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Metacognitive Systematic Inquiry Utilizing Individualized Cognitive Profiles Causes Reading Comprehension Achievement

Kathleen D. Allen

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METACOGNITIVE SYSTEMATIC INQUIRY UTILIZING INDIVIDUALIZED COGNITIVE PROFILES CAUSES READING COMPREHENSION ACHIEVEMENT

A dissertation submitted
April, 2005

by

Kathleen D. Allen

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the requirement for the
degree of

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in
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In April, 2005
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ABSTRACT

The positive effects of systematic metacognitive instruction on reading achievement have been demonstrated, but that research has generally not been translated into classroom practice. This mixed methods research study sought to facilitate reading comprehension by involving subjects metacognitively with profiles of their own cognitive strengths and weaknesses. The study was conducted with 196 intermediate elementary students in the naturalized setting of 10 classrooms. Student scores from Woodcock-Johnson III cognitive clusters were utilized to generate individual cognitive profiles. In each classroom there were three experimental levels: 1. cognitive assessment only (control group) vs. 2. cognitive assessment + profile awareness (profile awareness group) vs. 3. cognitive assessment + cognitive profile awareness + metacognitive systematic inquiry (metacognitive systematic inquiry group). The metacognitive systematic inquiry treatment occurred as part of classroom independent reading instruction with judgments of learning, feedback, self-reflection, and comprehension questions related to those individual cognitive strengths and weaknesses which have been shown to correlate with reading comprehension. This treatment yielded significantly higher comprehension on a state standardized reading test, but not on an informal reading inventory. In a qualitative analysis, the treatment groups seemed to be more proficient at articulating declarative knowledge about individual cognitive abilities and reading strengths, as well as procedural knowledge about the connection between reading comprehension and cognitive ability. This study provides an example of how research findings in metacognition and metacomprehension can be generalized into classroom practice.
Dedicated to

The other two “Doctors and Donna”

my grandfather

Dr. Thomas Cort Allen, Sr.

my father

Dr. Thomas Cort Allen, Jr.

my mother

Donna Hillebrand Allen

Dr. Kathleen Deanne Allen has finally joined the family business!

and to

my husband

Mark Andrew Gillispie

whose unconditional love and support

makes all my dreams come true
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CHAPTER I: INTRODUCTION

Research evidence on metacognition and metacomprehension in reading instruction and its positive effects on achievement has grown tremendously in the last three decades (Maki & McGuire, 2002). In spite of this research evidence, reading comprehension instruction in the classroom setting has often consisted of answering questions about reading passages and teacher directed instruction about different aspects of comprehension with little utilization of systematic metacognitive instruction (Durkin, 1978/1979; Rosenshine, 1980; Schmitt & Baumann, 1990). This dissertation is concerned with effective classroom practices that give students metacognitive instruction about the cognitive abilities required for successful reading comprehension.

Successful reading comprehension requires distinct cognitive abilities (Kintsch, 1998; Kintsch & Van Dijk, 1978; Tierney & Pearson, 1994). Four of these abilities strongly correlate with reading comprehension achievement at the intermediate grade level (Evans, Floyd, & McGrew, 2002). These abilities can be visually depicted in a profile of cognitive strengths and weaknesses (see Appendix A), and then used as part of systematic instruction to heighten student self-awareness. Research (Schraw & Dennison, 1994) shows that readers with such awareness should be able to monitor cognition more effectively.

Metacognitive monitoring can be further enhanced through instruction that includes the use of systematic reflection and self-questioning during the comprehension process. This has a positive effect on reading achievement in classroom practice (Lubliner, 2004; Shelley & Thomas, 1996). Classroom practices that use explicit instruction of comprehension strategies through explanation, modeling, and individualized guided practice have been shown to have a positive effect on reading comprehension achievement as well (Anderson & Roit, 1993; Collins 1991). The efficacy of these activities can be more fully understood if it is also determined
whether the knowledge of individual cognition and the comprehension process is embedded firmly enough in memory for students to actually utilize individual profiles to automatically select reading comprehension strategies.

Therefore, this study attempted to demonstrate that teaching reading comprehension in the naturalized classroom setting utilizing individualized, systematic, and explicit metacognitive comprehension instruction would result in higher reading achievement. This study also provided an example of how research findings in metacognition and metacomprehension can be generalized into classroom practice.

Statement of the Purpose

The purpose of this research study was to investigate the effect of utilizing cognitive profiles in structured metacognitive activities in a naturalized classroom setting using district adopted reading materials and assessment tools. Engaging readers as active participants in building metacognitive knowledge, while supporting the metacomprehension (metacognitive inquiry of comprehension) development of each individual should cause increased reading achievement. If classroom instruction were accomplished in this same explicit, systematic, and thorough manner, readers should have more embedded knowledge to use comprehension strategies effectively in a variety of contexts.

Definition of Terms

Metacognition

Having knowledge about one’s cognitive strengths and weaknesses, being able to accurately monitor one’s cognitive processes, and being aware of feelings and experiences while engaging in cognitive processes (Flavell, 1979; Kuhn, 2000).
**Metacomprehension**

Metacomprehension involves “...judgments about levels of comprehension and learning of the text, and predictions about future memory for the material” (Maki & McGuire, 2002. p. 39).

**Metacognitive Systematic Inquiry**

Metacognitive systematic inquiry is the systematic practice of monitoring one’s own cognitive abilities during the reading process. This “monitoring occurs before retrieval, either in advance of learning, or during ongoing learning and retention. This includes ease-of-learning judgments, judgments of learning, and feeling-of-knowing judgments” (Son & Schwartz, 2002, p. 17).

**Cognitive Abilities**

**Processing Speed**

“Ability to perform simple cognitive tasks quickly, especially when under pressure to maintain focused attention and concentration” (Evans, Floyd, & McGrew, 2002, p. 254).

**Working Memory**

The “ability to temporarily store and perform cognitive operations on information that requires divided attention and the management of the limited capacity of immediate memory” (Evans, Floyd, & McGrew, 2002, p.254).

**Background Knowledge**

Ability to use language and acquired knowledge effectively (Evans, Floyd, & McGrew, 2002, p. 259-60).
Retrieval Fluency

“Ability to store information and retrieve it later through association” (McGrew & Flanagan, 1997, p. 205).

Cognitive Profile

A comparison of an individual’s strengths and weaknesses in the different cognitive abilities (see Appendix A).

Hierarchy of Knowledge

Declarative Knowledge

Knowing the facts about content, tasks, abilities, and goals.

Procedural Knowledge

Knowing enough information about a task’s structure to convert knowledge into performance.

Conditional Knowledge

Knowing when and why to perform tasks.

The Research Question

“If students are provided with systematic metacognitive inquiry regarding individual cognitive strengths and weaknesses that are strongly correlated with comprehension, will they show gains in reading comprehension achievement?” This research question was tested empirically, and then qualitative research analysis was utilized to explore the plausible differences in results between the metacognitive systematic inquiry, profile awareness, and the control groups.
CHAPTER II: REVIEW OF RELEVANT RESEARCH AND THEORY

A. Metacognitive Inquiry

B. Metacomprehension

C. Cognitive Abilities

D. Hierarchical Knowledge

E. Classroom Instruction

F. Summary

Metacognitive Inquiry

Metacognitive knowledge acquisition about individual cognitive strengths and weaknesses positively affects a learner’s ability to accurately monitor performance (Flavell, 1979; Kuhn, 2000). Successful readers mindfully monitor reading comprehension performance through an awareness of strengths and weaknesses and an understanding of the self-monitoring process (Baker & Brown, 1984b; Karpov & Haywood, 1998).

Metacognitive accuracy has traditionally been assessed with judgments-of-learning (Nelson & Dunlosky, 1991). These judgments can be used to effectively monitor and control metacognitive understanding and response (Koriat & Goldsmith, 1996). Schunk and Rice (1993) found that feedback on judgments-of-learning have a correcting effect on a student’s estimation of reading comprehension performance. However, the feedback must be very structured (Glenberg & Epstein, 1987) and occur almost immediately (Kulik & Kulik, 1988) in order for an improvement in metacognitive accuracy to occur.

Metacomprehension

Studies by Paris and Winograd (1990) and Flavell (1979) have found that unsuccessful readers do very little to monitor individual reading comprehension performance. Managing an
understanding of text requires that the reader reflect on individual cognitive processes (Baker & Brown, 1984b) and actively construct meaning while reading (Mokhtari & Reichard, 2002). The use of systematic reflection improves metacognitive monitoring and increases reading comprehension achievement in the classroom setting (Lubliner, 2004; Shelley & Thomas, 1996).

Successful comprehenders actively manage understanding of text through a process of mediation between reader, text, and context factors (Baker & Brown, 1984a; Marshall, 2000). Throughout this process, readers continually formulate a schema (Anderson & Pearson, 1984; Mokhtari & Reichard, 2002) while utilizing knowledge about these different factors to employ the correct comprehension strategies (Carr, Kurtz, Schneider, Turner, & Borkowski, 1989; Pressley, Borkowski, & Schneider, 1986) and thus successfully monitor individualized comprehension performance (Britton, Stimson, Stennett, & Gülgoz, 1998; Paris, Lipson, & Wixson, 1983). To employ the correct comprehension strategies, readers must also have embedded knowledge about the reading comprehension process and individualized cognitive abilities (Pressley, Borkowski, & Schneider, 1986).

Cognitive Abilities

"We comprehend a text, understand something, by building a mental model... Comprehension implies forming coherent wholes with Gestalt-like qualities out of elementary perceptual, and conceptual features" (Kintsch, 1998, p. 93). According to the discourse model of reading, successful reading comprehension depends on the abilities to recall and understand text through inference, formulate a gist, summarize, and make connections (Kintsch, 1998; Kintsch & Van Dijk, 1978; Tierney & Pearson, 1994). Each of these comprehension skills is dependent on various cognitive abilities.
The Cattell-Horn-Carroll (CHC) theory is a fluid-crystallized model of intelligence, which been extensively researched and validated (Flanagan & Ortiz, 2001; McGrew & Flanagan, 1997). In this hierarchical theory there are three levels of cognitive abilities: general intelligence, narrow cognitive clusters, and broad cognitive clusters. The broad cognitive clusters are fluid reasoning, comprehension-knowledge, short-term memory, visual processing, auditory processing, long-term retrieval, processing speed, reading and writing, quantitative knowledge, and decision/reaction time (Flanagan & Ortiz, 2001; McGrew & Flanagan, 1997). Four cognitive clusters from Woodcock-Johnson III (Woodcock, McGrew, & Mather, 2001) have been shown to strongly correlate with reading comprehension at the intermediate grade level: comprehension-knowledge, working memory, processing speed, and long term memory retrieval fluency (Evans, Floyd, & McGrew, 2002). In a study of 8,818 participants with age levels of 24 months to 95 years, Evans and associates (2002) used multiple regression analyses to find those cognitive clusters that are significantly related to reading comprehension achievement at the intermediate grade level. The comprehension-knowledge (background knowledge and vocabulary) cluster was shown to have the strongest predictive relationship with reading comprehension. Working memory, processing speed, and short term memory were also moderately related to reading comprehension from age six to adolescence. The strength of correlation between processing speed and reading comprehension decreases markedly after the elementary school age. In addition, there was a significant correlation between long-term retrieval and reading comprehension while reading acquisition occurs.

