. After adjusting for preintervention Spanish reading levels, the results from the quasi-experimental study yielded no statistically significant differences between the treatment and the control groups on postintervention scores (recalls for Texts 13 and 14), $F(1,67) = 3.80, p = .06$, partial $\eta^2 = .05$ (a small effect size according to Cohen’s 1988 guidelines). On the other hand, the visual analyses of the single subject graphs indicated great variability among and within groups in their progress at recalling science text. The results of the randomization tests for both groups of students without and with special needs demonstrated that the overall differences were not statistically significant.

The second part of Research Question 1B used a paired-samples $t$-test to evaluate the impact of the intervention on the scores of students in the treatment group for the level of questions generated before and after the intervention. The results showed a statistically significant increase generated from the pretest ($M = 3.88$, $SD = 3.83$) to the
posttest ($M = 4.8$, $SD = 4.1$), $t(48) = 3.29$, $p = .01$. The $\eta^2 = .18$ indicated a small effect size. These results show students’ questions improved quantitatively between the pre and posttests.

Research Question 1C was designed to measure the effectiveness of the INSCIREAD intervention at helping students monitor their comprehension, as measured by their ability to detect incongruities. A one-way between groups analysis of covariance was conducted to compare the effectiveness of the INSCIREAD intervention on students’ ability to monitor their comprehension as measured by the total number of sentences they were able to identify correctly as congruent or incongruent. After adjusting for preintervention Spanish reading levels, the results show a statistically significant difference between the treatment and the control groups on postintervention scores in the total number of sentences correctly identified in the detecting incongruities measure, $F(1,67) = 5.03$, $p = .03$, partial $\eta^2 = .07$ (a moderate effect size according to Cohen’s 1988 guidelines). However, when controlling for guessing (subtracting points when students judged too many sentences to be incongruent), there was no significant difference between the treatment group on postintervention scores in the total number of incongruent sentences correctly identified, $F(1,67) = 3.76$, $p = .057$. $\eta^2 = .05$ (a small effect size according to Cohen’s 1988 guidelines). These results may suggest that students in the treatment group tended to overidentify sentences as incongruent. In general, the results of the detecting incongruities measure and those from the summarizing and rating importance (presented next) suggest that the intervention was effective at improving students’ reading monitoring ability.
Research Question 1D used one-way between groups analysis of covariance to study whether or not the INSCRIREAD intervention had an effect on fourth-grade children’s ability to summarize and rate importance. After adjusting for preintervention Spanish reading levels, the results showed a statistically significant difference between the treatment and the control groups on postintervention scores for the summarizing and rating importance measure, \( F(1,67) = 18.97, p = .01 \), partial \( \eta^2 = .22 \) (a large effect size according to Cohen’s 1988 guidelines).

Research Question 2 used confidence intervals for testing differences between dependent samples. The comparison of the results from the pre-post elicitation stages for students without disabilities showed improvement in 8 out of the 11 misconceptions, with 4 of them being statistically significant when analyzed using confidence intervals with dependent measures. The results from students with special needs showed improvement in 7 out of the 11 misconceptions. These results are presented on Figure 17 and on Table 14.

Research Question 3 used one-way between groups analysis of covariance with the number of propositions students generated in a science and reading concept map, to compare the effectiveness of the INSCRIREAD intervention at developing students’ awareness of the relationship between science and reading. After adjusting for preintervention Spanish reading levels, the results showed a statistically significant difference between the treatment and the control groups in the number of propositions they were able to generate to show their understanding of the relationship between
science and reading, $F(1,67) = 11.74, p = .01$, partial $\eta^2 = .15$ (a large effect size according to Cohen’s 1988 guidelines).

Research Question 4 was designed to use qualitative and quantitative analyses of the data collected through think alouds with selected students to study how the INSCIREAD intervention impacted fourth-grade children’s use of the online cognitive strategies of questioning and self-monitoring. The qualitative results suggested that most students asked questions to clarify and make sense of the text.

The quantitative analysis also showed that more students were able to monitor their reading cognitively at the end of the intervention than not. The results of students with no special needs revealed that they were more likely to identify the misconception than the incongruency.

The final question, Research Question 5, was based on the qualitative analysis of the data collected through interviews conducted at the end of the intervention. In summary, students’ answers from the interviews showed that the INSCIREAD intervention impacted fourth-grade children’s awareness of the parallelism and the interdependence of science and reading. Specifically, students made this connection in three areas: the content, the learning strategies, and the reading strategies.

The next chapter is a discussion of the relevance of these findings.
5. Discussion

This chapter provides a brief overview of the intervention and its major findings, followed by a discussion of each of the hypotheses, the limitations of the study, and the possibilities of future research.

The purpose of this study was to describe and set the context for an instructional model designed for upper elementary dual language students, based on the parallel use of similar cognitive strategies in both inquiry-based science (geomorphology), and reading comprehension. The goal of the research study was to help diverse fourth-grade students improve their science content knowledge in geomorphology, their reading comprehension of scientific texts, their awareness of the relationship between science and reading, and their ability to transfer the strategies of questioning and self-monitoring.

This investigation built on the work of others who have examined the benefits to students’ conceptual knowledge of an integrated approach to science and literacy (Guthrie & Ozgungor, 2002; Palinscar & Magnusson, 2001) to provide additional evidence that a combined science and literacy approach to learning science and reading has the potential to benefit dual language learners with and without disabilities in an inclusion environment. This study also attempted to illuminate the characteristics of an effective combined science and reading approach for all learners and the transferability of cognitive strategies that are used in science and in reading to the comprehension of scientific text.
Sixty students, including students with special needs, initially took part in the intervention, 21 of whom were in the control group. At the end of the intervention 3 of the students in the treatment group missing were assessments and were, therefore, eliminated from the data analysis. Data from 49 students without special needs, 8 students with special needs, and the 21 students in the control group were finally used for the analyses with the treatment group. To allow for a mixed method approach and to permit the analysis of larger and smaller groups (students with special needs) of students, the study combined two different designs, a mixed-methods quasi-experimental design (Study 1), and a multiple baseline single subject design (Study 2).

The integration of findings from both designs reveals that (a) although the results were not statistically significant, some of the students in the treatment group appeared to improve their overall ability to understand science text, as measured by text recall protocols; (b) students in the treatment group asked questions of a significantly higher quality as a result of the intervention; (c) the ability of students in the treatment group to monitor their own comprehension, as shown by a measure to detect incongruities, was statistically significant when compared to that of the control group, except when controlling for guessing; (d) quantitative analysis of the improvement in the summaries of science texts written by students in the treatment groups yielded statistically significant results; (e) the number of misconceptions held after the intervention by students (with and without special needs) about the geomorphological changes covered in the intervention decreased from preintervention levels; (f) students’ awareness of the relationship between science and reading, as shown by the number of propositions they
added to a concept map, increased significantly more than that of students in the control
group, (g) the think-aloud analysis indicates that the majority of students were able to
monitor their comprehension effectively after the intervention, and that most of the
students’ generated questions were at the intermediate level (a question concerning a
subordinate idea which would elicit a single-sentence answer from the text); and (h)
students increased their awareness of the parallelism and the interdependence of science
and reading in three areas, the content, the learning strategies, and the reading strategies,
as shown by the postintervention interview data. This data also indicated that the students
generally enjoyed participating in the intervention, found it useful, and would like to
continue using the strategies.

The following section presents a discussion of the results for each research
question and an analysis of the hypotheses. For the purposes of reaching overall
conclusions, the discussion of the results from both the quasi-experimental and the single
subject designs have been integrated.

Discussion of the Results of the Quantitative Research Questions

Hypothesis 1A. Students exposed to INSCIREAD will score higher on science text
recall assessments than the control group. A text recall protocol was used to measure
science text recall ability (a measure of text comprehension). Results were analyzed both
in a quasi-experimental design, with an analysis of covariance to compare the results of
the treatment versus the control groups, and in a single subject design, using visual
analyses and randomization tests.
The results from the text recall data analysis in Study 1, comparing postintervention performance between students in the treatment and in the control groups, showed near significant statistical levels ($p = .055$), after controlling for preintervention differences in students’ Spanish reading levels. Visual analyses of the results from the single subject design showed at least a minimal change in all groups, particularly in group 1 for students without disabilities and for students with disabilities in groups 1 and 2.

The finding that both groups of students with disabilities improved their ability to recall information from science texts is very critical because, as Zohar (2004) explains, the goal of teaching thinking is generally considered appropriate for high achieving students only. It is widely believed that low achieving students, who frequently have difficulty mastering even basic facts and skills, are unable to deal with tasks that require thinking. Such a belief could have enormous impact on instruction, for example, depriving low achievers of precisely the tasks that are so crucial for their development, those requiring higher order thinking. Zohar concludes that, if teachers take this belief about low achieving students to heart, they are likely to focus class work devoted to higher order thinking skills more on high achieving than low achieving students. Consequently, the gap between low and high achieving students would widen, which, as the findings from this study indicate, would be a grave error as low achieving students can benefit from cognitive strategy instruction.

The significant positive correlation between text recall and summarizing and rating importance suggests that, as students improve their skills to summarize and rate
importance, they can be expected to translate this improvement into an improved ability to recall information from a text. This correlation, together with the results from the analyses of the summarizing and rating importance measures, further supports Hypothesis 1A.

Because progression toward inquiry-based instruction and integration of appropriate text-based materials to improve reading comprehension of science instruction represent two nationally significant challenges for teachers (NRC, 2000), I chose to use a topic in one of the areas of need, slow geomorphological change caused by water. This topic is explicitly addressed in the standards. For example, chapter 4, “The Physical Setting,” of the *Benchmarks for Science Literacy* states that children in grades three through five should learn about surface features of the Earth.

The short duration of this intervention (6 days) and the need for research in these areas are assets with respect to the results. In addition, the participants of the proposed study are all dual language learners, learning in English and in Spanish, including 8 with special needs. Due to the challenges presented when both language learners and students with special needs are in the same classroom, these results are encouraging. Recommendations from research include helping both of these categories of students become “fluent with essential factual and conceptual knowledge” (Gersten & Baker, 1998, p. 24), before they have to engage in inquiry-based instruction, and providing them with significant coaching once the instruction has begun (Woodward & Noell, 1992; Mastropieri & Scruggs, 1992). In this research study, I acted on these two recommendations by using modeling and providing multiple opportunities for practicing
new information during the INSCIREAD instructional sequence. In a longer intervention the students would have had more opportunities to practice the content and to be coached.

The results support the top-down or knowledge-based processing theory (Goodman, 1970; Smith, 1978), which describes the reading process as a search for meaning, in which the reader is active. In this case, instruction emphasized the related strategies of questioning and self-monitoring, which resulted in an improved ability to recall text for most students.

*Hypothesis 1B.* Students exposed to INSCIREAD will use a higher level of generated questions in the posttest than in the pretest. This hypothesis was measured by having students in the treatment group generate two or more questions after completing their text recall protocol. They were asked to generate questions during the pretest (Texts 2, 3, and 4), and the posttest (Texts 12, 13, and 14). The analysis of the results was positive, showing that students wrote fewer questions at the basic and intermediate levels during the post than the pretest (56 vs. 74 questions) and more questions at the main idea and investigative levels during the post than the pretest (40 vs. 22 questions).

The qualitative analysis of these same questions and those they generated during class discussions and the think alouds showed that students’ questions were more reasonable. Additionally, questions that arose naturally during class discussion were more representative of students’ curiosity.

The significant improvements in the type of questions students generated demonstrated that young children can successfully generate questions, a finding which could evolve into a fully developed investigation. Consistent with the literature on this
topic, the effort and guidance required to encourage good questions suggests that, at the upper elementary level, formulating questions should be a priority of science education. In fact, in science, the Literature review shows that inquiry into authentic questions generated from students’ experiences is a central strategy for teaching science (NRCl, 1996). Osborne and Wittrock (2007) maintain that generation is a fundamental cognitive process in comprehension. As with questions in reading, students’ questions in science will help them actively construct meaning. People retrieve information from long-term memory, use this information to process strategies to generate meaning from the incoming information, and then send the updated information back for storage to long-term memory (Osborne & Wittrock). Through question generation, the model used in this study helped students in their journey toward long-term memory and, therefore, learning. These findings support Hypotheses 1A and 1B.

In this study, a significant but negative correlation was found between science text recall and question generation ($r = -.33, p = .05$). This finding is notable because it suggests that students who improve their ability to recall information from a science text, do not improve the level of questions they generate after reading that text. It has been documented that instruction in generating questions helps elementary students improve their comprehension of expository and narrative texts (e.g., King & Rosenshine, 1993). The negative correlation in this study suggests that questions do not necessarily need to be high level (i.e., concerning the main idea or requiring independent investigation) levels) to help students improve their comprehension of science texts; questions can be at the basic and intermediate levels. (See Appendix C for an explanation of question levels.)
Hypothesis 1C. Students exposed to INSCIREAD will demonstrate a greater ability to monitor their comprehension than the control group, as measured by the ability to detect incongruent sentences, before and after controlling for guessing. Students’ ability to monitor their comprehension was measured by having them read texts and find the embedded incongruent sentences among the correct ones. The results of this measure, before controlling for guessing, demonstrated statistically significant differences between the treatment and the control groups on postintervention scores in the total number of sentences correctly identified. Therefore, students exposed to INSCIREAD showed a greater ability to monitor their comprehension than students who were not exposed to the intervention.

The results of this measure, however, when controlled for guessing, demonstrated no significant difference between the treatment and the control groups on postintervention scores in the total number of incongruent sentences correctly identified. However, as the results are close to being significant, a larger sample is recommended for follow-up studies. The combination of results from the first (before controlling for guessing) and the second (after controlling for guessing) analyses, suggests that students in the treatment group overidentified incongruent sentences.

The qualitative analysis of students’ explanations supports this finding and also provides further support for the indication that students were actively monitoring their comprehension while reading the sentences, even if they overidentified incongruent sentences. For example, one of the students in the treatment group found the statement that the Grand Canyon was one of the biggest canyons in the world to be incongruent.
Her explanation was, “Yo creo que esto no es verdad porque el Grand Canyon es realmente el cañón más grande del mundo.” *I think this isn’t true because the Grand Canyon really is the biggest canyon in the world.* Thus, apparently her incorrect identification was not due to a misunderstanding of the main idea (that the Grand Canyon is big), but more likely, to an English language misunderstanding, that is, not knowing that the phrase “one of the biggest” does not exclude being the biggest.

Not only did the rate of detecting incongruities improve in the treatment group, but so did the quantity and the quality of written statements explaining the incongruities. During pretesting, two typical explanations of incongruities were, “No hay nada que ver con el título.” *(It has nothing to with the title.)* and “No habla de la misma cosa.” *(It isn’t talking about the same topic.)* In contrast, during the posttest, even when the students incorrectly evaluated a congruent line as incongruent, their reasoning was more illustrative of high level thinking and more connected to what they had learned during the INSCIREAD intervention. For example, after incorrectly labeling as incongruent a correct sentence explaining how glaciers erode because of their large size and weight, a student wrote, “Porque dice que por su gran tamaño y peso puede erosionar más fácilmente, pero es muy compacto y las cosas más duras y compactas se erosionan más lentamente.” *(Because it says that because of its big size and weight it can erode more easily, but it’s very compact and the hardest and most compact things erode more slowly.)* In another example, after a reading a text about how water erodes rocks, a student evaluated as incongruent a correct sentence describing the formation of the Grand Canyon by water erosion, including the information that the Grand Canyon is 1.6 kilometers deep. The
student explained, “No necesito saber la profundidad que tiene” (*I don’t need to know its depth.*) Both examples provided here give insight into students’ reasoning and suggest that their answers are not indicative of a misunderstanding of the main idea.

The results of the analysis conducted before the controlling for guessing are consistent with those of a study by Palincsar and Brown (1984), who found that the rate of detecting incongruities improved in the group who underwent an intervention based on cognitive reading strategies (Reciprocal Teaching). The researchers also reported improvement in the quality of verbal responses of these students. In the present case, the fact that the analysis of the results when controlling for guessing resulted in nonstatistical significance, suggests that these students might have been overly suspicious of the veracity of the information in the text as a result of the intervention. The results nonetheless show the efficacy of the intervention at helping students monitor their reading comprehension.

This is a key finding. In fact, Harris et al. (1981), when looking at students’ ability to monitor their understanding, found that 8-year-olds handled a recall task but failed to tag problematic lines, thereby creating difficulties in the comprehension monitoring task, which, in turn, impacted their ability to recall the information in the text. This study directly addressed students’ ability to identify incongruent sentences as they read relevant texts, including selections which challenged misconceptions that had already been identified and/or conclusions they generated while working in science.

Teaching metacognitive skills in reading is also important because research has shown that there is a relationship between metacognitive awareness and reading ability.
(Paris & Jacobs, 1984). In addition, it has been suggested by the literature in bilingual education that students who speak more than one language have an enhanced awareness of different linguistic codes, a skill which translates into cognitive flexibility (Cummins, 2001).

**Hypothesis 1D.** Students exposed to INSCIREAD will demonstrate a greater ability to summarize and rate importance than the control group. Students’ ability to summarize and rate importance was measured by having students read short pieces of science text and then select the most important ideas, crossing out unimportant ones and then writing a summary. The results showed a statistically significant difference between the scores of the treatment and the control groups on the postintervention assessment of summarizing and rating importance. These results are consistent with those of the study by Palincsar and Brown (1984), which is partially replicated in this study.

Others researchers have published similar results. For example, Kolic-Vehovec (2004) found significant improvements in summarizing abilities in an experimental group that had cognitive strategy training. Padrón (1992) used the *Reading Strategy Questionnaire* (Waxman & Padrón, 1987) as an assessment tool; his results showed that students who participated in the Reciprocal Teaching groups did better than those who did not on the strategies of self-generated questions and summarizing. His findings are consistent with those from the summarizing and level of questioning from this research study. The results of the present study showed that similar improvement could take place with dual language learners when enough background knowledge and opportunities for modeling and practicing are provided.
It is notable that the results of the point biserial correlation coefficient calculated between all quantitative measures show a significant positive correlation between science text recall and summarizing and rating importance. Findings from research conducted with English as a second language students have indicated that students who are taught cognitive strategies may use fewer weaker strategies (Padrón, 1992b). This is an important finding in support of strategy training for bilingual students as previous research has found that the use of weaker strategies is negatively related to students’ gain in reading comprehension (Padrón & Waxman, 1988). The high correlation between students’ ability to recall information from science texts (a measure of reading comprehension), and their ability to summarize and rate importance shows that it is, indeed, the case that students improve their reading comprehension as they receive instruction in and apply cognitive strategies.

*Hypothesis 2.* Students exposed to INSCIREAD will hold fewer misconceptions after the intervention than before. Research Question 2 focused on the science learning of the students by looking at the misconceptions they had before and after the intervention. For the purposes of this study, misconceptions were defined as prior concepts by which individuals explain concepts and processes in the physical world (Kendeou & van den Broek, 2005). Misconceptions were spotlighted in this study because they can differ so fundamentally from the concepts the teacher is trying to convey that they hinder learning (Alvermann et al., 1985).

The intervention proved efficient in helping all students decrease the number of misconceptions they about a geomorphological topic. The intervention was most
successful at helping students understand that natural causes are responsible for many landform changes. At the beginning of the intervention, when asked about the formation of the Grand Canyon, many students wrote or drew answers indicating a belief in unnatural or catastrophic explanations, such as the explosion of a meteorite or an attack by aliens. After the intervention, most students, including those with special needs, showed a more mature understanding of water erosion. In addition, the combination of activities involved in the intervention helped students understand that water moves from high to low, pulled by gravity.

These findings are far from trivial: As noted above, students’ conceptions prior to teaching can be markedly different from the concepts of the teaching program, and according to Andersson (1986), these concepts develop only to a minor extent as a result of teaching. In fact, these prior concepts have been found to be very resistant to change (Ausubel, 1968) and to hinder learning from text (e.g., Alvermann et al., 1985). Further, Ault (1994) explained that without a shared purpose (or without awareness of another’s purpose), shared meaning of concepts is unlikely. Therefore, the fact that the intervention was effective at helping students share the meaning of concepts with geomorphologists is an important step in the right direction.

One last important conceptual change took place in students’ interpretation of scientific language. For example, several students when asked before the intervention what erosion, transportation, and deposition had in common, gave explanations involving transporting people in vehicles. The intervention appeared to have helped students
develop their ability to interpret a multidefinition word appropriately in a scientific context.

In relation to the linguistically diverse population included in this research study, it is important to point out that the instructional model proposed here was based on the idea that culturally or linguistically different students bring with them to school intellectual resources which can be utilized in the classroom. The Spanish-English cognates are a fund of knowledge that can be used to bridge community with classroom ways of knowing, and therefore these were explored during the intervention. As part of the intervention, students were also encouraged to use their knowledge of two languages (English and Spanish) to figure out the words. The word transportation is very similar to the word transporte in Spanish. If students know a cognate in their first language, they may be able to figure it out from the context.

**Hypothesis 3.** Students exposed to INSCIREAD will make more connections on a science and reading concept map than the control group. Awareness of the relationship between science and reading was measured by having students in the intervention and control groups write and draw on a concept map to show their understanding of this relationship. The results showed students in the treatment group made significantly more connections than those in the control group.

In addition, the positive correlation between summarizing and rating importance and the connections students establish on a concept map between science and reading suggests that, as students improved their ability to state the relationship between science and reading, they also refined their ability to use that understanding to identify the
important information in a science text. The correlation supports both Hypothesis 1D (summarizing and rating importance) and Hypothesis 3 (number of connections made on a concept map).

According to the literature, the construct of cognitive flexibility as demonstrated by the flexible use of cognitive strategies in two contexts, reading and science, supports access to long-term memory. This finding is important because the integration of language skills and science was shown in the Literature review to be beneficial and necessary (Barber et al., 2006). For example Rivard (2003) made the case for including more activities involving language and higher order thinking skills in the diverse science class. It cannot be overemphasized that the literature on bilingual education underlines the cognitive flexibility of bilingual or multilingual people, due to their enhanced awareness of different linguistic codes (Cummins, 2001). Helping dual language learners become aware of this cognitive flexibility, then, is a brick in the critical path towards helping these learners transfer cognitive strategies across contexts.

Qualitative research question 4. How does INSCIREAD impact fourth-grade children’s use of the online cognitive strategies of questioning and self-monitoring as shown by a think-aloud protocol using texts with anomalous sentences?