*Working Memory*

One of the cognitive aspects of reading comprehension requires remembering what is read. There are three memory stores in most discourse models: short term memory (STM),
working memory (WM), and long term memory (LTM). As a gross approximation, STM holds the most recent clause being comprehended and WM holds about two sentences. Information that that reader deems as important is actively recycled in WM (Graesser, Millis, & Zwaan, 1997). Poor comprehenders do not have the ability to efficiently use working memory to integrate text concepts once they have been brought into active memory. Readers who have problems with comprehension also have difficulties activating topic and structure knowledge from long term memory into working memory (Long & Chong, 2001).

Processing Speed

Reading comprehension is a "cyclical process constrained by the limitations of working memory" (Kintsch & Van Dijk, 1978, p. 363). Dufva, Niemi, and Voeten (2001) found that the automatization of decoding skills allows readers to utilize both short term and working memory more efficiently for comprehension. As a reader automatizes the reading process, the cognitive demands of working memory decrease and therefore, processing speed increases (Fry & Hale, 2001; Kail & Hall, 2001).

Comprehension-Knowledge

Since short term memory capacity limits the amount of information held in consciousness at one time, readers that have a high level of domain knowledge or a high level of interest in the topic are the most efficient at automatically making inferences and formulating gists (Boscolo & Mason, 2003). Many other research studies have found that readers utilize this background knowledge to create meaning during the reading process (Anderson, Reynolds, Schallert, & Goetz, 1977; Pearson, Hansen, & Gordon, 1979; Steffensen, 1986). Efficient processing of information is more likely when a deep level of expertise in reading strategies and the topic background knowledge are stored in long term memory that allows for chunking material into
large meaningful units. If the reader has high domain specific background knowledge, then reading comprehension can occur without a dependency on the memory buffers between short term, long term, and working memories. While readers with this knowledge have automatic retrieval structures, readers without it have to do a controlled memory search for information to formulate a connection with the subject matter, and are forced into the cognition described by the classical model of memory: Using short term memory to continually process five to seven chunks into working memory, then using working memory for comprehension. (Pressley, Borkowski, & Schneider, 1986).

**Long Term Retrieval Fluency**

During the process of reading, the reader continually organizes a mental structure or gist about the text. Formulating a gist and making text inferences requires that the reader retrieve topic and structure knowledge from long term memory (Mannes & Kintsch, 1987). This retrieval can be automatic or actively controlled by the reader (Kintsch, 1998). The categorized elements in long term memory are often referred to as schema. Formulating a schema allows the reader to retrieve many elements at one time (Kalyguia, Chandler, & Sweller, 1998). Long term memory retrieval fluency is assessed using rapid automatic naming (RAN). Many research studies have found significant relations between RAN and reading comprehension (Denckla & Cutting, 1999; Meyer, Wood, Hart, & Felton, 1998; Neuhaus, Foorman, Francis, & Carlson, 2001; Swanson, Trainin, Necoechea & Hammill, 2003; Wolfe, Bowers, & Biddle, 2000).

**Hierarchical Knowledge**

Different types of knowledge are acquired as learners go from novice to expert in any cognitive endeavor, including reading comprehension (Bruner, 1972; Resnick, 1983). There are various terms to denote the hierarchy of cognitive representations, each of which have been
supported empirically. Declarative, procedural, and conditional knowledge are the terms commonly used in reading comprehension literature and practice (Alexander, Schallert & Hare, 1991; de Jong & Ferguson-Hessler, 1996).

Readers with declarative knowledge can identify the facts about individual abilities and reading comprehension. This level of knowledge includes perceptions about one's individual strengths and weaknesses as well as facts about the task being performed, such as the elements of reading comprehension (Alexander & Jetton, 2000; Baker & Brown, 1984a; Glenberg & Epstein, 1985; Karpov & Haywood, 1998; Pressley, 2000; Weaver, 1990; Zabrucky & Moore, 1994). Much of this type of knowledge occurs at the superficial level, rote learning that is stored in memory as a copy of the data learned (Glaser, 1991; Marton & Säljö, 1976). Declarative memory depends on the medial temporal lobe structures of the brain to accurately store and retrieve information intact, whereas procedural memory is dependent upon a network of brain structures (Ullman, 2004).

While much of declarative knowledge can be characterized as superficial learning, procedural and conditional knowledge require embedded learning that is thoroughly processed, structured, and stored in a way that makes it useful for later application (Glaser, 1991; Marton & Säljö, 1976). Those with procedural knowledge know the processes of reading, such as the steps involved in summarizing text and how to use context cues.

In 1983, Paris, Lipson, & Wixson surmised that there might be another level of knowledge beyond the declarative and procedural knowledge of information needed to execute skills. This level of knowledge addresses self regulation, knowing when and why to utilize specific strategies and having the intent and self-discipline to follow through with using the chosen strategy. It was labeled as conditional knowledge. Given declarative knowledge of
individual cognitive abilities, the elements of reading comprehension and the procedures for utilizing each element, subjects with conditional knowledge should be able to regulate reading comprehension by recognizing when to employ the correct comprehension strategies (Pressley, Borkowski, & Schneider, 1986).

In a conditional knowledge study of elementary students by Carr, et al (1989), subjects were given instruction in the advantages of specific strategy use in particular situations and feedback about performance. These students improved declarative knowledge about memory strategies. In a classroom study of poor readers, Meloth (1990) found that even slight increases in declarative, procedural, and conditional knowledge of cognition in reading led to increased reading comprehension as measured in a state standardized criterion referenced test.

Schraw & Dennison (1994) found that the declarative knowledge of cognition often precedes the ability to regulate cognition. Those subjects with only a declarative knowledge of cognition were more successful at predicting performance on a standardized reading comprehension test than at monitoring and adjusting cognition. Also, those who reported high knowledge of individual cognitive strengths and weaknesses did significantly better at cognitive regulation. Similar findings were obtained in a study of college students about the use of strategies to acquire, store, and retrieve information (Sperling, Howard, Staley, & Dubois, 2004). Knowledge about individual cognition and the ability to regulate cognition were strongly correlated with strategy use, with cognitive regulation being slightly more predictive.

Classroom Instruction

In 1984, Baker and Brown identified the inherent problems with the practice of using a skill package curriculum to teach reading comprehension in that the skills are practiced in isolation instead of during the process of independent reading. In particular, this practice does
not seem to foster the ability to transfer knowledge from skill to practice. However, subsequent studies of reading comprehension instruction in the classroom setting have found comprehension instruction that consisted of passive sub skill training: answering short answer or essay questions about reading passages and teacher directed instruction about different aspects of comprehension, despite the fact that there is little research support for its effectiveness (Durkin, 1978/1979; Rosenshine, 1980).

A study of ten teachers from four school districts (Schmitt & Baumann, 1990) found that these teachers taught the procedures of comprehension as outlined in the basal reader: activation of background knowledge, generating questions, verifying predictions, employing repair or “fix it” strategies, but there were few instances where students were actively involved in the process of metacomprehension. Instead, the work of comprehension was primarily done by the teacher.

Another study of ten fourth grade and fifth grade teachers who had been identified as outstanding in language arts instruction, revealed comprehension instruction that was focused on tasks and testing. There was scant evidence in these classrooms of comprehension strategy instruction using the metacognitive strategies required for the self regulation of comprehension (Pressley, Wharton-McDonald, Hampston, & Echevarria, 1998). According to Pressley and Wharton-McDonald (2002), “Although development of comprehension ability is a widely agreed-upon goal of literacy instruction, it is rarely offered as systematically as it could be in the elementary grades” (p. 279).

One reason that the extensive research findings on the relationship between text comprehension and metacognition have not become a regular part of classroom practice is that much of the research has been done in a laboratory setting with college age subjects reading short passages unrelated to their regular curriculum (Maki & Maguire, 2002). When research
studies are carried out in the laboratory or in settings very different from the teacher's own classroom, teachers need structured collaborative support to know how to put research findings into best practice instruction (Pressley, El-Dinary, & Beard, 1997). The few classroom studies that have been done on the use of metacognition in reading have had consistently positive results. Most of these studies have focused on the correlation between one metacognitive prediction and academic achievement level. Students focus predictions or judgments of learning only on a particular activity at a particular point in time (Maki & Maguire, 2002), instead of participating in a systematic series of metacognitive predictions and judgments.

According to Pressley (2002), the knowledge of how successful readers comprehend text has led to increased study of the effective use of strategy instruction in classroom practice. In 1991, Collins researched transactional strategy instruction effectiveness in grades five and six. Transactional strategy instruction involves explicit instruction of comprehension strategies through explanation, modeling, and individualized guided practice. Students were taught prediction, monitoring of understanding, synthesis, inference, interpretation, and summarization three days a week for 16 weeks. Post-test scores on a standardized reading comprehension test, had strong evidence of the effectiveness of explicit strategy instruction. Another study of delayed readers in grade 6-11 demonstrated the effectiveness of small group transactional strategy instruction. Students were placed in 16 reading groups. Only nine of the small groups received strategy instruction. The groups that received strategy instruction treatment achieved significantly higher gain scores on a reading comprehension test (Anderson & Roit, 1993).

Thus, it appears that there is research evidence that supports the use of explicit, individualized, and guided strategy instruction within classroom instruction as an effective method to increase reading comprehension, although the practice of individualizing reading
instruction by utilizing this guided strategy instruction, cognitive assessment and systematic metacognitive inquiry has not become an integral part of classroom reading practice.

Summary

Reading strategy instruction that has a positive effect on comprehension achievement often involves explicit instruction of comprehension strategies through explanation, modeling, and individualized guided practice (Britton, Stimson, Stennett, & Gülgöz, 1998; Lubliner, 2004; Paris, Lipson, & Wixson, 1983; Shelley & Thomas, 1996). Readers with declarative knowledge about these strategies can identify the facts about individual abilities and reading comprehension (Alexander & Jetton, 2000; Baker & Brown, 1984a; Glenberg & Epstein, 1985; Karpov & Haywood, 1998; Pressley, 2000; Weaver, 1990; Zabrucky & Moore, 1994). Given declarative knowledge of individual cognitive abilities and the procedural knowledge for utilizing each element of reading comprehension, subjects with conditional knowledge should be able to regulate reading comprehension by recognizing when to employ the correct comprehension strategies (Pressley, Borkowski, & Schneider, 1986).

Four cognitive clusters from Woodcock-Johnson III (Woodcock, McGrew, & Mather, 2001) have been shown to strongly correlate with reading comprehension at the intermediate grade level: comprehension-knowledge, working memory, processing speed, and long term memory retrieval fluency (Evans, Floyd, & McGrew, 2002). Each of these cognitive abilities is directly related to specific comprehension elements. These cognitive abilities can be assessed and utilized to give readers declarative, procedural, and conditional knowledge about cognitive abilities and the elements of comprehension.

Despite the evidence that even metacognitive knowledge embedded only at the declarative level can increase reading comprehension achievement (Meloth, 1990; Schraw &
CHAPTER III: METHODOLOGY

This is a mixed methods QUAN-qual research study (Creswell, 2002; Gay & Airasian, 2003). The focus is a quantitative investigation of the research question. The qualitative aspects of this study are used to provide a more in-depth understanding of the quantitative results. Thus the methodology that immediately follows focuses first on the quantitative investigation. Then the methodology will transition to the qualitative aspects of this study.

Part A: Quantitative Methodology

*Design*

The quantitative component of this study was a factorial design with three experimental levels: 1. cognitive assessment only (control group) vs. 2. cognitive assessment + cognitive profile awareness (profile awareness group) vs. 3. cognitive assessment + cognitive profile awareness + metacognitive systematic inquiry (metacognitive systematic inquiry group). Students in each literature block class were randomly assigned to one of these three groups. All three groups were represented in each literature block class to avoid the intact groups problem (i.e. minimize variable effects of the teacher, environment, curriculum, etc.). The metacognitive systematic inquiry treatment occurred during regular classroom instruction, after independent reading of school district adopted reading materials.