The data from the think-aloud protocols using texts with anomalous sentences further confirms the findings that the INSCIREAD intervention helped students actively monitor their reading comprehension. Students generated statements indicating they were spontaneously using self-monitoring several times during the think-aloud protocols. This is a significant finding given the evidence in the literature indicating that, in general,
students can handle the text recall protocol, but not the monitoring (Harris et al., 1981). In fact, research has shown that students of all ages are often surprisingly poor at monitoring their understanding of texts (Baker, 1989). Further, the finding that students evaluate and regulate is encouraging, particularly given the scientific nature of the texts students were reading. Otero (1998) explains that difficulties with monitoring are most apparent when students are asked to read information text, such as science books (Otero, 1998).

In addition, the results of the qualitative classification of students’ spontaneously generated questions showed that most students generated questions at the intermediate level. These results also confirm the idea that at the upper elementary level the science class should focus on the generation of appropriate questions, which could then evolve into a full inquiry cycle, an idea suggested above by the results of Research Question 1B. It was notable that students with special needs had more difficulty identifying the incongruency than the misconception. This finding suggests that the intervention helped students develop more elaborate ideas in the context of slow geomorphological changes, but that some students were sometimes hindered by language and may need assistance in decoding.

More specifically, the quantitative and qualitative analyses of students’ think alouds suggest that combining more than one standard when monitoring their comprehension of science texts helps them identify incongruencies and misconceptions. The results also showed that those students who applied a lexical standard and, therefore, identified an unknown or difficult vocabulary word in the text, had to first clarify the
meaning of the word prior to being able to continue applying the internal and external
dimensions of comprehension monitoring. There seemed to be a pattern in the way
students applied the different dimensions of monitoring. Those who needed to apply the
lexical standard always started with that one. Then, among those students who applied
the external standard, their think alouds revealed that they did not refer back to the text,
so they failed to apply the internal consistency standard. Finally, those students who
applied the internal standard, seemed to be very familiar with the information they were
reading (had the prior knowledge), but chose to back up their commentaries by referring
to extracts from the text. There were students who, after applying the lexical standard,
demonstrated they were applying the internal standard. For these students, it was not
clear whether they were also using their prior knowledge, and therefore applying the
external standard as well. It can be inferred that there is a natural sequence of acquisition
of these different standards. The application of the standards starts at an emergent level
with application of the lexical standard (least sophisticated), progresses to the
intermediate level with application of the external standard (prior knowledge), and
finally, the data suggests that the most sophisticated stage takes place when students
apply the internal consistency standard (checking their comprehension against
information previously read).

This lexical standard is often not very effective with scientific texts due to the
high frequency of technical and uncommon terms. It is not always possible to figure out
the meaning of a word embedded in a text. Students who apply the lexical standard might
stop monitoring their comprehension when they meet a roadblock. In fact, the research in
comprehension monitoring reveals a relationship between poor reading skills and applying the lexical standard. For example, Garner (1985) found that poor readers in the fifth grade were more likely to evaluate passages word for understanding than for internal consistency.

It is important to interpret the results in the context of the research on bilingual learners. It can be assumed that dual language students who are reading a science text written in their weakest language will need to apply a lexical standard more often than if they were reading in their stronger language. However, it is essential that students be encouraged to apply other standards of comprehension monitoring. Jiménez et al. (1996) suggest that bilingual students need reassurance that not knowing some vocabulary is to be expected and that they will need to determine the relative importance of unknown words. The results from the think alouds conducted in this investigation show that dual language learners who have been studying the topic they are now reading about, and who have also received instruction in comprehension monitoring strategies, can successfully monitor their comprehension at advanced levels, using different dimensions, with little or no prompting.

As mentioned earlier, the literature indicates that bilingual students may demonstrate some linguistic advantages due to their cognitive flexibility (Cummins, 2001). Some theorists have even speculated that bilingualism may actually enhance children’s capacity for conscious introspection (Jiménez et al. 1996). Jiménez et al. also explored the question of how Spanish/English bilingualism and biliteracy affect, and even enhance, metacognition. The results of this and other data indicate that dual language
students are capable of demonstrating deep processing of a scientific text in their weakest language and, they can, therefore, learn from a text while they are developing their language skills. These findings were suggested earlier in the literature of second language acquisition (e.g., Bernhardt & Kamil, 1995).

The combination of the qualitative and quantitative analyses of data from the think-alouds indicates that students who participated in the think-aloud protocols were able to apply the strategies of self-monitoring and questioning successfully to actively make sense of science texts.

Qualitative research question 5. Does INSCIREAD have an effect on fourth-grade children’s awareness of the parallelism and the interdependence of science and reading, as shown by their answers to interview questions?

Interview data were analyzed to answer Research Question 5. The qualitative analysis of the data confirmed the results from data collected earlier in the intervention and reinforced the idea that students’ awareness of the relationship between science and reading was enhanced as a result of the intervention. These findings, which are consistent with the general monitoring skills hypothesis (Schraw & Nietfeld, 1998), showed that students were able to make connections in relation to the content, the learning strategies, and the reading strategies shared by both contexts. Studies in cognitive strategies provide evidence that these strategies are general and global, rather than domain-specific (Chi, 1987). Metacognitive theorists assert that it is our metacognitive knowledge which enables us to perform as independent learners with the ability to adapt our cognitive activity to different settings (Gavelek & Raphael, 1985). These findings imply that when
students learn these strategies, they will be able to transfer and use them for better understanding of texts they are reading and for better meaning making of the science content while working in science.

Further, studies have indicated that English as a second language students’ perceptions of the cognitive strategies that they use have predictive validity with respect to their reading comprehension (Padrón & Waxman, 1988; Padrón, 1992a). In addition, the literature indicates that successful bilingual readers possess a special awareness of the relationship between the languages they know that enables them to use the bilingual strategies of searching for cognates, transferring, and translating (Jiménez et al. 1996). Just as bilingual students use strategies to function successfully in two different languages, they develop the ability to use strategies to function in two different contexts. This ability is reflected in the present study.

Limitations

This study like any other research was limited by the prior beliefs and prejudices of the researcher. In fact, as already mentioned in the introduction to this research study, measurement and actual meaning are two different things. In an effort to increase the validity of this study, multiple data collection sources were used to triangulate the quantitative data, and multiple methods were implemented to analyze the same data. I drew on two inferences from Brewer and Hunter (2006) to try to close the gap between measurement and meaning: The first is that multiple operationism is required to learn what a concept means, and the second is that measures must be compared to determine which of a concept’s various implications are sufficiently related to be useful within a
single construct. For example, to measure students’ science learning and progress toward more scientifically-based views, a quantitative component was used to measure students’ responses to open ended questions. At the same time, students showed their understanding of slow geomorphologic process by drawing and writing on a picture.

These data were then analyzed qualitatively to detect the progression of students’ thinking. The measure of reading comprehension used here provides another example of an attempt at narrowing the measurement-meaning gap. It is helpful here to bear in mind Hewitt’s cautious appreciation of the connection between comprehension and recall. He states that although it cannot be assumed that what is recalled is not comprehended and what is not recalled is not comprehended, there is some kind of relationship between recall and comprehension (1982). Given the complexity of the construct of reading comprehension and the results from the pilot study, data from the quantitative analysis from text recalls, which were used to measure the off-line products, additional data from online processes, were collected in the form of think alouds (Kendeou & Van Den Broek, 2005; Pressley & Afflerbach, 1995).

Another threat to validity, the reliance on humans to create the pausal units from the texts and score students’ text recalls, was addressed by reaching interobserver agreement. To establish the hierarchy of the texts into ranked pausal units, a second observer (I was the first.) also divided 100 of the texts and then we discussed and compared the results. In the case of the scoring of students’ written text recalls, a second observer scored 42% of the data and the interobserver agreement was calculated.
I was able to sidestep, to some extent, an important concern in data collection with respect to dependent measures, that is, that the researcher cannot objectively establish the degree to which an intervention is implemented with fidelity. Following Kennedy’s (2005) recommendation, I collected the data on the implementation of the independent variable. Additionally, by serving as the teacher-researcher, I eliminated variables related to changes in a teacher’s style or classroom interactions. In addition, I created a checklist detailing the steps to follow during the intervention and kept it with me as I conducted the intervention. To further ensure all groups received the same treatment, all sessions were videotaped and 50% of them were reviewed by a second observer using the checklist.

The effectiveness of the intervention is important, but it was not the only goal sought during this study or studies in general in the social sciences. On par with effectiveness are practicality, interest-level, and enjoyment: Did the participants think the intervention was practical? Will they continue to use it? Did they enjoy it? This study was designed so that the intervention would motivate the students to continue using the strategies and, ultimately, have sufficient mastery to be able to use the strategies in different contexts, long after the conclusion of the intervention. Social validity was addressed by interviewing all students individually after the treatment had ended. In addition, a follow-up data collection was built into the study to provide information on the maintainability of the interventions. An analysis of these data is included in this report.
Finally, one limitation of this study is the variables among participants. In an effort to minimize the effects of these variables, I collected demographic data before the study began and tested all students’ reading levels in Spanish, controlling for existing differences. However, socioeconomic levels and prior experiences do greatly influence students’ academic performance. As diversity in this group was particularly pronounced, given that the parents of some participants were born outside of the United States, clearly there were variables among the participants.

**Future Studies**

As this study only involved 8 students with special needs, future research should further investigate the effectiveness of the INSCIREAD intervention at helping this population of students become more aware of the relationship between science and reading, learn science content, and improve their reading comprehension skills through the use of transferable strategies. In addition, even the results achieved in a short intervention—6 days—are encouraging. Length of the intervention should be taken into account for further investigations based on the INSCIREAD intervention.

In addition, a future study could explore the performance of dual language groups vis-à-vis that of monolingual groups.

Studies investigating the transfer of strategies in other scientific domains and across diverse contexts are needed to improve learning in the United States’ increasingly diverse schools. Teaching students strategies that can be transferred across settings could help relieve jam-packed schedules, address the needs of a variety of students with widely
differing backgrounds, and ultimately let students have some fun while they learn. “¡Era divertido!” (It was fun!).
Appendix A

Matrix at a Glance

*Developing Students’ Awareness of the Interdependence and Parallelism of Cognitive Strategies in Science and Reading: Effect on Students’ Reading Comprehension and Misconceptions*

<table>
<thead>
<tr>
<th>RQ1-A (Quasi-Experimental: Study 1)</th>
<th>Hypothesis</th>
<th>Methodology</th>
<th>Measures</th>
<th>Scoring System</th>
<th>Data Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does explicit instruction of scientific text content and comprehension-fostering cognitive based strategies (questioning and self-monitoring)—INSCIREAD—have an effect on fourth-grade children’s science text recall?</td>
<td>-Students exposed to INSCIREAD will achieve higher text recall scores than the control group.</td>
<td>-Multiple-baseline design with three groups randomly assigned to one of three baselines and three phases: baseline, treatment, and maintenance.</td>
<td>-Text Recall (offline measure of comprehension)</td>
<td>-Hierarchical organization of texts into pausal units, which are awarded points according to level of ideas. Students’ recalls are scored by number of pausal units included, and correct interferences and illustrations. A percentage is calculated.</td>
<td>-Percentage obtained in text recall for treatment group will be graphed, according to baseline with two lines: one for group of students with disabilities (SPED) and one for group of students without disabilities (NONSPEDE). -Graph shows mean pre (baseline)-posttests (maintenance) differences between control, SPED, and NONSPED groups. -Graphs analyzed using visual analyses: level of data. -Randomization test for treatment groups (SPED/NONSPED). -t-Test to check for pretest NONSPED/control group -If no significant differences, t-test for posttest data only. -If significant differences, one-way ANCOVA controlling for pretest. Descriptive Statistics for students with disabilities.</td>
</tr>
</tbody>
</table>
### RQ1-B (Quasi-Experimental: Study 1)
**Does INSCIREAD have an effect on the level of questions fourth-grade children generate?**

<table>
<thead>
<tr>
<th><strong>Hypothesis</strong></th>
<th><strong>Methodology</strong></th>
<th><strong>Measures</strong></th>
<th><strong>Scoring System</strong></th>
<th><strong>Data Analysis</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- It is hypothesized that students exposed to <strong>INSCIREAD</strong> will use a higher level of generated questions in the posttest than in the pretest.</td>
<td>- Immediately after text recall procedure during pre and posttest, students in treatment group are asked to write two questions they would like to answer related to water erosion, transportation and deposition.</td>
<td>- List of student-generated questions from pre and posttest in treatment group.</td>
<td>- Four point scoring rubric (see below).</td>
<td>- <strong>T</strong>-Test before and after the treatment. - Descriptive Statistics for students with disabilities.</td>
</tr>
</tbody>
</table>

- **Hypothesis Methodology**
  - List of student-generated questions from pre and posttest in treatment group.