*Participants and Setting*

The research took place in an intermediate elementary school in a rural community with a population of 4,270. The median income level of the town was $29,875 and 11.8 percent of the population lived below the federal poverty level (Profile of Economic Characteristics, 2000). The school had a population of 477 students in grades 4-6. Out of this population, 62 percent
qualified for free or reduced lunch. The ethnicity of the student population was 88 percent white and 12 percent Latino.

There are 15 classrooms at the school, five in each grade level. Students from all 15 of these classrooms are divided into literature block classes for 90 minutes a day to receive reading and writing instruction. They are placed into the literature blocks by their grade equivalent reading level as measured by the STAR and IRI tests (Advantage Learning Systems, 1998; Burns & Roe, 1999), as well as by their scores on the Oregon State Reading Assessment (Oregon Department of Education, 2002).

Since readers who are reading above grade level are already proficient at using reading comprehension strategies (Mokhtari & Reichard, 2002; Paris, Wasik, & Turner, 1991), for the purpose of this study, subjects were selected due to their enrollment in literature block classrooms where the students are reading at or below grade level. These subjects should derive greater benefit from the structured metacognitive processing of cognitive and comprehension knowledge imparted in the systematic inquiry. There were 10 of these literature block classes selected: four at the 4th and 6th grade levels, and two at the 5th grade level. Each literature block classroom had approximately 19 students, for a total number of 196 subjects. An equal number of students in each literature block class were randomly assigned to each of the three experimental conditions. Each of the 10 classes had approximately six students in each group. There were 65 subjects in the control (cognitive assessment only) and the profile awareness groups. In the metacognitive systematic inquiry group, there were 66 subjects. During the research study, several students changed literature block classes. Those that changed to a class already included in the study continued treatment. Those that did not were dropped from the study. In addition, several students did not receive both pre and post assessment for both reading
comprehension tests. One teacher did not give the self perceived reading ability questionnaire post-test and several students were absent on the day the teachers gave out the questionnaire, so the reported sample differs for each of these data sets.

The university’s human subject review procedure was followed. In addition, school district policy required that parents or guardians of each subject receive a letter explaining the research procedure and giving participants or parents permission to opt out of the study. This was done and all of the subjects opted to participate.

To maintain confidentiality of data sources, each subject was given an identity number that was used to analyze and report all data. Individual results of the cognitive profiles were shared only with those subjects in two of the groups during the study. After the study, these results were shared with the control group subjects and parents or guardians of subjects by request. Because the study was set in a classroom practice framework, assessment results were not formally shared as a part of the research study, but within the context of classroom instruction and family conferences by the literature block teacher.

Materials

Tests for Reading Comprehension Achievement

Reading comprehension achievement gain differences were used to evaluate the effectiveness of the metacognitive treatments with an analysis of variance using the composite score of the RIT on the Oregon State Assessment (Oregon Department of Education, 2002) and the grade level score on the Burns and Roe Informal Reading Inventory (1999) as the dependent measures.
**Oregon State Assessment**

One of the quantitative measures for assessing reading comprehension gains was the Oregon State Assessment of reading given each year to all students in grades 4-6 (Oregon Department of Education, 2002). It was designed to measure whether students have mastered the benchmark grade level expectations in reading. These benchmarks are predetermined by the state department of education. The Oregon State Assessment: Reading and Literature test assesses literal (16 percent), inferential (16 percent), and evaluative (16 percent) comprehension as well as word meaning (10 percent), locating information (11 percent), literary forms (16 percent), and literary elements (9 percent). The testing format is selected reading passages from a variety of genres with multiple choice questions (Oregon Department of Education, 2002). Questions were generated by professional test developers and then reviewed by a panel of teachers and specialists. Two separate research reviews (Haladyna, 2002; The Princeton Review, 2002) gave Oregon's state testing high marks for validity and reliability in student reading comprehension performance. Validity and reliability were also measured by Oregon Department of Education assessment specialists. Concurrent validity was determined using the California Achievement Test (CAT) and the Iowa Test of Basic Skills (ITBS). The resulting validity coefficient was .80 for the CAT and .84 for the ITBS. The Oregon State Assessment has three different forms. The internal consistency of these forms was measured using a Kuder-Richardson (K-R 20) reliability index. Results were .90, .88, and .79, for Forms A, B, and C respectively (Oregon Department of Education, 2001).

**Burns and Roe Informal Reading Inventory**

The Burns-Roe Informal Reading Inventory (1999) was in wide classroom use as a criterion-referenced measure of individual reading comprehension. The comprehension portion
of the inventory contained inference, cause-effect, main idea, detail, sequence, and vocabulary questions that relate to a selected fiction or nonfiction passage. These questions were answered orally in an open answer format. Comprehension was measured according to pre-established grade level standards. The Spache-Frye readability formula was used to determine grade level of each passage. There were four different forms of the test. Each form had a different passage and questions for each grade level. This test is not standardized and there was no available evidence of reliability or concurrent validity, although test-retest reliability, predictive validity, and construct validity could be established (Shanahan, 2000).

Tests for Cognitive Abilities

Cognitive abilities were measured quantitatively on the strands that are most highly correlated with intermediate reading comprehension. The cognitive abilities of short term memory, processing speed, long term retrieval fluency, and general comprehension-knowledge were assessed with the Woodcock-Johnson-III (Woodcock, McGrew, & Mather, 2001). Short term memory was assessed by giving subjects a string of numbers orally and asking them to recite those numbers in reverse order. For processing speed, the students were given rows of written numbers and asked to circle matching numbers in each row in a timed test. Long term retrieval efficiency was tested by giving subjects one minute to name as many examples as possible from a particular category. The general information task was a series of questions about objects and their uses. Grade level equivalent scores in each of the areas were used to create a profile for each student on their cognitive strengths and weaknesses. Individual student results were displayed in a visual graph format without numeric labels. This profile displays background knowledge, processing speed, as well as long term retrieval and short term memory in a grade
level equivalent format. Each subject’s cognitive profile was printed out on an 8 ½” X 11” paper (see Appendix A).

The Woodcock-Johnson III had scores for stability, test-retest, and rater reliability ranging from .80s to .90s for each of these individual tests. The test-retest reliability ratings for the timed tests for students aged 7-11 were visual matching (processing speed) at .87 and .81 for retrieval fluency. There was a one day retest interval (McGrew & Woodcock, 2001). The reliability coefficients for subjects ages 10-12 in all cluster tests was between a .79 and .91 given range.

Evidence of construct validity is provided by the comparison of the cluster tests to the Cattell-Horn-Carroll theory of intelligence, using internal structure and cluster intercorrelation evidence (McGrew & Woodcock, 2001). Extensive research has been done on successfully proving the predictive validity of the tests (Cizek & Sandoval, 2002). Comparisons of the WJIII General Intellectual Ability scores with the Wechsler Intelligence Scale for Children and the Differential Ability Scale have correlations of .70 to .80 respectively. This percentage was similar to validity results reported in other intelligence test manuals (McGrew & Woodcock, 2001).

Metacognitive Systematic Inquiry

The Metacognitive Systematic Inquiry (see Appendix D) instrument was comprised of the structured activities that subjects in the metacognitive systematic inquiry group used to monitor cognitive profiles and comprehension. The practical reading applications of working memory, processing speed background knowledge, and long term retrieval fluency were researched to determine the match between each of these cognitive abilities and independent reading comprehension elements. The questions were designed by the researcher to connect each
specific cognitive ability in a student's profile with the reading comprehension process as it
occurs while reading independently (Glenberg & Epstein, 1985; Kintsch 1998; Mokhtari &
Reichard 2002; Zabrucky & Moore, 1994). Each question on the metacognitive systematic
inquiry instrument was tested and revised several times during the pilot testing to elicit clear
responses from subjects.

For each cognitive cluster, subjects were asked to perform various tasks (see Appendix
D). Subjects first made a judgment of learning about a specific cognitive aspect of reading
comprehension. After making the judgment, students answered related comprehension questions.
Perusing the reading selection for the correct answers allowed for feedback on the first judgment
of learning accuracy estimation. Subjects then responded to that feedback with another judgment
of learning.

Subjects in the metacognitive systematic inquiry group also wrote about one of the four
cognitive abilities included in the profile each week. The writing prompts included asking
subjects to analyze individual strength and weakness in that strand using cognitive profiles and
reflecting on how this strength or weakness affected particularized reading comprehension (see
Appendix D).

*Self Perceived Reading Comprehension Ability Questionnaire*

The self perceived reading comprehension ability questionnaire was created for the
qualitative analysis. See Part B of the methodology.

*Procedures*

Subjects within each selected literature block classes were assigned to one of the three
experimental groups using a random number generator. The research sequence had five phases:
cognitive profile foundational testing of cognitive abilities, pre-testing on reading
comprehension, profile awareness (definition explanation), metacognitive systematic inquiry, then post-testing on reading comprehension and analysis (see Table 1).

| Table 1:  
Timeline of Procedures |
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control Group</strong> (Cognitive Assessment Only) N=65</td>
</tr>
<tr>
<td><strong>Pre-tests of Reading Comprehension</strong> January, 2004</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Cognitive Profile Awareness</strong> January, 2004</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Metacognitive Systematic Inquiry</strong> Feb 1-Apr 9, 2004</td>
</tr>
<tr>
<td><strong>Post-tests of Reading Comprehension</strong> April 9-25, 2004</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Selection of Participating Classrooms

Six literature block classroom teachers were chosen to participate in the study. Two of the teachers had three literature blocks, one at each grade level. The other four teachers had only one literature block. Teachers were selected who, in the researcher's opinion, were flexible, cooperative, and had a high interest in improving reading comprehension instruction. The teachers that fit these criteria were asked to volunteer and received a $100 stipend for their participation.

Foundational Testing of Cognitive Abilities

The Woodcock-Johnson III cognitive tests of General Information, Visual Matching, Numbers Reversed, and Retrieval Fluency (Woodcock, McGrew, & Mather, 2001) were given to each subject to all participants by the researcher before the treatment began. The testing followed the test manual directions (Woodcock, McGrew, & Mather, 2001). The assessment of all four of these cognitive clusters takes about twenty minutes per subject. Since these tests must be given in an environment with little or no distractions, much of the testing occurred in the small offices reserved for student evaluation.

Pre-tests of Reading Comprehension

Oregon State Assessment. Oregon state reading scores for each student were collected by the researcher from the school data base. This assessment was given in January, 2004 as a practice test to all students in grades 4-6. A different form of the same Oregon State reading test was given again in April 2004. Both of these tests were administered in the computer lab by the literature block teachers using the directions included in the testing booklets (Oregon Department of Education, 2002).
Burns and Roe Informal Reading Inventory. The Burns-Roe Informal Reading Inventory (1999) was given individually to each subject by the researcher, teacher assistant or literature block teacher, all of whom received guided practice in administering the test according to the manual directions by school district personnel. Each participant started the inventory at a particular grade level. The starting grade level was determined by results of the STAR reading test (Advantage Learning Systems, 1998) and the literature block teacher’s estimation of classroom performance. Subjects were asked to independently read a passage from the inventory at that grade level. During the pre-test, all subjects were given Form B of the test. Form D was used for the post-test. After reading independently, participants were asked to answer the comprehension questions orally without looking at the passage. This was done in a one-on-one format in a corner of the classroom or in the hall. Subjects with a score of 90 percent or greater repeated the task at one grade level higher. Those with scores of less than 75 percent went down one grade level. This re-testing was done the following school day and repeated daily until a score of 75-89 percent was achieved on the grade level criterion.

Student Questionnaire of Self Perceived Reading Comprehension Ability. All subjects answered a pretest questionnaire of Self Perceived Reading Ability (see Appendix B). Data collection procedures are articulated in the qualitative methodology (see Part B).

Cognitive Profile Awareness

Subjects in the two groups receiving cognitive profile awareness treatment had the opportunity to see the cognitive profile generated by the researcher. The profile was presented by the researcher to the subjects in each literature block classroom. Each 20 minute demonstration was done only once in each literature block. It occurred before the metacognitive systematic inquiry treatment. Absent students were included in another literature block class for the purpose
of demonstration. Subjects in the control group, who did not receive cognitive profile awareness treatment, were taken out of the classroom by the literature block teacher. During the demonstration, each student received his or her cognitive profile, and the researcher explained the definition of each of the clusters and examples of how that cluster relates to reading comprehension (see Appendix F). The instruction followed this consistent structure with some flexibility based on the questions of the subjects. The definitions and examples were the same for every presentation. Whether the student had internalized those results was ascertained by having the students write definitions of short term memory, processing speed, long term retrieval, background knowledge, and a self reflection about his or her own profile. This information was used to ascertain whether the subject had an adequate understanding of cognitive profiles. One subject was dropped from the study due to incomprehensible written answers and lack of cooperation with the cognitive profile awareness procedure.

**Metacognitive Systematic Inquiry**

The metacognitive systematic inquiry group completed structured activities (see Appendix D) twice a week within the naturalistic setting of literature block classroom independent reading time. Every week for 10 weeks, the researcher and teacher assistants placed two pages of questions in each metacognitive development subject’s folder. This was a two pocket folder with the subject’s cognitive profile on the inside front cover. These folders were kept in the literature block classroom. Literature block teachers determined the logistics of where in the classroom the folders were kept and how subjects accessed them. Twice a week, with prompting from the literature block teacher, these subjects read independently for 20 minutes (as did all students in the other two groups) and then thoughtfully responded to one of the pages in their folder for about 10 minutes while the students in the other two groups engaged in usual
classroom reading activities. Literature block teachers monitored and encouraged student effort during response time.

The two pages of questions placed in the subject's folder each week were on a particular cognitive strand. On one of the pages, students made judgments of learning predictions about their comprehension in relation to background knowledge, long term retrieval, short term memory, and processing speed. Students then answered reading comprehension questions directly related to each of the measured cognitive abilities (see Appendix D). Students wrote responses in pen so that answers could not be changed. After writing the answers, subjects looked at the book they were reading to compare their judgment to the correct answer. The second page of questions included an analysis of individual strength and weakness in that strand, the strand's definition, and its relationship to reading comprehension (see Appendix D).

Post-Test Assessment

The 2004 Oregon State Assessment: Reading and Literature test and the Burns and Roe Informal Reading Inventory were re-administered to all subjects using the same procedures as during the pre-testing phase. Procedures followed for the questionnaire of Self Perceived Reading Ability are included in the qualitative methodology (see Part B).

Part B: Qualitative Analysis

Design

A questionnaire was designed to determine presence of response patterns using the language of the study participants. This qualitative component was overlaid onto the quantitative methods and thus occurred concurrently. Thus participants and setting are the same.
Materials

The qualitative measure for the analysis of the quantitative reading comprehension achievement results was a self perceived reading ability questionnaire given to all participants to help ascertain each student's self evaluation about reading comprehension strengths and weaknesses and the relationship between cognition and the reading process (see Appendix B). This questionnaire was originally developed by the researcher for the pilot test (see Appendix C) and then revised with teacher and student input for the purpose of this study.

Data Coding and Summary Building

Open coding (Strauss & Corbin, 1990) was the first method used to evaluate responses on the Self Perceived Reading Comprehension Ability questionnaire data. The data were first read holistically with no attempt to categorize. Then a line-by-line analysis was done to potentially identify properties, categories, and dimensions. The phenomena that emerged from this process were the subject's understanding about the relationship between reading comprehension and cognition, and the rationale for reading failure or success. The reading comprehension category was further dimensionalized into comprehension and word attack strategies. The cognitive category was divided into the clusters contained in the cognitive profile (background knowledge, working memory, long term retrieval fluency, and processing speed), visualization, and general memory. Upon further analysis, it was ascertained that the relationship between the categories had another component, level of embedded knowledge about the phenomenon. Axial coding was then used to define the properties of declarative, procedural, and conditional knowledge across each of the previous categories. For example, one student's response to the question “What are your strengths as a reader?” was “I sound out the words. I look to see if I could see a small word.” During the line-by-line analysis coding, this response was categorized as reading
comprehension and then dimensionalized into the sub-category of word attack strategies. The axial coding process defined this same response as "conditional knowledge of when to use strategies."

Validity

The data were generated in similar situations across all literature block classes. Each literature block teacher gave the same directions. All subjects filled out questionnaires at the beginning of class, and were all given as much time as needed to complete them. In addition, each student was monitored to be sure they were staying on task. Thus, data for questionnaires were gathered consistently across all groups.

At the data analysis stage, one pass was made in a blind situation with all data before coding. Thus, the researcher had no "story" consciously in mind to impose on the data during the first encounter. During the second pass, the data were sorted into similar categories, yet hierarchies were not pre-determined. During the third pass, coding occurred, and during the fourth, hierarchies were identified. This process necessitated that research evidence on aspects of qualitative analysis be collected after coding of the data. Thus, traditional steps were followed to increase the likelihood that the codes were determined by the data and not by the researcher.

Another measure taken to increase validity was the use of the Atlas-ti.software program (Muhr, 2004). Parameters were set by defining words for each property, category, and dimension. Parameters were then inputted into the program. The software then sorted all of the responses. Each response was double checked by the researcher to ensure that the responses were sorted into the correct category. For example, all responses were entered into the program exactly as written. Several times subject spelling errors caused responses to be categorized incorrectly.
To determine construct validity, the categories generated from the data were reviewed to see if there was a match to categories of cognitive abilities and reading comprehension elements as found in the literature. There is much research evidence of the categorization of cognitive abilities and reading comprehension elements as used to code data for this study (Anderson, Reynolds, Schallert, & Goetz, 1977; Boscolo & Mason, 2003; Evans, Floyd, & McGrew, 2002; Kintsch, 1998; Pearson, Hansen, & Gordon, 1979; Steffensen, 1986). The hierarchical dimensions of embedded level of knowledge have also been well researched (Glaser, 1991; Marton & Säljö, 1976; Paris, Lipson, & Wixson, 1983; Pressley, Borkowski, & Schneider, 1986).

**Reliability**

Finally as another check on validity, an intra-rater reliability check was performed. All of the 675 responses were recoded in a blind situation thirty days after the initial coding by the researcher using the same line-by-line procedure. For categorical data, consensus is measured as number of agreements divided by total number of observations. The percentage of agreement between the two coding sessions was 73 percent.
CHAPTER IV: RESULTS

The effect of systematic metacognitive inquiry regarding individual cognitive abilities correlated with comprehension was analyzed in a combined quantitative/qualitative, between-subjects design. Gain scores from the Informal Reading Inventory (1999) and the Oregon State Assessment: Reading and Literature test (Oregon Department of Education, 2002) were the dependent measures in two one-way ANOVAs using SPSS (2001). The quantitative results were further explained and interpreted with visual qualitative data analysis of the Self Perceived Reading Ability questionnaire (see Appendix A) using Atlas.ti software (Muhr, 2004).

Oregon State Assessment: Reading and Literature

A one-way ANOVA (control x profile awareness x metacognitive inquiry) indicated significant differences in OSA reading comprehension achievement scores, $F(2, 170) = 5.51, p = .005$ (see Table 2).

Table 2

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>194.159</td>
<td>5.514*</td>
<td>.005</td>
</tr>
<tr>
<td>Within Groups</td>
<td>170</td>
<td>35.215</td>
<td>17.621</td>
<td>.0001</td>
</tr>
<tr>
<td>Total</td>
<td>172</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* alpha level =.05.

Mean gain scores for each treatment group were -1.08, 1.65, and 2.29 for the control (cognitive assessment only), profile awareness, and metacognition systematic inquiry groups respectively (see Table 3 and Figure 1).
Table 3

Descriptive Statistics for Gain Scores by Group: Oregon State Assessment

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (Cognitive Assessment Only)</td>
<td>61</td>
<td>-1.08</td>
<td>6.12</td>
</tr>
<tr>
<td>Profile Awareness</td>
<td>49</td>
<td>1.65</td>
<td>5.94</td>
</tr>
<tr>
<td>Metacognitive Systematic Inquiry</td>
<td>63</td>
<td>2.29</td>
<td>5.75</td>
</tr>
<tr>
<td>Total</td>
<td>173</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1 Oregon State Assessment: Reading and Literature: Mean Gain Scores by Group

To assess paired differences among the three conditions, the Scheffe follow-up procedure (alpha = .05) was performed (see Table 4).
Table 4

Scheffe Post Hoc test of the Oregon State Assessment: Reading and Literature

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean Difference</th>
<th>SE</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (Cognitive Assessment Only)</td>
<td>-3.37*</td>
<td>1.07</td>
<td>.008</td>
</tr>
<tr>
<td>Metacognitive Systematic Inquiry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profile Awareness</td>
<td>-2.74</td>
<td>1.14</td>
<td>.059</td>
</tr>
<tr>
<td>Profile Awareness</td>
<td>2.74</td>
<td>1.14</td>
<td>.059</td>
</tr>
<tr>
<td>Control (Cognitive Assessment Only)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metacognitive Systematic Inquiry</td>
<td>-.63</td>
<td>1.13</td>
<td>.855</td>
</tr>
<tr>
<td>Metacognitive</td>
<td>3.37*</td>
<td>1.07</td>
<td>.008</td>
</tr>
<tr>
<td>Control (Cognitive Assessment Only)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profile Awareness</td>
<td>.63</td>
<td>1.13</td>
<td>.855</td>
</tr>
</tbody>
</table>

*alpha level = .05.

The results indicated significance for the mean gain score difference of 3.37 between the metacognitive systematic inquiry group and the control (cognitive assessment only) group. To further examine the effects of metacognitive systematic inquiry, a trend analysis was conducted. Results indicated a significant linear trend, \( F(1, 171) = 10.41, p = .0015 \) (see Figure 1).

Informal Reading Inventory

A one-way ANOVA (control x profile awareness x metacognitive inquiry) of the Informal Reading Inventory did not demonstrate significant differences in reading comprehension gain scores across all levels, \( F(2, 148) = .253, p = .776 \), as shown in Table 5.
Table 5 *Analysis of Variance for Informal Reading Inventory*

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>.370</td>
<td>.253</td>
<td>.776</td>
</tr>
<tr>
<td>Within Groups</td>
<td>148</td>
<td>1.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The mean gain scores for the control (cognitive assessment only), profile awareness, and metacognition systematic inquiry groups were .44, .26, and .37 respectively (see Table 6 and Figure 2).