- **Scoring System**
  - Four point scoring rubric (see below).

- **Data Analysis**
  - **T**-Test before and after the treatment.
  - Descriptive Statistics for students with disabilities.

### RQ1-C (Quasi-Experimental: Study 1)
**Does INSCIREAD have an effect on the ability of fourth-grade children to monitor their comprehension as measured by their ability to detect incongruent sentences, before and after controlling for guessing?**

<table>
<thead>
<tr>
<th><strong>Hypothesis</strong></th>
<th><strong>Methodology</strong></th>
<th><strong>Measures</strong></th>
<th><strong>Scoring System</strong></th>
<th><strong>Data Analysis</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- It is hypothesized that students exposed to <strong>INSCIREAD</strong> will demonstrate a greater ability to monitor their comprehension than the control group before and after controlling for guessing.</td>
<td>- Eight texts are be prepared: In six of them, one line is anomalous with the title. - Four of the stories, three with anomalous lines, are presented at pretest, the remainder at posttest. - Students receive a booklet and are asked to circle “yes” or “no” indicating the line did or did not make sense.</td>
<td>- Student's identification of congruent and incongruent sentences in eight pieces of text (four each for pre and posttest)</td>
<td>- Accuracy is defined as the total number of sentences correctly identified as incongruent minus three times the percentage of times a student said “no” when evaluating if the sentences made sense in the text.</td>
<td>- <strong>T</strong>-Test to check for pretest differences of NONSPED/CONTROL group. - If no significant differences exist, <strong>t</strong>-test for the posttest data only. - If significant differences exist, one-way ANCOVA controlling for pretest. - Descriptive Statistics for students with disabilities.</td>
</tr>
</tbody>
</table>

- **Hypothesis Methodology**
  - Accuracy is defined as the total number of sentences correctly identified as incongruent minus three times the percentage of times a student said “no” when evaluating if the sentences made sense in the text.

- **Scoring System**
  - Accuracy is defined as the total number of sentences correctly identified as incongruent minus three times the percentage of times a student said “no” when evaluating if the sentences made sense in the text.

- **Data Analysis**
  - **T**-Test to check for pretest differences of NONSPED/CONTROL group.
  - If no significant differences exist, **t**-test for the posttest data only.
  - If significant differences exist, one-way ANCOVA controlling for pretest.
  - Descriptive Statistics for students with disabilities.
### RQ1-D (Quasi-Experimental: Study 1)
**Does INSCIREAD have an effect on fourth-grade children’s ability to summarize and rate importance?**

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Methodology</th>
<th>Measures</th>
<th>Scoring System</th>
<th>Data Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>-It is hypothesized that students exposed to INSCIREAD will demonstrate a greater ability to summarize and rate importance than the control group.</td>
<td>-Passages used for the detecting incongruities measure are in their original form. -Students are asked to delete $N$ lines (¼ of the text) by crossing out least important information, examples, or redundant lines with colored pencil. -They highlight $N$ lines (¼) which are most important lines. -Students write main idea of the text.</td>
<td>-Students’ work on passages with deleted and highlighted lines, and their summaries. -Two texts for posttest only.</td>
<td>-Independent raters score students’ work and summaries: -1 point if summary uses the highlighted sentences only. -1 point for inventions/connections rated as important. -Total number of points from pre and posttest tallied and compared.</td>
<td>-$T$-Test to check for pretest differences of NONSPED/CONTROL group. -If no significant differences exist, $t$-test for posttest data only. -If significant differences exist, one-way ANCOVA controlling for pretest. -Descriptive Statistics for students with disabilities.</td>
</tr>
</tbody>
</table>

### RQ2 (Quasi-Experimental: Study 1)
**Does INSCIREAD have an effect on the number of misconceptions fourth-grade children identify, as shown by descriptions and illustrations they create to answer open-ended questions?**

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Methodology</th>
<th>Measures</th>
<th>Scoring System</th>
<th>Data Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>-It is hypothesized that students exposed to INSCIREAD will hold fewer misconceptions after the intervention than before.</td>
<td>-Students answer four open-ended questions and are asked to write and/or draw to show their thinking. -Exercise conducted pre and postintervention</td>
<td>-Students’ drawings and words showing their answers to four-open ended questions</td>
<td>-Most frequent misconceptions are identified by reviewing students’ answers and tallying frequency. -Responses are scored according to number of listed misconception in their responses to open-ended questions.</td>
<td>-Prior Knowledge-numerically categorized in form of misconceptions pre and postintervention -Systemic network to allow for semi- quantitative analysis. -Confidence intervals for testing differences between proportions with dependent samples to check for significant differences. -Descriptive Statistics for students with disabilities.</td>
</tr>
</tbody>
</table>
RQ3 (Quasi-Experimental: Study 1)

**Does INSCIREAD have an effect on the awareness fourth-grade children have of the parallelism and the interdependence of science and reading, as shown by the number of connections they are able to make on a science and reading concept map?**

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Methodology</th>
<th>Measures</th>
<th>Scoring System</th>
<th>Data Analysis</th>
</tr>
</thead>
</table>
| -It is hypothesized that students exposed to INSCIREAD will make more connections on a science and reading concept map than control group. | -Students create a conceptual map after the intervention showing understanding of relationship between science and reading and how strategies can be applied across contexts. | -End of treatment conceptual map showing students’ understanding of interconnection between science and reading. | - Number of elements and connections in conceptual maps of students in the treatment and control groups are analyzed | - T-Test to check for pretest differences of NONSPED/CONTROL group.  
- If no significant differences exist, t-test for posttest data in the concept map only.  
- If significant differences exist, one-way ANCOVA controlling for pretest.  
- Descriptive Statistics for students with disabilities. |
**RQ4** (Quasi-Experimental: Study 1)

**How does INSCIREAD impact fourth-grade children’s use of the online cognitive strategies of questioning and self-monitoring as shown by a think-aloud protocol using texts with anomalous sentences?**

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Methodology</th>
<th>Measures</th>
<th>Scoring System</th>
<th>Data Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Students read text shown sentence by sentence in accordion-like pamphlet. They are asked to think aloud after each asterisked sentence.</td>
<td>- Individual think-aloud protocols of each student (online measure)</td>
<td>- Think alouds are transcribed and analyzed using open coding and systemic networks.</td>
<td>- Open coded is used to identify evidence of students’ use of strategies in think alouds, dialogues, and explanations.</td>
<td>- Results separated into SPED and NONSPED students.</td>
</tr>
<tr>
<td>- Text includes two anomalous sentences, one targeting a student misconception, the other presenting an incongruency with what students had learned during the intervention.</td>
<td>- Student explanations generated during the “monitoring comprehension” measure.</td>
<td>- Potential Analysis Code for Think Alouds: Adapted from Pritchard, R. (1990)</td>
<td>- Students explanations generated during the “monitoring comprehension” measure are typed and analyzed as above.</td>
<td></td>
</tr>
</tbody>
</table>

**RQ5** (Single Subject: Study 2)

**Does INSCIREAD have an effect on fourth-grade children’s awareness of the parallelism and the interdependence of science and reading, as shown by their answers to interview questions?**

- Randomly selected students are interviewed. Interview consists of a series of open-ended questions.
- Students’ posttreatment answers to interview questions

- Answers to open-ended interviews.

- Answers are analyzed using open coding to look for patterns in students’ responses.
Appendix B

Example of a Scoring Guide for Text 3

<table>
<thead>
<tr>
<th>Pausal Units within Text 3</th>
<th>Value</th>
<th>Retell Sample Student</th>
<th>Student’s Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>la erosión</td>
<td>3</td>
<td>La erosión</td>
<td>3</td>
</tr>
<tr>
<td>es el movimiento</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>de rocas y suelos</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>degradados</td>
<td>2</td>
<td>degrada</td>
<td>2</td>
</tr>
<tr>
<td>a veces</td>
<td>1</td>
<td>a veces</td>
<td>1</td>
</tr>
<tr>
<td>la erosión</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ocurre</td>
<td>1</td>
<td>ocurre</td>
<td>1</td>
</tr>
<tr>
<td>muy rápidamente</td>
<td>3</td>
<td>rápido</td>
<td>3</td>
</tr>
<tr>
<td>las olas</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>causadas</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>por una tormenta intensa</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pueden arrastrar</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>la arena</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>de una playa</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>en cuestión de horas</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>una tormenta de polvo</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>intensa</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>puede llevarse</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>toneladas de suelo</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rápidamente</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pero la mayoría</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>de la erosión</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ocurre</td>
<td>1</td>
<td>y a veces ocurre</td>
<td>1</td>
</tr>
<tr>
<td>muy lentamente</td>
<td>3</td>
<td>lentamente</td>
<td>3</td>
</tr>
</tbody>
</table>

Importations 1 En el patio de la escuela había erosión lenta +1
Illustrations 2 No illustration 0

Free Recall Total 52
Score+Importations+Illustrations 12
Free Recall Percent Correct 5200/52= 100%
                                1200/52= 23%

<table>
<thead>
<tr>
<th>Categories</th>
<th>Number of Points</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main</td>
<td>3</td>
<td>Most important ideas: Read consecutively from a text summary</td>
</tr>
<tr>
<td>High Subordinate</td>
<td>2</td>
<td>Ideas which are important to understand the content of the text, but not essential</td>
</tr>
<tr>
<td>Detail Level</td>
<td>1</td>
<td>Least important ideas: Not essential for the comprehension of the text</td>
</tr>
<tr>
<td>Importations</td>
<td>1</td>
<td>Inferences/extensions, prior experience, information from texts/class discussions</td>
</tr>
<tr>
<td>Illustrations</td>
<td>1-2</td>
<td>Manifestations of students’ comprehension which represent an idea from the text</td>
</tr>
</tbody>
</table>
Guide for Scoring Students’ Text Recall:

1. Create the pausal units; a pausal unit has a pause at its beginning and end during normally paced oral reading.
2. Place pausal units on a tree diagram to represent the text organization and hierarchy.
3. Code each clause as the main idea, high subordinate idea, or detail level idea, based on the levels of the tree diagram.
4. Develop weighted analysis by having raters rank each pausal unit in terms of its salience to the message of the text. Main ideas receive 3 points if read consecutively and they form a summary of the text, high subordinate ideas receive 2 points, and detail level ideas receive 1 point.
5. Add the ranks assigned to each pausal unit to calculate a total value for each assessment passage.
6. Record the clausal and hierarchical information for each text on a retelling coding sheet. There are empty lines beneath each text analysis for adding student importations and intrusions. For the purposes of this investigation, importations are “text-related information, but information that is not explicit in the words of a book” (Elster, 1998, p. 54). Importations are categorized as inferences and extensions of text, prior experience, information from other texts in the unit, or class discussion. Erroneous importations, unrelated information, and personal narratives are categorized as intrusions (Stahl, 2003).