Table 6

*Descriptive Statistics for Gain Scores by Group: Informal Reading Inventory*

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (Cognitive Assessment Only)</td>
<td>55</td>
<td>.44</td>
<td>1.14</td>
</tr>
<tr>
<td>Profile Awareness</td>
<td>39</td>
<td>.26</td>
<td>1.30</td>
</tr>
<tr>
<td>Metacognitive Systematic Inquiry</td>
<td>57</td>
<td>.37</td>
<td>1.22</td>
</tr>
<tr>
<td>Total</td>
<td>151</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Self Perceived Reading Comprehension Ability

Results of the Self Perceived Reading Comprehension Ability questionnaire gave evidence of each subject’s embedded levels of understanding and remembering: declarative knowledge (knowing the facts about cognitive comprehension elements and individual cognitive abilities), procedural knowledge (knowing about how individual cognitive abilities and reading strategies can be used for comprehension), as well as conditional knowledge of when to use comprehension and word attack reading strategies. The coded results for this evidence were put into one table per question, with noteworthy findings elaborated one question at a time. In each dimension by treatment cell of each table below, percentage of responses are recorded as well as response counts (in parentheses). For example, in Table 7, the first row of the last column, 70 indicates the percentage of metacognitive subjects who had post-test phase answers coded into the processing speed category, while the 33 in parentheses indicates the number of responses.
Question One: What is Happening in Your Brain When You Read?

Comparisons of the pre-test and post-test responses to “What is happening in your brain when you read?” demonstrate the difference in knowledge level of cognition and reading comprehension between the different groups after treatment (see Table 7).

Table 7

What is Happening in Your Brain While You Read?

Response Percentages (Counts) by Embedded Knowledge Level Dimensions and Treatment Group

<table>
<thead>
<tr>
<th>Knowledge Level</th>
<th>Control Group (Cognitive Assessment Only)</th>
<th>Profile Awareness Group</th>
<th>Metacognitive Systematic Inquiry Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=37</td>
<td>N=31</td>
<td>N=47</td>
</tr>
<tr>
<td></td>
<td>Pre Post</td>
<td>Pre Post</td>
<td>Pre Post</td>
</tr>
<tr>
<td>Declarative knowledge about cognitive elements of comprehension:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Processing Speed</td>
<td>0(0) 3(1)</td>
<td>0(0) 3(1)</td>
<td>0(0) 70(33)</td>
</tr>
<tr>
<td>Working Memory</td>
<td>3(1) 11(4)</td>
<td>0(0) 16(5)</td>
<td>4(2) 70(33)</td>
</tr>
<tr>
<td>Long Term Memory Retrieval Fluency</td>
<td>0(0) 0(0)</td>
<td>0(0) 0(0)</td>
<td>0(0) 51(24)</td>
</tr>
<tr>
<td>Background Knowledge</td>
<td>0(0) 5(2)</td>
<td>0(0) 10(3)</td>
<td>0(0) 72(34)</td>
</tr>
<tr>
<td>Visualization</td>
<td>51(19) 78(29)</td>
<td>61(19) 61(19)</td>
<td>60(28) 23(11)</td>
</tr>
</tbody>
</table>
Table 7
What is Happening in Your Brain While You Read?

Response Percentages (Counts) by Embedded Knowledge Level Dimensions and Treatment Group

<table>
<thead>
<tr>
<th>Knowledge Level</th>
<th>Control Group (Cognitive Assessment Only)</th>
<th>Profile Awareness Group</th>
<th>Metacognitive Systematic Inquiry Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre Post</td>
<td>Pre Post</td>
<td>Pre Post</td>
</tr>
<tr>
<td>N=37</td>
<td></td>
<td>N=31</td>
<td>N=47</td>
</tr>
<tr>
<td>Procedural knowledge about how cognitive abilities are used for comprehension:</td>
<td>0(0) 0(0)</td>
<td>0(0) 3(1)</td>
<td>0(0) 21(10)</td>
</tr>
<tr>
<td>Declarative knowledge about individual cognitive abilities:</td>
<td>0(0) 3(1)</td>
<td>3(1) 3(1)</td>
<td>0(0) 85(40)</td>
</tr>
<tr>
<td>Procedural knowledge about how individual cognitive abilities are used for comprehension</td>
<td>0(0) 0(0)</td>
<td>0(0) 0(0)</td>
<td>0(0) 34(16)</td>
</tr>
</tbody>
</table>

**Declarative Knowledge about Cognitive Elements of Comprehension**

**Cognitive Profile Abilities.** In the dimension of declarative knowledge about cognitive elements of comprehension, the metacognitive systematic inquiry group had the most growth in percentage of responses coded into the categories contained in the cognitive profile abilities. The processing speed category increased from 0 to 70 percent (or 0 to 33 counts) of coded responses. The other cognitive profile categories had increased response levels as well. Working memory response levels increased from 4 to 70 percent. Long term retrieval fluency (0 to 51) and background knowledge (0 to 72) response percentages also increased. This is in comparison to the control group in which the highest response level increase was in the working memory category (3 to 11 percent). The profile awareness group had higher response levels than the
control group in working memory (0 to 16 percent) and background knowledge (0 to 10 percent). Examples of these types of coded responses were “Working memory is how much info you hold in your brain” and “Background knowledge is how much we know about the world and how big is your vocabulary.”

**Visualization.** Declarative knowledge about the cognitive element of visualization generated the most responses across all treatment groups. During the pre-test phase, all groups had a response level between 51 and 61 percent in the visualization category. Post-test answers to this question elicited 61 percent visualization responses from the profile awareness group, and 78 percent visualization responses from the control subjects. However, subjects that received systematic metacognitive treatment gave 23 percent of such responses. Responses were coded into the visualization category when subjects responded with either the word “picture” or “movie” as in “I try to picture what is happening in the book” or “It’s like a movie going on in my brain.”

**Procedural Knowledge about How Cognitive Abilities are Used for Comprehension**

Although procedural knowledge about how cognitive abilities are used for reading comprehension did not have the same level of response as declarative knowledge of cognitive abilities, procedural knowledge was demonstrated by 21 percent of the metacognitive systematic inquiry group in the post-test questionnaire, whereas the control group had no response increase and the profile awareness group had an increase of one subject response from the pre-test to the post-test phase. Two responses in this category were “I am thinking about what is happening in the story and focusing on what might happen and what already has and putting it together like a puzzle with pieces missing” and “What happens in my brain is that it sort of copies the page and breaks the sentence into chunks, then stores the information into different files.”
Declarative Knowledge about Individual Cognitive Abilities

Declarative knowledge about individual cognitive abilities showed the highest increase in level of coded responses for the question, "What is happening in your brain while you read?" On the pretest questionnaire, only one subject (in the profile awareness group) across all treatments articulated this type of knowledge. In the post-test phase, only one subject from the control group and one from the profile awareness group evoked individual cognitive ability. However, 40 subjects in the metacognitive systematic inquiry group used the language of declarative knowledge of individualized cognitive abilities. An example of this type of response was "...I'm not very good at processing speed either. I can only hold about 4-5 chunks of information in my working memory. And don’t get me started on my long term retrieval fluency!"

Procedural Knowledge about How Individual Cognitive Abilities are used for Comprehension

Procedural knowledge about how individual cognitive abilities included in the profile are used for reading comprehension responses exhibited a 34 percent increase. In the pre-test phase, there were no subject responses in any of the groups that indicated procedural knowledge. In the post-test phase, the level of response in the control and profile awareness groups remained at zero, but 16 of the subjects in the metacognitive systematic inquiry group gave responses indicating this level of embedded knowledge about the subject’s individual profile and reading performance. These replies were typified by two examples: "I’m focused on the book and my brain is thinking about words I don’t understand. Mostly I’m thinking about what is happening. I can look stuff up in my head fast. I know a lot about the world around me. I can think real fast, and I can hold an average amount of information in my head" and "Is that when the words you’re reading go into your brain. The brain knows or doesn’t know what those words mean, so it tries
to figure it out. Processing speed is one of my weaknesses and I can’t read very fast. Working memory is a weakness, too. I can’t remember all that I read. Background knowledge is my strength. I know what the background is when I read.”

**Question Two: Do You Understand What You Read? Why or Why Not?**

Pre-test and post-test responses to “Do you understand what you read? Why or why not?” reveal procedural knowledge of how cognitive abilities and reading strategies are used for comprehension before and after treatment (see Table 8).

**Table 8**

**Do You Understand What You Read? Why or Why Not?**

*Response Percentages (Counts) by Embedded Knowledge Level Dimensions and Treatment Group:*

<table>
<thead>
<tr>
<th>Knowledge Level</th>
<th>Control Group (Cognitive Assessment Only)</th>
<th>Profile Awareness Group</th>
<th>Metacognitive Systematic Inquiry Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=37</td>
<td>N=31</td>
<td>N=47</td>
</tr>
<tr>
<td></td>
<td>Pre  Post</td>
<td>Pre  Post</td>
<td>Pre  Post</td>
</tr>
<tr>
<td>Procedural knowledge about how cognitive abilities are used for comprehension:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Processing Speed</td>
<td>3(1) 0(0)</td>
<td>6(2) 3(1)</td>
<td>2(1) 2(1)</td>
</tr>
<tr>
<td>Working Memory</td>
<td>0(0) 0(0)</td>
<td>0(0) 0(0)</td>
<td>0(0) 0(0)</td>
</tr>
<tr>
<td>Long Term Memory Retrieval Fluency</td>
<td>0(0) 0(0)</td>
<td>0(0) 0(0)</td>
<td>0(0) 2(1)</td>
</tr>
<tr>
<td>Background Knowledge</td>
<td>11(4) 11(4)</td>
<td>10(3) 16(5)</td>
<td>21(10) 15(7)</td>
</tr>
<tr>
<td>Visualization</td>
<td>11(4) 8(3)</td>
<td>6(2) 3(1)</td>
<td>4(2) 2(1)</td>
</tr>
</tbody>
</table>
Table 8

Do You Understand What You Read? Why or Why Not?

Response Percentages (Counts) by Embedded Knowledge Level Dimensions and Treatment Group:

<table>
<thead>
<tr>
<th>Knowledge Level</th>
<th>Control Group (Cognitive Assessment Only)</th>
<th>Profile Awareness Group</th>
<th>Metacognitive Systematic Inquiry Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=37</td>
<td>N=31</td>
<td>N=47</td>
</tr>
<tr>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Comprehension Strategies</td>
<td>35(13) 14(5)</td>
<td>32(10) 13(4)</td>
<td>17(8) 21(10)</td>
</tr>
<tr>
<td>Word Attack Strategies</td>
<td>5(2) 0(0)</td>
<td>0(0) 0(0)</td>
<td>0(0) 9(4)</td>
</tr>
<tr>
<td>Total of Comprehension and Word Attack Strategies</td>
<td>40(15) 14(5)</td>
<td>32(10) 13(4)</td>
<td>17(8) 30(14)</td>
</tr>
</tbody>
</table>

Procedural Knowledge about How Cognitive Abilities are Used for Comprehension

Analysis of the other procedural knowledge dimension did not seem to generate substantial differences between groups. However, when comparing responses between categories, it is noteworthy that for all groups, the category of background knowledge (the ability to use language and acquired knowledge effectively) was coded with the most responses. These responses used the language of content and vocabulary: “Sometimes. Because I only understand things like what people say in a book not like all of that science and stuff” and “No, because there are some words that I never heard.”

Procedural Knowledge of How Reading Strategies are Used for Comprehension

Responses to the question, “Do you understand what you read? Why or why not?” showed some evidence of growth in procedural knowledge about how reading strategies are used
in reading comprehension for the group who received metacognitive systematic inquiry. While the control group’s coded responses in this category decreased (from 41 to 14 percent), and the profile awareness group also showed a decrease (from 32 to 13 percent), the percentage of coded responses from the metacognitive systematic inquiry group actually increased (from 17 to 30 percentage points). Three examples of this type of response are “Yes because if I don’t understand it I go back and reread it” and “Yes I do because I break down the words and then I understand them.”

*Question Three: Do You Remember What You Read? Why or Why Not?*

Pre-test and post-test responses to “Do you remember what you read? Why or why not?” demonstrated growth in procedural knowledge of how cognitive abilities and reading strategies are used for comprehension before and after treatment (see Table 9).
### Table 9

**Do You Remember What You Read? Why or Why Not?**

*Response Percentages (Counts) by Embedded Knowledge Level Dimensions and Treatment Group*

<table>
<thead>
<tr>
<th>Knowledge Level</th>
<th>Control Group (Cognitive Assessment Only)</th>
<th>Profile Awareness Group</th>
<th>Metacognitive Systematic Inquiry Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre N=37</td>
<td>Post N=31</td>
<td>Pre N=47</td>
</tr>
<tr>
<td><strong>Procedural knowledge about how cognitive abilities are used for comprehension:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Processing Speed</td>
<td>0(0)</td>
<td>6(2)</td>
<td>0</td>
</tr>
<tr>
<td>Working Memory</td>
<td>0(0)</td>
<td>0(0)</td>
<td>0(0)</td>
</tr>
<tr>
<td>Long Term Memory Retrieval Fluency</td>
<td>5(2)</td>
<td>3(1)</td>
<td>2(1)</td>
</tr>
<tr>
<td>Background Knowledge</td>
<td>0(0)</td>
<td>3(1)</td>
<td>2(1)</td>
</tr>
<tr>
<td>Visualization</td>
<td>5(2)</td>
<td>5(2)</td>
<td>0(0)</td>
</tr>
<tr>
<td><strong>Procedural knowledge of how reading strategies are used for comprehension:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comprehension Strategies</td>
<td>11(4)</td>
<td>10(3)</td>
<td>19(9)</td>
</tr>
<tr>
<td>Word Attack Strategies</td>
<td>3(1)</td>
<td>3(1)</td>
<td>0(0)</td>
</tr>
<tr>
<td><strong>Total of Comprehension and Word Attack Strategies</strong></td>
<td>14(5)</td>
<td>13(4)</td>
<td>19(9)</td>
</tr>
</tbody>
</table>


Procedural Knowledge about How Cognitive Abilities are Used for Comprehension

"Do you remember what you read?" responses demonstrated little or no growth in the control and profile awareness groups for procedural knowledge of personal cognitive strengths and weaknesses in reading comprehension but some growth in the metacognitive systematic inquiry group. Most of this growth (from 2 to 17 percent) occurred in the long term retrieval fluency category. Subjects in the metacognitive systematic inquiry condition were more likely to recount anecdotes of the brain’s memory storage system. For example, “Yes because I have a long memory and if I do forget it there are clues in my life that help me remember like maybe a name or a place” and “Yes and no, because if the story is short I can remember what I read. If the story isn’t short I have trouble remembering.”

Question Four: What Are Your Strengths as a Reader?

Responses to “What are your strengths as a reader?” identified level of embedded knowledge about individual cognitive abilities and when to use reading comprehension strategies (see Table 10).
Table 10

What Are Your Strengths as a Reader?

Response Percentages (Counts) by Embedded Knowledge Level Dimensions and Treatment Group:

<table>
<thead>
<tr>
<th>Knowledge Level</th>
<th>Control Group (Cognitive Assessment Only)</th>
<th>Profile Awareness Group</th>
<th>Metacognitive Systematic Inquiry Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
</tr>
<tr>
<td><strong>N=37</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declarative and Procedural knowledge about individual cognitive abilities:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Processing Speed</td>
<td>8(3)</td>
<td>11(4)</td>
<td>6(2)</td>
</tr>
<tr>
<td>Working Memory</td>
<td>0(0)</td>
<td>0(0)</td>
<td>0(0)</td>
</tr>
<tr>
<td>Long Term Memory Retrieval Fluency</td>
<td>0(0)</td>
<td>0(0)</td>
<td>0(0)</td>
</tr>
<tr>
<td>Background Knowledge</td>
<td>5(2)</td>
<td>5(2)</td>
<td>16(5)</td>
</tr>
<tr>
<td><strong>Total cognitive profile abilities</strong></td>
<td><strong>13(5)</strong></td>
<td><strong>5(2)</strong></td>
<td><strong>22(7)</strong></td>
</tr>
<tr>
<td>Visualization</td>
<td>5(2)</td>
<td>5(2)</td>
<td>6(2)</td>
</tr>
</tbody>
</table>

**Conditional knowledge of when to use strategies**

<table>
<thead>
<tr>
<th></th>
<th>Control Group</th>
<th>Profile Awareness Group</th>
<th>Metacognitive Systematic Inquiry Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehension Strategies</td>
<td>27(10)</td>
<td>27(10)</td>
<td>20(6) 0(0)</td>
</tr>
<tr>
<td>Word Attack Strategies</td>
<td>0(0)</td>
<td>0(0)</td>
<td>0(0) 7(2)</td>
</tr>
<tr>
<td><strong>Total of Comprehension and Word Attack Strategies</strong></td>
<td><strong>27(10)</strong></td>
<td><strong>27(10)</strong></td>
<td><strong>20(6)</strong></td>
</tr>
</tbody>
</table>
Declarative and Procedural Knowledge about Individual Cognitive Abilities

The response category that evidenced the most growth for the question “What are your strengths as a reader?” was declarative and procedural knowledge about individual cognitive abilities. While the control group (13 to 5 percent) and the profile awareness group (22 to 18) had decreased response levels, the metacognitive systematic inquiry group had a 25 percent increase in responses that defined reading strengths in terms of the abilities contained in the cognitive profile. This growth occurred in the processing speed, long term memory retrieval fluency, and background knowledge categories. Processing speed responses increased in each group, and background knowledge responses in the profile awareness group decreased from 16 to 6 percent. Long term memory retrieval fluency had the greatest growth in the metacognitive systematic inquiry group (0 to 11 percent). A response indicative of declarative knowledge of individualized cognitive abilities was “long term retrieval fluency.” These responses evidenced procedural knowledge: “Well I think that my strength is keeping things that I’ve learned about in the past years. And then using it in the future”, “I can read good and store the info”, “I can read fast and understand it” and “My strengths are that I can remember things and I know what most words mean.”

Question Five: What Could You Improve About Your Reading?

Responses to “What could you improve about your reading?” evinced procedural and declarative knowledge about individual cognitive abilities and the conditional knowledge of when to use reading comprehension strategies (see Table 11).
Table 11

*What Could You Improve About Your Reading?*

*Response Percentages (Counts) by Embedded Knowledge Level Dimensions and Treatment Group:*

<table>
<thead>
<tr>
<th>Knowledge Level</th>
<th>Control Group (Cognitive Assessment Only)</th>
<th>Profile Awareness Group</th>
<th>Metacognitive Systematic Inquiry Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
</tr>
<tr>
<td>Declarative and Procedural knowledge about individual cognitive abilities:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Processing Speed</td>
<td>14(5)</td>
<td>8(3)</td>
<td>23(7)</td>
</tr>
<tr>
<td>Working Memory</td>
<td>0(0)</td>
<td>0(0)</td>
<td>0(0)</td>
</tr>
<tr>
<td>Long Term Memory Retrieval Fluency</td>
<td>0(0)</td>
<td>0(0)</td>
<td>0(0)</td>
</tr>
<tr>
<td>Background Knowledge</td>
<td>3(1)</td>
<td>3(1)</td>
<td>3(1)</td>
</tr>
<tr>
<td>Total cognitive profile abilities</td>
<td>17(6)</td>
<td>11(4)</td>
<td>26(8)</td>
</tr>
<tr>
<td>Visualization</td>
<td>0(0)</td>
<td>0(0)</td>
<td>0(0)</td>
</tr>
<tr>
<td>Conditional knowledge of when to use strategies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comprehension Strategies</td>
<td>43(16)</td>
<td>27(10)</td>
<td>23(7)</td>
</tr>
<tr>
<td>Word Attack Strategies</td>
<td>11(4)</td>
<td>11(4)</td>
<td>3(1)</td>
</tr>
<tr>
<td>Total of Comprehension and Word Attack Strategies</td>
<td>54(20)</td>
<td>38(14)</td>
<td>26(8)</td>
</tr>
</tbody>
</table>
Declarative and Procedural Knowledge about Individual Cognitive Abilities

Although the question about reading strengths generated an increase in the articulation of cognitive profile responses for the metacognitive systematic inquiry group (see Table 10), when subjects were asked about areas for improvement (see Table 11), the profile awareness group was the only one to increase percentage of coded responses (26 to 42 percent). The response “Processing speed” was coded as indicative of literal recall of the subject’s profile. Other responses, such as “Understand more words” and “If I could be a little bit faster at reading instead of staying on one or two pages for a long time” demonstrate some procedural knowledge of the cognitive elements of reading.

Conditional Knowledge of When to Use Comprehension Elements and Strategies

Conditional knowledge of personal strengths and weaknesses in the strategies of reading comprehension only increased (26 to 36 percent) in the profile awareness group. This small increase was due to the growth of the comprehension strategy responses (23 to 29 percent) and the word attack strategies category (3 to 7 percent of responses). Comprehension strategies mentioned were making connections, practicing, re-reading, reading aloud, retelling, and reading at instructional level. Students generated the following examples of this type of response: “I need to improve on reading more books. I have trouble finding a sport book in AR (Accelerated Reader)” and “Passing the test and understand what you’re reading, not hard books, your level, so you understand it that’s why.” Word attack strategies included decoding, chunking, using context cues, and reference skills. A sample of these responses included “Sound out words better and to read better the words that have a lot of letters” and “I think I can improve reading big words the right way. Not just skipping the words” and “Maybe in my free time I could study with a dictionary.”
Summary

The most noteworthy qualitative finding seems to demonstrate that subjects in the metacognitive systematic inquiry treatment group showed growth in declarative knowledge about cognitive elements of comprehension and individual cognitive abilities (see Table 7). Growth also occurred in procedural knowledge about how reading strategies and cognitive abilities are used for comprehension, when subjects were queried about understanding what was read (see Table 8). Growth in conditional knowledge of reading strategies was only evidenced by the profile awareness group with an increase of three subject responses, while the other two groups showed decreases in coded responses (see Table 11).

Subjects given only profile awareness treatment also showed growth in declarative and procedural knowledge about cognitive abilities in comparison to the control group, but did not show the same level of increase as those given the metacognitive systematic inquiry treatment. However, when asked, “What could you improve about your reading?” profile awareness subjects were more likely to demonstrate declarative and procedural knowledge about weaknesses in cognitive abilities, whereas the metacognitive systematic inquiry group had a higher number of responses when replying to, “What are your strengths as a reader?”
CHAPTER V: DISCUSSION

This study was designed to determine the effects of metacognitive systematic inquiry using individualized cognitive profiles in the regular classroom instructional environment by measuring reading achievement with assessment tools commonly utilized in schools.