The retellings are scored using the coding sheet. Each student’s recall receives four scores, (a) Text Free-Recall (explicit information recall), (b) Importations, (c) Free Recall Total (a total score for text-based clauses and importations), and (d) Intrusions.
Appendix C

4-Point Rubric to Score the Questions and Classification of Questions

Explanation

Collaborative Strategic Reading (CSR) Measure: Generating Questions

**Basic**: Given for a question that is irrelevant, true or false, yes or no, or choice (A/B) (1 point).

**Intermediate**: Given for a question for which the answer is in a single sentence in the text, and is not a main idea. Answer by one or two words or with a definition. Or questions which show attempts to clarify words/parts of the text (2 points)

**Main Ideas**: Given for a question for which the answer is in the text, but involves different parts or sentences and refers to a main idea of the text (e.g., synthesis). Must be answered by at least a whole sentence (3 points).

**Investigative**: Given for a question for which the answer is not directly stated in the text, and to find the answer, students will have to do type of research to answer or they will need to integrate their own previous experiences with what they have learned from the texts and classroom instruction. The question could be answered by planning and conducting an investigation or researching the answer by other means (4 points).
<table>
<thead>
<tr>
<th>Categories</th>
<th>Description</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic</td>
<td>Irrelevant, true or false, yes or no, or choice (A/B) question</td>
<td>1</td>
</tr>
<tr>
<td>Intermediate</td>
<td>The answer is in a single sentence in the text read, one or two words or with a definition, not a main idea. Questions to clarify words from the text</td>
<td>2</td>
</tr>
<tr>
<td>Main Ideas</td>
<td>Answer is in the text, but involves different parts or sentences and refers to a main idea of the text (whole sentence)</td>
<td>3</td>
</tr>
<tr>
<td>Investigative</td>
<td>Answer not directly stated in the text, and answering will require the student to do some research, or integrate previous experiences with information learned in class</td>
<td>4</td>
</tr>
</tbody>
</table>
# Classification of Questions by Pre or Posttest

<table>
<thead>
<tr>
<th>Pretest (texts 3, 4 and 5)</th>
<th>Posttest (Texts 12, 13, and 14)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1 Point</strong></td>
<td><strong>1 Point</strong></td>
</tr>
<tr>
<td>¿Qué son barrancos? Y ¿Para que sirven?</td>
<td>¿Qué es ribera?</td>
</tr>
<tr>
<td>¿Qué es conservar?</td>
<td>¿Qué son riberas?</td>
</tr>
<tr>
<td>¿Qué es degradación?</td>
<td>¿Qué es agua?</td>
</tr>
<tr>
<td>¿Qué es erosión?</td>
<td>¿Qué es degradación?</td>
</tr>
<tr>
<td>¿Qué es un cerro?</td>
<td>¿Qué es erosión?</td>
</tr>
<tr>
<td>¿Qué es degradados?</td>
<td>¿Qué es erosión?</td>
</tr>
<tr>
<td>¿Qué es erosión?</td>
<td>¿Qué son glaciares?</td>
</tr>
<tr>
<td>¿Qué es conservar?</td>
<td>¿Cuántas veces pasa al día?</td>
</tr>
<tr>
<td>¿Qué es degradación?</td>
<td>¿Por qué hay erosión?</td>
</tr>
<tr>
<td>¿Qué es erosión?</td>
<td>¿Cuál es un ejemplo de agua que erosiona?</td>
</tr>
<tr>
<td>¿Qué son y para qué sirven los barrancos?</td>
<td>¿Cómo pueden las olas erosionar las playas?</td>
</tr>
<tr>
<td>¿Qué son barrancas?</td>
<td>¿El agua limpia va al océano?</td>
</tr>
<tr>
<td>¿Qué es erosión causada por el agua?</td>
<td>Los científicos, ¿saben mucho de erosión?</td>
</tr>
<tr>
<td>¿Qué es una barranca?</td>
<td>¿Por qué se llama erosión?</td>
</tr>
<tr>
<td>¿Qué es el proceso de erosión de agua?</td>
<td>¿Por qué necesita ríos?</td>
</tr>
<tr>
<td>¿Qué es erosión?</td>
<td>¿Por qué hay mucha arena o sedimentos si las olas las traen al océano?</td>
</tr>
<tr>
<td>¿Qué es una tormenta de polvo?</td>
<td>¿De donde viene la erosión?</td>
</tr>
<tr>
<td>¿Qué erosión es la causada por el agua?</td>
<td>¿Por qué hay erosión en la tierra?</td>
</tr>
<tr>
<td>¿Qué es un barranco?</td>
<td><strong>2 Points</strong></td>
</tr>
<tr>
<td>¿Qué es erosión?</td>
<td>¿Por qué se llama denominación?</td>
</tr>
<tr>
<td>¿Qué son barrancos?</td>
<td>¿Por qué son importantes?</td>
</tr>
<tr>
<td>¿Qué es una tormenta de polvo?</td>
<td>Cuándo erosiona, ¿por que reduce las montañas?</td>
</tr>
<tr>
<td>¿Va a haber erosión en el futuro?</td>
<td>¿Por qué no mover las playas si hay mucha erosión?</td>
</tr>
<tr>
<td>¿Cómo empezó la erosión? Y ¿Cuándo terminará?</td>
<td>¿Por qué el mar rompe los sedimentos?</td>
</tr>
<tr>
<td>¿Cómo sucede la erosión?</td>
<td>¿Por qué el agua es el principal agente de erosión?</td>
</tr>
<tr>
<td>¿Qué pasa después de la erosión?</td>
<td>¿Por qué toda esta erosión crea un cañón?</td>
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<td>¿Cuántas horas puede durar una tormenta?</td>
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<td>¿Todas las rocas del mundo se erosionan?</td>
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<td>¿Cuáles son ejemplos de erosión rápida?</td>
<td>¿En que dirección empujan las corrientes?</td>
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<tr>
<td>¿Hay un número específico de años que toma erosionar?</td>
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3 Points

¿Qué planta decorativa se puede plantar para evitar la erosión?
¿Por que la erosión puede suceder rápida y lentamente?
¿Puedes conservar el suelo con erosión?
¿Cómo se para la erosión?
¿Dónde se va lo que se erosiona?
¿Cuántos tipos de erosión hay y cuales son

3 Points

¿Cómo gana fuerza el agua?
¿Cómo el agua forma las playas?
¿Por qué el agua rompe la roca?
¿Por qué hay mucha fuerza en el agua?
¿Cómo las olas cambian playa?
¿Cómo cambian las playas en diferentes maneras?
¿Cómo se forman las olas?
¿Qué otros sedimentos hay?
¿Por qué no hacen más playas si han
los tipos?

4 Points
¿En que estación pasa la erosión más rápido?
¿Se pueden hacer los agujeros de los barrancos más profundos?
¿Por qué a veces la erosión sucede más rápidamente?
¿Cuáles son otras maneras de salvar el suelo?
¿Cuál es otro cañón, además del Grand Canyon causado por erosión?
¿Son mejores los árboles para controlar la erosión que las flores de decoración?
¿Cuál es el tamaño del agujero más grande causado por la erosión?
¿Puede una roca de mi casa erosionarse?
Un huracán y un tsunami, ¿causan erosión?
¿En un año de una roca cuantas millas se mueve?
¿Qué velocidad tiene el agua?
¿Qué causa la erosión?
¿Qué pasaría si ocurre un tsunami a la vez que la erosión?
¿Puede un tsunami erosionar?

desaparecido muchas de ellas?
¿Por qué no ponen más arena en las playas?
¿Cuáles son los tipos de sedimentos? ¿Qué rápido se erosionan las cosas?
¿Cuáles son otros ejemplos de sedimentos?
¿Por qué hay muchas conchas en la playa?
¿Puede una corriente mover una roca grande o quitar un árbol?
¿Pueden las olas erosionar una montaña grande?
¿Es el agua el único agente importante en el tema de la erosión?
¿En cuanto tiempo se puede erosionar el suelo?

4 Points
¿Qué parte de la roca se degrada más rápido?
¿Cuándo comenzó el océano?
¿Cuando comenzó la tierra, había agua?
¿Hay algo que resiste la erosión?
¿Cómo las rocas y la grama hacen la river move slower?
¿Cuál es el tamaño más grande de una cascada?
¿Cómo afectan las personas la erosión?
¿Usan las personas la erosión?
¿Los animales necesitan erosión?
¿Es la erosión buena para la tierra?
¿Qué es la parte mala de la erosión?
¿Cómo se lleva la lluvia la arena?
¿El agua dulce erosiona más que el agua salada?
Si pusieramos el agua y el viento en una competición de erosión, ¿Por cuánto tiempo ganaría el agua al viento?
¿Puede ser que el agua se seque porque hay más tierra que agua en algunos lugares?
¿Por qué las olas pierden fuerza?
¿Cómo se hizo tan profundo el Grand Canyon?
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<th>¿Qué otras cosas hacen las olas además de erosionar?</th>
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<td>¿Puede el viento también erosionar?</td>
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## Classification of Questions by Number of Points

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<tr>
<th>Level</th>
<th>Basic (1 point)</th>
<th>Intermediate (2 points)</th>
<th>Main Ideas (3 points)</th>
<th>Investigative (4 points)</th>
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<tr>
<td>Pretest (texts 3, 4 and 5)-96 Questions</td>
<td><strong>38 Questions</strong>&lt;br&gt;¿Qué son barrancos?  ¿En que año comenzó la erosión?  ¿Es la erosión fuerte?  ¿Qué es conservar?  ¿Qué es degradación?  ¿Para que sirven los barrancos?  ¿Qué es conservar?  ¿Qué es degradación?  ¿Qué es erosión?  ¿Qué es un cerro?  ¿Qué es degradados?  ¿Qué es</td>
<td><strong>36 Questions</strong>&lt;br&gt;¿Qué hace la erosión de agua?  ¿Qué pasaría si no hubiera erosión?  ¿Qué hace la erosión del agua?  ¿Qué es el proceso de erosión del agua?  ¿Qué es erosión por el agua?  ¿Por qué es importante el tema de la erosión por el agua?  ¿Cómo sobreviven las plantas del mar con tanta agua?  ¿Qué es el proceso de la erosión de agua?</td>
<td><strong>8 Questions</strong>&lt;br&gt;¿Qué planta decorativa se puede plantar para evitar la erosión?  ¿Qué planta controla más la erosión?  ¿Puede ser mala la erosión?  ¿Por qué la erosión puede suceder rápidamente y lentamente?  ¿Puedes conservar el suelo con erosión?  ¿Cómo se para la erosión?  ¿Dónde se va lo que se erosiona?  ¿Cuántos tipos de erosión hay y cuales son los tipos?</td>
<td><strong>14 Questions</strong>&lt;br&gt;¿En qué estación pasa la erosión mas rápido?  ¿Se pueden hacer los agujeros de los barrancos más profundos?  ¿Por qué a veces la erosión sucede más rápidamente?  ¿Cuáles son otras maneras de salvar el suelo?  ¿Cuál es otro cañón, además del Grand Canyon causado por erosión?  ¿Son mejores los árboles para controlar la erosión que las flores de decoración?  ¿Cuál es el tamaño del...</td>
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<td>tipos de erosión hay?</td>
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| ¿Qué es ribera? | ¿Qué es agua? | ¿Qué es deposición? |
| ¿Qué son riberas? |
| ¿Qué es agua? |
| ¿Qué es deposición? |

| ¿Por qué se denomina? | ¿Por qué son importantes? | Cuándo erosiona, ¿por qué reduce las montañas? |
| ¿Por qué gana fuerza el agua? |
| ¿Cómo el agua forma las playas? |
| ¿Por qué hay mucha fuerza en el agua? |

<p>| ¿Qué parte de la roca se degrada más rápido? |
| ¿Cuándo comenzó el océano? |
| ¿Cuándo comenzó la tierra, había agua? |
| ¿Hay algo que |
| ¿Qué son riberas?       | ¿Por qué hay erosión?                                                                                   | ¿Cómo las olas cambian playa?                                                                                   | resiste la erosión?                                                                 |
| ¿Qué son glaciares?     | ¿Por qué rompe el mar los sedimentos?                                                                  | ¿Cómo cambian las playas en diferentes maneras?                                                                | ¿Cómo las rocas y la grama make the river move slower? |
| ¿Cuántas veces pasa al día? | ¿Por qué el agua es el principal agente de erosión?                                                        | ¿Cómo se forman las olas?                                                                                       | ¿Cuál es el tamaño más grande de una cascada? |
| ¿Por qué hay erosión?   | ¿Por qué toda esta erosión crea un cañón?                                                               | ¿Qué otros sedimentos hay?                                                                                     | ¿Cómo afectan las personas la erosión? |
| ¿Cuál es un ejemplo de agua que erosiona? | ¿Por qué el agua es el principal agente de erosión?                                                        | ¿Por qué no hacen más playas si han desaparecido muchas de ellas?                                              | ¿Usan las personas la erosión? |
| ¿Cómo pueden las olas erosionar las playas? | ¿Por qué el agua empuja?                                                                                | ¿Por qué no ponen más arena en las playas?                                                                    | ¿Los animales necesitan erosión? |
| ¿El agua limpia va al océano? | ¿En qué dirección empujan las corrientes?                                                                | ¿Cuáles son los tipos de sedimentos?                                                                            | ¿Es la erosión buena para la tierra? |
| Los científicos, ¿saben mucho de erosión? | ¿Por qué se llama erosión?                                                                              | ¿Qué rápido se erosionan las cosas?                                                                             | ¿Qué es la parte mala de la erosión? |
| ¿Por qué se llama erosión? | ¿Por qué necesita ríos?                                                                                  | ¿Cuáles son otros ejemplos de sedimentos?                                                                       | ¿Cómo se lleva la lluvia la arena? |
| ¿Por qué hay mucha arena o sedimentos si las olas las traen al océano? | ¿Por qué hay erosión?                                                                                     | ¿Por qué hay muchas conchas en la arena?                                                                        | ¿El agua dulce erosiona más que el agua salada? |
| ¿De donde | Mucha erosión? | ¿Cómo las olas cambian playa? | Si pusiéramos |</p>
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mucha fuerza?
¿Cómo depositan los ríos lo que llevan?
¿Hay playas que midan millas de largo?
¿Traen las olas mucho sedimento?
¿Por qué se forman los cañones?
¿Hay cañones que no tienen agua?
¿Por qué es importante estudiar la erosión?
¿Cambian las olas?
¿Por qué son importantes las olas?
¿Por qué hay muchas conchas, si las olas las traen al océano?
¿Traen las olas animales al océano?
| ¿Cuándo erosión y depósito más arena, más arena lleva cada ola? |   |   |
Appendix D

Detecting Incongruities Measure: Text 1

Modificación de los Accidentes Geográficos

Toda la superficie de la tierra cambia,
Sí No

Los ríos desgastan la roca y producen cañonesprofundos.
Sí No

Las olas erosionan los acantilados, convirtiéndolos en arena.
Sí No

Los glaciares desgastan las cimas de las montañas.
Sí No

Los animales necesitan oxígeno para respirar.
Sí No

Aunque es casi imperceptible, los accidentes geográficos, las características físicas de la superficie del planeta, se transforman.
Sí No
Scoring Sheet for the Detecting Incongruities Measure

GENERAL INFORMATION

Pretest: Posttest:
Total of 26 sentences Total of 26 sentences
Congruent: 23 Congruent: 23
Incongruent: 3 Incongruent: 3
Name or Number _____________________________________________

PART A

Total number of lines which were correctly identified (congruent and incongruent)
Pre Post
______ _________

PART B

Number of correct detections of incongruous sentences MINUS 3 × % of times a student said “no” when evaluating the sentences (Total of “no”s), transformed to a decimal #.
Pre Post
________________________ ___________________
Summarizing and Rating
Importance
Post-Assessment (only)

Name ____________________________

Date ____________________________

Name of Spanish Teacher __________
El hielo en forma de glaciares también puede cambiar los accidentes geográficos. Los glaciares son capas gruesas de hielo que se forman donde cae más nieve durante el invierno que la que se derrite durante el verano. Los glaciares parecen inmóviles, pero se desplazan. Por su gran tamaño y peso, lo erosionan todo a su paso, se llevan el sedimento y lo depositan en otro lugar.

Texto para la casita de muñecas:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
El viento es otro agente de degradación y erosión. El viento puede llevarse trozos de roca y arena, degradar la superficie de las rocas y trasladar el sedimento de un lugar a otro. El traslado del sedimento de un lugar a otro arrastrado por el viento, es lo que llamamos la erosión causada por el viento. Cuando sopla con fuerza, el viento erosiona gran cantidad de sedimento. El viento erosiona más si hay poca vegetación.

Texto para la casita de muñecas:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Appendix F

Most Important Ideas and Ideal Summary for Summarizing and Rating Importance

Text 5
El hielo en forma de 2 glaciares también puede cambiar los accidentes geográficos. 3
Los glaciares son capas gruesas de hielo 3 que se forman donde cae mas nieve durante el invierno que la que se derrite durante el verano. 1
Los glaciares 3 parecen inmóviles, pero 1 se desplazan. 3
Por su gran tamaño y peso, 2 lo erosionan todo a su paso, 3 se llevan el sedimento y lo depositan en otro lugar.1

Model of Summary
Los glaciares, capas gruesas de hielo, cambian los accidentes geográficos. Los glaciares, al desplazarse, lo erosionan todo a su paso. 20 Words
El viento es otro agente de degradación y erosión.

El viento puede llevarse trozos de roca y arena, degrada la superficie de las rocas y trasladar el sedimento de un lugar a otro.

El traslado del sedimento

de un lugar a otro arrastrado por el viento es lo que llamamos la erosión causada por el viento.

Cuando sopla con fuerza, el viento erosiona gran cantidad de sedimento.

El viento erosiona más si hay poca vegetación

Model of Summary

El viento erosiona y degrada al trasladar sedimentos. El viento erosiona más cuando sopla con fuerza y cuando hay poca vegetación.
Appendix G

Written Directions for Raters Scoring the Summary Sheets

Key:
3, essential ideas
2, less essential ideas
1, non essential

- Assign 1 point for each important idea included in the summary and for each non-essential idea deleted. (Brown & Palincsar, 1987)
- Calculate the integration measure (it reflects success in production of short summaries [Garner, 1985]) as follows:
  0 points: no important ideas present
  1 point: important ideas presented in separated sentences
  2 points: Two or more important ideas combined in a single sentence (e.g., “Los glaciares, capas gruesas de hielo, cambian los accidentes geográficos,” from Text 1 postassessment)
- Word count
- Garner (1985) used the number of important ideas and number of words/succinctness measures in her study on text summarization.
Appendix H

Think-aloud Protocol

(Adapted from Magliano & Millis, 2003)

Students read the story one sentence at a time. The sentences were presented on individual cards joined together to form an accordion. Students were allowed to flip the sentences back and forth as they wished. The order in which students moved through the sentences was recorded by the researcher. Reading was self-paced.

The text used as stimulus material was selected at the fourth-grade level according to the Fry Readability formula. The original text was ten sentences long with a title. Three additional sentences were added by the researcher. Two of these sentences included information that was incongruent with what students’ had learned during the intervention. The sentences targeted students’ identified misconceptions. At the end of five of the sentences an asterisk was placed to indicate that students were to say what they were thinking at that point. Two of the asterisks were placed at the end of the incongruent content sentences and the other three at the end of congruent ones. The researcher did not provide feedback regarding the content of the thoughts reported while reading the passage. If the student forgot to think aloud at the pre-determined parts of the text or they only restated the sentence, the experimenter provided one or more of the following prompts:

- “¿Qué estás pensando?”
- “¿Cómo sabes que éso es lo que dice?”

In the event that the student self-corrected while decoding, the researcher asked:
If the student failed to identify the incongruent sentences out loud as such, the researcher used the prompt:

- “¿Cómo sabes que ahí te habías equivocado?”

Introducing the Think Aloud to Students:

“Lee este texto a la velocidad que tú quieras. Puedes volver atrás tantas veces como quieras. Cuando veas un asterisco me dices todo lo que estás pensando, sobretodo lo que te ayuda a entender esa oración en el contexto del texto. Algunas oraciones son correctas y algunas son incorrectas. Intentar averiguar cuáles son las oraciones incongruentes o incorrectas. Si las encuentras, me lo dices y me explicas cómo sabes que son incorrectas. Si necesitas ayuda leyendo alguna palabra yo te puedo ayudar.”
Appendix I

Checklist for the independent variable (intervention)

DAY 1-Focus on System (High and Low)

Explain the intervention to students in general terms: reading, science, think about what you are doing and ask questions to learn about erosion, deposition and transportation. Show posted signs with the two strategies and read them. Explain that we use them in both reading and science (self-monitoring—asking questions, clarifying what I do not understand, selecting important information, synthesizing—and questioning).

Show tray/soil/water and talk about the factors under which the movement of water and soil varies (High/Low; Steep/Shallow; Loose/Compact and Soft/Hard)

Introduce the system with one of the stamps:

Choose one of the stamps

Think and stamp and answer the question

Select other stamp. Think and stamp and answer question

Read what other teams have written

Insert at least one word/definition in dictionary

Insert at least one question in the question bank

I will be asking about the words at the end of the activity

After two stamps, you will write a synthesis page. Explain

Distribute cards with passwords (school Key, teacher Martínez, group names and password 123). Start using system and ask them to raise hands if questions arise. End after synthesis page.
Checklist for the independent variable (intervention)

DAY 2 - Focus on Text

First text for the intervention. En clase: de qué estamos hablando. Palabras destacadas que han salido. Leer textos y ciencias, las dos estrategias.