Reading Comprehension Achievement

State standardized tests and informal reading inventories are both commonly used criterion referenced assessments used in the school setting to measure reading achievement. Subjects in the metacognitive systematic inquiry group did make significant gains in reading achievement as measured by the state standardized reading test (OSA). Even the one time feedback that the profile awareness group received on personal cognitive strengths and weaknesses had some effect on student reading achievement as measured by this test, but it was the metacognitive systematic inquiry group, who received the organized metacognitive instruction and wrote self reflections regarding individual cognitive profiles that showed the highest reading achievement gains. However, the informal reading inventory (IRI) did not reveal evidence of significant growth in reading achievement in any of the groups. Differences in the quantitative results between the two assessments (OSA and IRI) could be attributed to the factors of design specifications, testing format, and scoring.

Scoring

The OSA produces a scale (RIT) score. The IRI currently reports achievement in ordinal grade level scores, although the author of the Informal Reading Inventory has expressed an interest in making the IRI scores more precise for use at both research and practitioner levels (B.D. Roe, personal communication, July 30, 2004). Since the treatment occurred over a ten
week period, with both tests given in January and April, the more finely tuned measure of the
OSA might have allowed for more specificity of results.

*Design Specifications*

Both tests measure literal, evaluative, and inferential comprehension of passages
approximately the same length. The standardized Oregon State Assessment Reading and
Literature test was designed to assess how successful students have been at mastering the
expected course content in reading and literature. Since the Oregon State Assessment is designed
to be a criterion referenced measure of what students should have learned during classroom
instruction, it is a valuable instrument in determining the effectiveness of a treatment in the
regular classroom setting. The Informal Reading Inventory is designed to determine the grade
level comprehension ability of an individual student, so it might be more effective in determining
growth in achievement of individual subjects over a longer time span.

*Testing Format*

*OSA and IRI*

The Oregon State Assessment (OSA) is given online and involves answering only
multiple choice questions. The reader is allowed to look at the passage while choosing between
four answers. The informal reading inventory (IRI) has an oral open answer format. Subjects do
not have the opportunity to look at the passage while replying, and have no answers to choose
from. Because subjects do not see the passage, it must be stored in memory. Subjects must
formulate a gist while reading, make text inferences and then create their own answers.
Therefore, long term memory retrieval of text becomes another factor in the Informal Reading
Inventory. Subjects with a weakness in long term retrieval fluency might not perform as well on
this type of assessment.
The research study that ascertained the correlations between cognitive abilities included in the subject profiles and reading comprehension used the reading vocabulary and passage comprehension achievement sub-tests from the Woodcock-Johnson III (WJIII) tests of achievement to define reading comprehension achievement (Evans, Floyd, & McGrew, 2002). So it might be expected that after receiving metacognitive treatment in those particular cognitive abilities, subjects might demonstrate higher achievement in assessments similar to the two Woodcock-Johnson III sub-tests used to generate the correlation. The WJIII and the OSA are both standardized and have good ratings of validity and reliability. It can be assumed that both assessments are valid and reliable measures of reading achievement. However, the OSA was designed to measure the attainment of reading content standards on an individual, school, district, and state level (Oregon Department of Education, 2002), while the WJIII measures an individual’s reading comprehension ability using a broad measure of achievement (McGrew & Woodcock, 2001). Although the tests were designed for different purposes, significant results in this study could be due to the interconnections of abilities used in individual attainment of reading content and achievement.

Self Perceived Reading Ability

Quantitative reading assessments only give information about the product of comprehension, determining whether the subject has enough understanding of content and the ability to comprehend text. Qualitative data can furnish information about the process of comprehension. Analysis of the responses from the self perceived reading ability questionnaire helped determine how different aspects of the treatment might have influenced reading comprehension achievement and at what level the subjects apparently internalized the treatment.
It appears from the pre-test and post-test response levels in the self perceived reading ability questionnaire that providing metacognitive systematic inquiry allowed subjects in this group to receive declarative and procedural knowledge about individual cognitive abilities and how they are used in reading comprehension. The metacognitive treatment might have allowed the subjects to internalize the profile enough to provide written evidence of declarative and procedural knowledge about individual cognitive abilities and how they are used in reading comprehension after only 100 minutes of instructional activities and 100 minutes of self reflection on cognitive abilities.

The question “What happens in your brain while you are reading?” generated the most responses from the metacognitive systematic inquiry and profile awareness groups in the post test questionnaire. There are perhaps several reasons for this. This particular question was directly focused on cognition, whereas the others were more focused on aspects of reading comprehension (remembering and understanding what was read) and judgments of aptitude (strengths and weaknesses in reading). This question, that was directly focused on cognition and worded clearly, could have cued subjects to focus written answers on individual cognitive abilities. Another factor could be in the post test procedure. Only in the post-test phase, this question was actually given the week before the other questions. Although all groups answered the question at the same time, using the same protocol, having just one question to answer might have allowed all of the subjects the time and inclination to give more thorough and thoughtful answers.
Response Patterns

Visualization

An interesting response pattern occurred in the visualization category for the “What is happening in your brain while you read?” question. During the pre-test stage, there was preponderance of visualization coded responses to this question. It could be that the teachers of these subjects are explaining cognition during reading as primarily a visual process (i.e. “your brain makes a picture while you read”). After the systematic metacognitive treatment, subjects in the metacognitive systematic inquiry group could articulate different cognitive processes, while the profile awareness and control groups reiterated primarily visual responses.

Profile Awareness Group

During the cognitive profile awareness treatment given to the profile awareness and the metacognitive systematic inquiry groups, subjects were given individualized profiles of strengths and weaknesses in cognitive abilities, the definition of each ability, and how that ability relates to reading comprehension. This seemed to allow an increased number of subjects from both groups to articulate cognitive strengths and weaknesses when answering the self perceived reading ability questionnaire given three months later. However, the group that received only the profile awareness did not have the same level of response as the metacognitive systematic inquiry group in declarative and procedural knowledge about cognitive abilities.

Conditional Knowledge

Subjects that received the metacognitive systematic inquiry treatment apparently were able to articulate declarative and procedural knowledge about individual cognitive abilities and how they are used in reading comprehension, but not conditional knowledge of when to use strategies to manage individual comprehension, other than a 10 percent (equal to three responses)
increase in the profile awareness group. The metacognitive systematic inquiry did provide implied instruction in the relationship between individual cognitive abilities and the matching reading comprehension elements. Subjects did comprehension activities, received feedback, and then wrote about the matching cognitive ability within individual profiles. However, it is likely that for subjects to embed knowledge of individual cognition and comprehension enough to articulate when to use strategies, explicit teaching of matching each individual’s profile to particularized strategies and giving guided practice in using and articulating strategies would need to occur for much longer than the 10 weeks provided in this study.

*Qualitative Analysis of Quantitative Results*

The 10 week metacognitive systematic inquiry about individual cognitive profiles did have a significant effect on reading comprehension as measured by the Oregon State Assessment. According to the qualitative results, this could have been due to an increase in declarative and procedural knowledge about individual cognitive strengths and weaknesses as well as the cognitive aspects of reading comprehension. Research has shown that successful readers monitor understanding of the text through knowledge of cognition. This monitoring requires that the reader reflect on individual cognitive processes. Those who have embedded knowledge of individual cognitive strengths and weaknesses are significantly better at the cognitive regulation required to effectively comprehend text. The metacognitive treatment’s focus on knowledge of individual cognition and the cognitive elements of comprehension within the classroom setting appear to have allowed the subjects in the metacognitive systematic inquiry group to perform significantly higher on a valid, reliable, and standardized state assessment of reading achievement that was designed to measure performance in content standards contained in classroom instruction.
Classroom Practice Implications

Since state standardized tests and informal reading inventories are in wide classroom use, teachers and administrators should have a thorough understanding of these measurements. According to Spear-Swerling (2004), "without an understanding of the specific abilities tapped by these tests and by different testing formats, the tests can not be used effectively to inform classroom teaching" (p. 125). State standardized assessments are customarily used to compare classroom, school, district and state achievement levels. Classroom assessments such as the IRI are generally used to inform instruction and place students in reading ability groups. The standardized measurement of cognitive abilities has primarily been used for remediation purposes and to determine special education eligibility (Woodcock, McGrew, & Mather, 2001). Traditionally, none of these assessments have been utilized in the classroom to provide students with the feedback required for supporting the metacomprehension (metacognitive inquiry of comprehension) needed to actively understand text.

This study used standardized measurement to formulate an individualized profile of strengths and weaknesses in the cognitive abilities (see Appendix A) correlated with reading comprehension for each subject. This profile was then utilized by the metacognitive systematic inquiry group in the regular classroom to give readers practice in metacognitively monitoring individual understanding of text while reading independently. The use of standardized instruments in the regular classroom setting has powerful implications. In this study, it allowed students to monitor reading comprehension with individual cognitive profiles generated from a valid and reliable assessment. This helped assure that participants were receiving accurate
information about strengths and weaknesses in individual cognitive abilities which made the profile an effective tool for feedback and metacognitive monitoring of comprehension.

Suggestions

*IRI Precision, Validity, and Reliability*

In this particular study, the Informal Reading Inventory (Burns and Roe, 1999) was chosen primarily because of its common classroom use as an indicator of reading comprehension achievement. Eventually, the Burns and Roe Informal Reading Inventory (1999) might also become valuable for research done in the classroom environment if issues of validity, reliability and precision of measure were addressed. Shanahan suggested in his test review (2000) that test-retest reliability, predictive validity, and construct validity could be determined fairly easily. This determination would add to the generalizability of the test results for classroom research. Since this present research took place over a period of four months, and the Burns and Roe Informal Reading Inventory (1999) measured growth in grade level increments, the grade level increments were perhaps not precise enough to get an accurate measure of reading comprehension growth for this research study. If reading comprehension growth could be measured in months, percentages, or finer incremental reading gradients (such as guided reading levels), student progress could be gauged over a shorter time span. The increased specificity of feedback generated by such a measure might help inform reading comprehension instruction and allow for student growth in reading comprehension to be reported to stakeholders more frequently.

*Student Self Reporting*

An additional student self report on cognitive abilities and strategies used during the OSA and the IRI either directly after or during the assessments, might have provided an even clearer picture of which aspects of treatment brought about an increase in reading comprehension
achievement. Due to immediacy of feedback, students might have reported strategy use or application of cognitive abilities during the testing not reported on the Self Perceived Reading Comprehension Ability questionnaire.

Further Research

Much research has been done on reading comprehension strategies and how to scaffold and support the use of strategies during the reading process. However, further study could be done on the aspect of individualizing comprehension instruction using profiles so that students can become aware of and metacognitively monitor cognitive strengths and weaknesses. This would require additional empirical data on the match between cognitive profile abilities and reading comprehension strategies. In particular, which strategies are most effective for students with exact cognitive strengths and weaknesses as portrayed in the individualized profile? Which procedures would be most effective for situating cognitive strategy instruction into regular classroom instruction? How much instruction do students need before the use of cognitive and comprehension strategies become automatic? What is needed instructionally to maintain this automaticity? The next step would seem to be investigating the efficacy of providing explicit instruction in strategies related to individual cognitive profiles, both procedural knowledge- the process of using the strategy- and conditional knowledge, when to use a particular strategy. This instruction could allow students to self select strategies based on individual strengths and weaknesses as a natural part of the reading comprehension process.
APPENDIX A

Student Cognitive Profile

Cognitive Profile

Background Knowledge  Processing Speed  Working Memory  LIT Retrieval Fluency

Cognitive Abilities
APPENDIX B

Self Perceived Reading Comprehension Ability

Name ______________________

Pre and Post Questionnaire

1. Do you understand what you read? Why or why not?

2. Do you remember what you read? Why or why not?

3. What are your strengths as a reader?

4. What could you improve about your reading?

5. What is happening inside your brain while you read? (write or draw a picture)
APPENDIX C

Pilot Study

A pilot study was conducted in the spring of 2003. Two classes of sixth graders were selected and the students were randomly assigned to conditions using a random number generator. The Burns-Roe Informal Reading Inventory (Burns & Roe, 1999) was given to each student as a pre and post test of reading comprehension. The Woodcock-Johnson III tests of Visual Matching, Numbers Reversed, and Memory for Words (Woodcock, McGrew, & Mather, 2001) were administered to all subjects. The STAR test (Advantage Learning Systems, 1998) was also given to all participants on the computer.

Students in the two experimental groups receiving cognitive profile awareness had the opportunity to see their own cognitive abilities profile. Once a week, students in the systematic metacognitive inquiry condition answered reading comprehension questions that were directly related to each of the measured cognitive abilities (see Appendix D).

A one-way ANOVA did not indicate significant differences in increased reading comprehension between the three conditions ($F (2, 48) = 1.878, p = 0.164$). The highest increase in reading comprehension gains did occur in the metacognitive systematic inquiry group ($M = 6.471$, $SD = 14.9$). Reading comprehension scores on the IRI decreased in both the profile awareness group ($M = -1.765$, $SD = 26.75$), and the control group ($M = -7.06$, $SD = 14.90$). The results of the pilot study were compromised by two factors: The teacher in one of the classes showed profile results to several members of the control group before the training was concluded, and the teacher in the other class missed two of the weeks of metacognitive inquiry. Because the inquiry was only one month long and occurred in May, when there are many
classroom disruptions, it was not as consistent and efficient as inquiry during the actual
dissertation research.

However, the cognitive testing and the informal reading inventory assessments were
given in a time efficient manner, the subjects and teachers were cooperative and anxious to see
their results and the statistical analysis shows a trend towards reading comprehension gains in the
metacognitive systematic inquiry group.
APPENDIX D

Metacognitive Systematic Inquiry

Page One Questions

Question #1 (Working Memory)

Halfway through the reading please close the book.

1. Do you remember what you just read? (circle one)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>I'm positive</td>
<td>I think</td>
<td>I think</td>
<td>I'm positive</td>
<td></td>
</tr>
<tr>
<td>I do not remember</td>
<td>I do not remember</td>
<td>I remember</td>
<td>I remember</td>
<td></td>
</tr>
</tbody>
</table>

Write three important details you remember here:

Go back and look at the book where you stopped reading.

How close were you?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>I was completely wrong</td>
<td>I was mostly wrong</td>
<td>I was mostly right</td>
<td>I was completely right</td>
<td></td>
</tr>
<tr>
<td>I was wrong</td>
<td>I was mostly wrong</td>
<td>I was mostly right</td>
<td>I was completely right</td>
<td></td>
</tr>
</tbody>
</table>

Question #2 (Working Memory)

After you finish reading, please close the book and answer the following question:

Can you remember the last sentence you just read? (circle one)

Yes

No

Write it down (no peeking!)

Now take a look!

How close were you?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>I was completely wrong</td>
<td>I was mostly wrong</td>
<td>I was mostly right</td>
<td>I was completely right</td>
<td></td>
</tr>
<tr>
<td>I was wrong</td>
<td>I was mostly wrong</td>
<td>I was mostly right</td>
<td>I was completely right</td>
<td></td>
</tr>
</tbody>
</table>
Question #3 (Background Knowledge)

How much did you know about the book’s topic before you started reading? (circle one)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never heard of it</td>
<td>I have heard about it</td>
<td>I could tell someone else about it</td>
<td>I'm an expert</td>
<td></td>
</tr>
</tbody>
</table>

Can you think of connections between the reading and your own life and experiences? (circle one)

Yes No

Can you think of connections between the reading and a movie or another book you’ve read? (circle one)

Yes No

Write 3 of the connections you made here:

How did you do at thinking of connections?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>I couldn’t think of any!</td>
<td>It was fairly easy</td>
<td>It was fairly easy</td>
<td>It was really easy!</td>
<td></td>
</tr>
</tbody>
</table>

Question #4 (Background Knowledge)

There were less than 10 words in the reading that I did not know and understand. (circle one)

Yes No

Write down all of the words you did not understand. (You can use the book)

How many words did you write down? _________

Were there more than 10 words that you did not know and understand?

Yes No
<table>
<thead>
<tr>
<th>Question #5 (Long Term Retrieval Fluency)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Do you understand what you just read?</strong> (circle one)</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>I'm positive</td>
</tr>
<tr>
<td>I do not understand</td>
</tr>
</tbody>
</table>

Write down the 5 most important events that have happened in the book so far. Put them in order.

Now take a look!
How close were you?

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>I was completely wrong</td>
<td>I was mostly wrong</td>
<td>I was mostly right</td>
<td>I was completely right</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question #6 (Long Term Retrieval Fluency)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I remember the important ideas of the reading.</strong> (circle one)</td>
</tr>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

What are the important ideas the author wants you to know from your reading today?

How did you do at remembering the important ideas of the reading?

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>It was impossible!</td>
<td>It was fairly hard</td>
<td>It was fairly easy!</td>
<td>It was really easy!</td>
</tr>
</tbody>
</table>
Question #7 (Long Term Retrieval Fluency)

How interested are you in what the book is about? (circle one)

1 2 3 4
Not Not very Interested Really
at interested interested!
all!

Write down the four most important events that occurred in the reading.

How did you do at writing down the most important events?

1 2 3 4
I couldn’t It was It was It was
think fairly fairly really
of any! hard easy easy!

Question #8 (Processing Speed)

Before you start reading:

Write down the time here: ______________

At what time will you finish reading? ______________

How many pages will you read? ______________

After you finish reading:

Write down the time here: ______________

How many pages did you read? ______________

How close were your predictions?

1 2 3 4
I was Not I was I was
way very close exactly
off! close right!
Page Two Questions

**Processing Speed**

How fast do you think?

Look at your cognitive profile.

What does it say about how fast you can think?

How would being able to think faster help you read better?

---

**Long Term Retrieval Fluency**

How fast can you find what you have stored in the files in your brain?
How well organized are those files?

What is long term retrieval fluency? Please write a definition. (Hint: Look at the top of the paper)

Look at your cognitive profile.

What does it say about how fast you can find what you have stored in the files in your brain?

How well organized do you think those files in your brain are? (write or draw a picture)

How would having an organized brain help you understand what you read?

---

**Working Memory**

How much information can you hold in your brain at once?
For most people, it’s 5-7 chunks of information

Look at your cognitive profile.

What does it say about how much information you can hold in your brain at once?
What is working memory?

How would being able to hold a lot of information in your brain for a short time help you understand what you read?
Background Knowledge
How much do you know about the world around you?
How many words do you know?

What is background knowledge? Please write a definition. (Hint: Look at the top of the paper)

Look at your cognitive profile.

What does it say about how much you know about the world around you and how many words you know (your background knowledge)?

How would knowing more words help you understand what you read?

How would knowing about the world around you help you remember what you read?
## APPENDIX E
Visual Map of Procedures Sequence

<table>
<thead>
<tr>
<th>Foundational Testing of Cognitive Abilities</th>
<th>Control Group (Cognitive Assessment Only) N=65</th>
<th>Profile Awareness Group N=65</th>
<th>Metacognitive Systematic Inquiry Group N=66</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodcock-Johnson III Cognitive Tests</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Visual Matching</td>
<td>measures processing speed</td>
<td>measures processing speed</td>
<td>measures processing speed</td>
</tr>
<tr>
<td>2) Numbers Reversed</td>
<td>measures short term memory</td>
<td>measures short term memory</td>
<td>measures short term memory</td>
</tr>
<tr>
<td>3) Retrieval Fluency</td>
<td>measures long term retrieval fluency</td>
<td>measures long term retrieval fluency</td>
<td>measures long term retrieval fluency</td>
</tr>
<tr>
<td>4) General Information</td>
<td>measures background knowledge</td>
<td>measures background knowledge</td>
<td>measures background knowledge</td>
</tr>
<tr>
<td>Pre-tests of Reading Comprehension</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Self Perceived Reading Comprehension Ability</td>
<td>self-reflection on comprehension</td>
<td>self-reflection on comprehension</td>
<td>self-reflection on comprehension</td>
</tr>
<tr>
<td>B. Oregon State Assessment</td>
<td>standardized test of reading and literature</td>
<td>standardized test of reading and literature</td>
<td>standardized test of reading and literature</td>
</tr>
<tr>
<td>C. Burns &amp; Roe Informal Reading Inventory</td>
<td>grade level reading comprehension test</td>
<td>grade level reading comprehension test</td>
<td>grade level reading comprehension test</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control Group (Cognitive Assessment Only) N=65</td>
<td>Profile Awareness Group N=65</td>
<td>Metacognitive Systematic Inquiry Group N=66</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-----------------------------------------------</td>
<td>-------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td><strong>Cognitive Profile Awareness</strong></td>
<td>D. Cognitive Profile Demonstration</td>
<td>E. Cognitive Profile Feedback</td>
<td>D. Cognitive Profile Demonstration</td>
</tr>
<tr>
<td></td>
<td>explanation of cognitive profiles</td>
<td>student cognitive definitions and individual cognitive profile explanations</td>
<td>explanation of cognitive profiles</td>
</tr>
<tr>
<td></td>
<td><strong>Metacognitive Systematic Inquiry</strong></td>
<td></td>
<td>F. Metacognitive Systematic Inquiry Instrument</td>
</tr>
<tr>
<td></td>
<td><strong>Post-tests of Reading Comprehension</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A. Self Perceived Reading Comprehension Ability</td>
<td>A. Self Perceived Reading Comprehension Ability</td>
<td>A. Self Perceived Reading Comprehension Ability</td>
</tr>
<tr>
<td></td>
<td>self-reflection on comprehension</td>
<td>self-reflection on comprehension</td>
<td>self-reflection on comprehension</td>
</tr>
<tr>
<td></td>
<td>B. Oregon State Assessment</td>
<td>B. Oregon State Assessment</td>
<td>B. Oregon State Assessment</td>
</tr>
<tr>
<td></td>
<td>standardized test of reading and literature</td>
<td>standardized test of reading and literature</td>
<td>standardized test of reading and literature</td>
</tr>
<tr>
<td></td>
<td>C. Burns &amp; Roe Informal Reading Inventory</td>
<td>C. Burns &amp; Roe Informal Reading Inventory</td>
<td>C. Burns &amp; Roe Informal Reading Inventory</td>
</tr>
<tr>
<td></td>
<td>grade level reading comprehension test</td>
<td>grade level reading comprehension test</td>
<td>grade level reading comprehension test</td>
</tr>
</tbody>
</table>
APPENDIX F

Cognitive Profile Awareness Demonstration

Definitions of Cognitive Abilities

**Processing Speed**
How fast do you think?

**Working Memory**
How much information can you hold in your brain at once?
For most people, it’s 5-7 chunks.

**Background Knowledge**
How much do you know about the world around you?
How big is your vocabulary?

**Long Term Retrieval Fluency**
How fast can you find what you have stored in the files in your brain?
How well organized are those files?

Student Feedback

1. What is processing speed?

2. What is working memory?

3. What is background knowledge?

4. What is long term retrieval fluency?

5. What does your own cognitive profile say about how your brain works?
REFERENCES


*Profile of economic characteristics: 2000* (SF3) [Data file]. Washington, DC: U.S. Bureau of the Census