Introducir: trozos, fragmentos, paredes laterales, lecho del río, erosiona, disgrega, agentes atmosféricos, lagos, ríos, glaciares, manantial, pendiente escarpada.

diccionario, valor preguntas, lista de preguntas, libritos, tags

Whole group: Read text. Post name of the two strategies, main questions, and category of questions. Introduction: “Today we are going to be working on a series of reading comprehension strategies to help us better comprehend scientific (non-fiction) text.”

What do good readers do when they are reading? The strategies are called: self-monitoring and questioning.”

Present text on smart board; students have a pencil. Students receive an individual copy of the text. Students read individually. Teacher asks if any of the students wrote something on the text. Teacher explains that they must be active when they are reading challenging texts. That’s what the strategies are for. Bring back the strategies. What do you think self-monitoring means? (predicting and revising, reading and rereading, clarifying? (strategies for figuring words out, synthesizing). Start with predicting by looking at title and skimming through. Verbally state one sentence prediction. Following is the text:
Los Ríos y los Lagos

“Los ríos en su recorrido esculpen y modelan el paisaje. El agua de los ríos erosiona, disgrega y destruye las superficies rocosas por las que discurre, y transporta y deposita en las cuencas lacustres y marinas el material erosionado. Un río puede formarse a partir de un manantial, de un lago o de un glaciar. Veamos cuál es su historia. Un pequeño curso de agua fluye a lo largo de una pendiente escarpada, sobre su fondo caen de las paredes laterales fragmentos rocosos disgregados por los agentes atmosféricos. El agua transporta estos fragmentos que al erosionar el lecho del joven río excavan un valle en forma de “V”. La erosión continúa, el valle se hace cada vez más ancho y las laderas que lo delimitan son menos escarpadas.”

Read the text sentence by sentence teacher model with the help of students mainly to clarify words while reading (divide words in parts, use what they know in English, use context, etc.). Formulate questions and self-monitor as appropriate to model for students. Also, try to ask, “What is this sentence/paragraph saying?”

After a couple of sentences, students generate questions. Teacher discusses with students the type of question it is. (Assign a symbolic price to each question.)

Finish the whole text and move students inside to complete assessments.

Checklist for the independent variable (intervention)

DAY 3-Focus on System (Hard and Soft)

Second text recall for the intervention.
List words that have come up. Quickly talk to them about how to clarify and make sure all students know what the words mean.

Work in system: Students work with the GoInquire system using hard/soft stamps. Two pictures and synthesis page.

**Checklist for Reciprocal Teaching**

**DAY 4-Focus on self-monitoring while reading**

MAPA CONCEPTUAL-What are the strategies? What’s self-monitoring? Questioning?

Focus today on self-monitoring (autocontrol). Does it make sense? Do I understand?

What’s the main idea? Use highlighter.

---

**Cascadas, Montañas y Meandros**

“Cuando el agua se despeña sobre capas de roca dura, forma una cascada. La fuerza del agua erosiona rocas blandas en el fondo, haciendo retroceder a las capas de arriba. Por eso las cataratas ¡avanzan hacia atrás!

El agua de un río al bajar por una montaña, cuando la pendiente no es tan escarpada como en una catarata, también erosiona la roca y el terreno. En su primer tramo de la pendiente en una montaña, arriba del todo, el río erosiona las rocas excavando un valle profundo. En su discurrir el río transporta, erosiona y deposita gran cantidad de sedimentos. Cuando se reduce la pendiente, puede dar lugar a un pequeño lago de montaña del que parte para llegar al mar tras un recorrido por amplios meandros. El meandro se forma cuando
cambia el curso de un río, cuando queda cortado por un banco de arena, se convierte en un lago.

Ask them to look at the passage. “What’s the first thing we can do when we look at a text that could be a little more challenging? Let’s do what the preview does with a movie, but with the text. How can we do this?” (Brainstorm ideas).

Demonstrate and post summary of ideas for predicting next to the name of the strategy-read.

Say, “Now, as you read, you need to be VERY ACTIVE. You have to monitor and see if you understand what you’re reading. If you are NOT understanding, you MUST DO SOMETHING about it. For example, when you are in the class and your teacher tells you something, you must understand it. If your teacher asks you to go get a sharpener and you don’t know what that is, what would you do? Would you just sit there and continue living your life? (Ask a student, ‘Look around for clues; look in the dictionary….’) “The same thing when you’re reading.”

“We are going to monitor to see if I understand the idea, the words and to see if I can read the words. We are going to read and we are going to put a plus on the ideas/words I can read and understand well and a minus sign on those I cannot.”

Have a student read and write the minus or plus sign with a marker. Have at least two students do it.

“Now, what can we do to help us understand/read these ideas? Let’s look at each part and think how to break the wall down.” What’s this strategy called? Do we understand the
whole text?” Make sure everyone understands the whole text. (You might have to stop after the first sentence is understood by all and you may continue the next day.)

“Can anyone give me a question that has already come to mind about the text? What's this strategy called?”

Students give two or three questions. As they give you their questions, write it on the board and assign them an amount of money ($5, $10, or more) and explain why.

Students work in pairs to read the rest of the text. Distribute little cards with the strategies. Each student in the pair focuses in one strategy, self-monitoring or questioning (hanging signs). Highlight most important ideas. Write a summary of the text. Teachers assist as students work.

Checklist for Reciprocal Teaching

DAY 5-Focus on science in the field

Talk about the relationship between science and reading:

- Where they use questioning and monitoring in science and in reading (concept map—students make connections between questioning and self-monitoring and reading and science and add at least one detail). Where are we using the strategies in the system: “Which strategy are we using here?” Continue until we’ve named questioning and self-monitoring (asking questions, clarifying what I do not understand, selecting important information, synthesizing).

- When they read in science, including the GoInquire system, to find out more information, to answer their science questions, and so on.
• How reading can take them to science, by helping them generate questions and make sure their findings as they experiment and observe are correct, learn more information

Add words to our wall.

Go to the field with the pages to fill out and note observations. Explain, “We are going out to the field. Find the locations as a group and then write a few sentences on what you observe. Try to use as many words as you can to describe what you observe.” Students select areas where they’d like to take pictures:

Questions in the Field [Answers]

- Where did the sand come from? [Transported from a higher elevation.]
- What turned the cement to sand? [Usually weathering.]
- What keeps the roots from becoming loose? [Dirt.]
- What do you mean by erodes quickly? [It takes up to thousands of years.]
- What do you mean by erodes slowly? [It takes millions of years.]
- If it rains at Key, where does the water end up? [At sea level.]
- What causes water to go from high to low? [Gravity.]
- What landform do you see in this photograph? [I see the ground/hill/river channel.]
- Is the hill steep or shallow? [Usually hills are steep.]

Back in the classroom if time permits look at a few of the pictures. Preguntar: What are the agents that make erosion take place faster?
End with text recall. Don’t forget, as you write about the text, write what you know and use visuals.

Revisar los pasos de:

AUTOCONTROL

Predecir

Read and Reread. Entiendo? + o –

Resaltar las ideas principales, cuál es la idea principal?

PREGUNTAR: Todo el tiempo:

Con respuestas en el texto

Sin respuestas en el texto.

Day 6- Strategies and GoInquire System (Steep and Shallow and Intact and Loose)

Start in the Smart Board. Present students with a text with inserted incongruent sentences. First model and then get students to demonstrate the strategies. Distribute the little cards and review the strategies.

Create questions and give them points. Make sure they write questions about the last text!!

Students are placed in groups and they practice the strategies as they try to make sense of the text and try to identify the incongruent sentences! First model and then send them to practice in groups.

“El agua de un río al bajar por una montaña, cuando la pendiente no es tan escarpada como en una catarata, también erosiona la roca y el terreno. En su primer tramo de la pendiente en una montaña, arriba del todo, el río erosiona las rocas excavando un valle
profundo. El agua erosiona más si hay menos pendiente. Si hay mucha cantidad de agua y los materiales son blandos y sueltos también el río erosiona más. En su discurrir el río transporta, erosiona y deposita gran cantidad de sedimentos. Los sedimentos pueden ser nubes, zapatos, y otras cosas.

Cuando se reduce la pendiente, puede dar lugar a un pequeño lago de montaña del que parte para llegar al mar tras un recorrido por amplios meandros. Tengo unos pendientes de color rojo que mi hermana me trajo de México. El meandro se forma cuando cambia el curso de un río, cuando queda cortado por un banco de arena, se convierte en un lago.”

Have students look at the pictures and discuss them by talking about the four stamps (1. High/Low; 2. Steep/Shallow; 3. Loose/Compact, and 4. Soft/Hard).

Questions:

- What are the agents that make erosion take place faster?
- What is the relationship between erosion, deposition and transportation?
- Is erosion always good or bad?

Class discussion of the pictures using the vocabulary and adding more words as needed

Identify important parts thinking about erosion, deposition, and transportation of a picture, then cut them up and glue them again on a large sheet of paper.

Discuss what you do when you are reading a text if you want to learn. Talk about the strategies.

Finish with the text.
Appendix J

Specific Sequence of Instruction

**DAY 1-Focus on System**
1. Introduce intervention
2. Show tray/soil/water and talk about the factors under which the movement of water and soil varies
3. Introduce system

**DAY 2-Focus on Text**
1. First text for the intervention
2. Introduce vocabulary
3. Introduce and practice the two strategies in whole group

**DAY 3-Focus on System**
1. Second text recall for the intervention
2. List words that have come up
3. Work in system

**DAY 4-Focus on Self-monitoring**
1. Concept Map on the shared strategies between science and reading
2. Read and practice strategies

**DAY 5-Focus on Science in the Field**
1. Talk about the relationship between science and reading
2. Add words to our wall
3. Go to the field
Day 6-Strategies and GoInquire System

1. Create questions and give points

2. Students practice the strategies in groups
Appendix K

Student Interview: Perception about the Intervention (Spanish)

Name_________________________ Grade_____________________ Age___________

Introducción: Me gustaría hacerles algunas preguntas acerca del trabajo que hemos estado haciendo con el GoInquire en el computador (mostrar si no recuerdan) y también lo que hemos hecho en la clase con las estrategias de lectura. Voy a grabar las respuestas para luego poder escucharlas.

1. En general, ¿Qué te ha parecido lo que hemos hecho en el computador?
2. Qué te ha parecido lo que hicimos en la clase con las estrategias?
3. ¿Qué es lo que más te ha gustado del trabajo en el computador? ¿Y con las estrategias de lectura?
4. ¿Había alguna parte del computador que no te ha gustado? ¿Y del trabajo con las estrategias de lectura?
5. ¿Te ha ayudado el trabajo con las estrategias a mejorar la lectura de textos? ¿Cómo? ¿Y el trabajo con el sistema de GoInquire?
6. ¿Hay algo que no te ha ayudado?
7. ¿Cuál es la relación entre el sistema de GoInquire y las estrategias de lectura que hemos aprendido?
8. ¿El trabajo en el computador se parece a lo que sueles hacer en otras clases?
9. ¿Te gustaría usar más el sistema de GoInquire? ¿Por qué?
10. ¿Vas a seguir usando las estrategias de preguntarte y monitorizar tu trabajo? ¿Por qué? ¿Cómo vas a usarlas en ciencias? ¿Cómo vas a usarlas en lectura?
11. ¿Crees que tu lectura ha mejorado después del trabajo con el computador y con las estrategias? ¿Cómo?

12. ¿Hay alguien más que ha notado que tu lectura ha mejorado? ¿Qué dijeron?

13. Crees que te ayuda tu español a entender los textos que hemos estado leyendo mejor? ¿Cómo?

Student Interview: Perception about the Intervention (English)

Name_________________________ Grade_____________________ Age___________

Introduction: I would like to ask you a few questions about what we have been doing in the classroom with the GoInquire in the computer (show) and also with the reading strategies. If you agree, I am going to tape all your answers so that then I can listen to them and write them down to study what you say.

1. In general, what do you think about our work in the computer?

2. What about our work with the strategies?

3. What did you like best about our work in the computer? And with the reading strategies?

4. Was there anything about our work in the computer that you didn’t like? How about our work with the reading strategies?

5. Did the work we did with the class help you better understand texts about erosion? How? How about our work with the GoInquire?

6. Is there anything that didn’t help you?
7. What’s the relationship between our work with the GoInquire and the work with the strategies in reading?

8. The work we have done in the computer and with the strategies, is it similar to what you usually do in other science and reading classes? Why?

9. Would you like to use the GoInquire more? Why?

10. Are you going to continue using the strategies of questioning and self-monitoring? How would you use it in science? How would you use it in reading?

11. Do you think your reading skills have improved after the work we have done? How?

12. Is there anybody else who has noticed your improvement? What did they say?

13. Do you think your knowledge of Spanish helps you better understand the type of texts we have been reading in class? How?
Appendix L

Text for the Think-aloud and English Translation

Page 1
La Vida de un Río
(The Life of a River)

Page 2
El nacimiento de un río se llama fuente. *
(The place where a river is born is called the fountain)

Page 3
Un río puede nacer en la cima de una montaña.
(A river can be born on the top of a mountain)

Page 4
A medida que desciende, el agua tropieza con piedras, o cae en cascadas.
(As it descends, the water trips over pebbles, or falls in waterfalls)

Page 5
El agua en movimiento arrastra arena y piedras, que ayudan a dar forma al terreno circundante.*
(The moving water drags sand and pebbles, which help shape the surroundings)

Page 6
Una corriente de agua puede tener mucha fuerza.
(A water current can be very strong)

Page 7
Cuanta más cantidad de agua lleva el río al bajar por la pendiente, más erosiona el terreno.
(The more the water the river carries as it moves downhill, the more terrain it erodes)

Page 8 (sentence with incongruity)
También si la pendiente es muy poco empinada, o escarpada, o sea es casi plana, más se erosiona el terreno. *
(Also, if the slope is not very steep, or escarped, that is, if it is almost flat, more erosion occurs)
El agua de un río puede ir excavando lentamente el terreno por el que pasa. 
*(The waters of a river can slowly dig on the terrain it flows by)*

Las piedras que lleva también van arrastrando tierra. 
*(The pebbles it carries also drag soil)*

Con el tiempo, un río puede formar un profundo valle con abruptas laderas. 
*(As time goes by, a river can form a deep valley with very steep slopes)*

Este tipo de valle se denomina cañón. * 
*(This type of a valley is called a canyon)*

El Gran Cañón del Colorado es uno de los mayores cañones del mundo. 
*(The Grand Canyon is one of the world’s biggest canyons of the world)*

El Gran Cañón del Colorado se formó por una explosión de un meteorito contra la tierra.* 
*(The Grand Canyon was formed by the explosion of a meteorite against the earth).*
Appendix M

Human Subjects Consent Forms

INFORMED CONSENT FORM-COVER PAGE IN ENGLISH:

George Mason University

PARALLEL SCIENCE AND READING COGNITIVE STRATEGIES INSTRUCTION

INFORMED CONSENT FORM
RESEARCH PROCEDURES
Dear Parent:

This study is being conducted to evaluate the activities of the Comprehension Strategy Support in Inquiry-based Science project at George Mason University. If you agree to your child's participation, your child will be asked to participate in using the Web-based comprehension strategy support system in science learning, taking reading comprehension tests, videotaped interviews and observations using or commenting on the system and to permit access to journals or school work related to the system during the course of the school year. The instructional sequence will be implemented in six consecutive sessions of 1-1½ hours.

RISKS
There are no foreseeable risks or discomfort involved in the program that might be negative.

PARTICIPATION
Your permission is voluntary, and you may withdraw your child from the study at any time and for any reason. There is no penalty for not participating or withdrawing. The research will not affect the children's grades. There are no costs to you or any other party.

ALTERNATIVES TO PARTICIPATION
Students will be able to participate and learn from the classroom activities even if you do not give permission to collect and report data on their learning.

BENEFITS
The benefits to participating in this evaluation for your child include:

- Child-centered activities that intersect hands-on scientific inquiry with reading comprehension skills
- Application of reading comprehension skills to science content through the use of a Web-based system
- Promotion of inquiry-based methods of learning science
- Informing science teaching, professional development of teachers and improve understanding of children's learning when provided with comprehension strategy support in science activities.

CONFIDENTIALITY
Only the researchers associated with this project will have access to any of the videotaped observations and interviews on the use of the system. At the end of the project, all tapes will be erased. All data collected in this study will be confidential; all person identifiable data will be coded so that your child cannot be identified.

Revised June 17, 2007
CONTACT
This study is being conducted by Dr. Brenda Bannan-Ritland, (703) 993-2067 of the Graduate School of Education at George Mason University. You may also contact the George Mason University Office of Research Subject Protections at 703-993-4121 if you have questions or comments about your rights as a participant in this research.

This project has been reviewed according to George Mason University procedures governing your participation in this research.

Signature

Approval for the use of this document
EXPIRES

JUN 20 2008

Protocol # 5248
George Mason University

Revised June 17, 2007
INFORMED CONSENT FORM-CONSENT FORM IN ENGLISH:

I, ____________________________, give permission to the project investigator(s) of the Comprehension Strategy Support in Inquiry-based Science project, (including, but not limited to Dr. Brenda Bannan-Ritland and Patricia Martinez) to copy, abridge, or paraphrase any of my child’s written assignments, reading comprehension texts, and/or videotape interaction with his/her teacher or the investigator related to the study and use of the Inquiry-based Strategy Support System program which are considered necessary by the investigators for research and/or evaluation activities.

No names or social security numbers will be used. Reports of the program will also not include any person identifiable features. Only the primary investigators of the Comprehension Strategy Support in Inquiry-based Science project program will have access to this information. Some of the material, which could be used for research or presentations, include: student journals, reading comprehension tests, formal interviews, and comments on program features or other formative evaluation materials.

Name of the Student ____________________________

Signature ___________________________________ Date ____________________________

Approval for the use of this document EXPIRES

JUN 20 2008

Protocol # 52168
George Mason University

Revised June 17, 2007
FORMULARIO DE CONSENTIMIENTO

PROCEDIMIENTO
Estimados Padres:

Este estudio ha sido diseñado para evaluar las actividades de apoyo al proyecto de estrategias de comprensión basado en preguntas de los estudiantes (Comprehension Strategy Support in Inquiry-based Science) de la universidad de George Mason. Si accede a la participación de su hijo/a, la instrucción será grabada como parte de su clase regular de ciencias. La observación de las grabaciones se enfocará, principalmente, en las acciones de los profesores, pero también incluirá la interacción con los estudiantes como parte de las actividades normales de la clase e incluyen permiso para tener acceso a los diarios y trabajos de la escuela de los estudiantes. Los estudiantes también tomarán un examen de comprensión lectora. La secuencia de enseñanza se llevará a cabo en seis sesiones que durarán de 1 a 1 ½ horas.

RIESGOS
No existirá ningún riesgo o incomodidad para su hijo/a durante el estudio que pueda tener ningún impacto negativo.

PARTICIPACIÓN
Su permiso es voluntario, y puede retirar a su hijo/a del estudio en cualquier momento y por cualquier motivo. No hay penalidad por no participar o por retirar a su hijo/a del estudio. El estudio no afectará las notas de su hijo/a. El programa es gratis.

ALTERNATIVAS DE PARTICIPACIÓN
Los estudiantes se pueden retirar del estudio en cualquier momento y podrán participar en las actividades incluso aunque usted no de permiso para que se recoja información para el análisis de su aprendizaje y progreso.

BENEFICIOS
Los beneficios para su hijo/a por participar en esta evaluación incluyen:

- Mayor entendimiento de cómo los niños y los profesores interactúan durante las clases de ciencias.
- Promoción del método de aprendizaje basado en las preguntas de los niños/as (inquiry-based methods).
- Informando a los profesores de ciencias, incrementando el desarrollo profesional de los profesores y mejorando el entendimiento del aprendizaje de los niños cuando se provee con el apoyo de esta estrategia (inquiry-based methods).

CONFIDENCIALIDAD

Revised June 17, 2007
Yo, ________________, doy permiso al investigador del proyecto de estrategia de comprensión basado en la interrogación (Comprehension Strategy Support in Inquiry-based Science) de la Universidad George Mason, incluyendo pero no limitado a la Dr. Brenda Bannan-Ritland y a la maestra Patricia Martinez para copiar, resumir o parafasar cualquier de las tareas de escritura de mi hijo o hija, exámenes de lectura, reportes de notas y/o grabaciones de video de la interacción de los estudiantes con sus profesores relacionadas con el estudio y uso de la estrategia de comprensión basado en la interrogación (Comprehension Strategy Support in Inquiry-based Science), el cuál es considerado necesario por las investigadoras en la evaluación de las actividades.

Ningún nombre o número de seguridad social será usado. Los reportes del programa tampoco incluirán ninguna característica que pueda identificar ninguna persona. Solo los investigadores principales del proyecto de estrategias de comprensión basado en la interrogación (Comprehension Strategy Support in Inquiry-based Science) tendrá acceso a esta información. Algunos de los materiales que podrán ser usados durante esta investigación o su consecuente presentación incluyen: diarios de los estudiantes, exámenes de lectura, entrevistas formales, y comentarios en programas o en otros materiales de evaluación continua.

Nombre del estudiante

Firma __________________________ Fecha __________________________

Approval for the use of this document EXPIRES

JUN 20 2008

Protocol # 5268
George Mason University

Revised June 17, 2007
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Curriculum Vitae

Patricia Martinez graduated from the Instituto Cardenal Herrera Oria, Madrid, Spain, in 1992. She received her Bachelor of Education from the Escuela Universitaria Cardenal Cisneros, Madrid, Spain in 1996. She received her Masters in Curriculum and Instruction in 2001. Her Masters Degree program was in the area of bilingual special education and Mrs. Martinez received endorsements to teach students with learning disabilities, emotional disturbances, and cognitive impairments.

She was employed as a special education teacher in Arlington County for 9 years (1997-2001) and (2002-2007). For the 2001-2002 school year, she was employed as a linguistic consultant in the Madrid Public Schools, Spain.

In August, 2005 Mrs. Martinez presented a paper at the IX Congreso Nacional de Educadores in Lima, Peru. The following year she co-presented a paper at the 2006 American Educators Research Association (AERA) in San Francisco. Her interest in science teaching led her to attend and present a paper at the National Association of Research in Science Teaching (NARST) in 2006. She also developed and ran a workshop on “Differentiation” for teachers at the Bank Street College, as part of the 2007 Language Series in February, 2007.

From 2005-2007, Mrs. Martínez attended George Mason University in Fairfax, Virginia to pursue a Doctor of Philosophy degree in Education. While completing her doctoral studies she has continued to work as a special education teacher for Arlington County and as a Math mentor.