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The Role Of Cognitive And Metacognitive Reading Comprehension Strategies In The Reading And Interpretation Of Mathematical Word Problem Texts Reading Clinicians' Perceptions Of Domain Relevance And Elementary Students' Cognitive Strategy Use

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THE ROLE OF COGNITIVE AND METACOGNITIVE READING COMPREHENSION
STRATEGIES IN THE READING AND INTERPRETATION OF MATHEMATICAL WORD
PROBLEM TEXTS: READING CLINICIANS' PERCEPTIONS OF DOMAIN RELEVANCE
AND ELEMENTARY STUDENTS' COGNITIVE STRATEGY USE

by

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ABSTRACT

The intent of this concurrent mixed method study was to examine teacher perceptions and student applications of cognitive reading comprehension strategy use as applied to the reading and interpretation of a mathematics word problem. Teachers' perceptions of the relevance and application of cognitive reading comprehension strategies to mathematics contexts were investigated through survey methods. Additionally, students' cognitive strategy use was explored by eliciting verbalization of cognition using think aloud protocol and clinical interview probes with purposively selected first through sixth-grade students. An experimental component of this study involved the random assignment of teachers to a professional development book study focused on either a) instructional methods supportive of integrated cognitive strategy instruction in reading and mathematics (treatment group) or b) a review of cognitive strategy instruction in reading (control group). The results of this study indicate that the elementary student participants did not recognize the cognitive comprehension strategies that they were using during the initial reading of the mathematical text as relevant to mathematics based text, which is why initial patterns of strategy use were not sustained or renegotiated, but were instead replaced or extinguished without replacement upon identification of the text as mathematical. This may be due to a lack of: 1) domain-general instruction, 2) varied text examples in their schooling, and/or 3) conditional knowledge instruction for strategy use, effects that may be caused by the students' teachers' own domain-specific perceptions of cognitive strategy use at the elementary level. The teachers in the treatment group demonstrated greater awareness of the relevance of cognitive reading comprehension strategies for mathematics text than the control group; however, there was no evidence that this new awareness impacted their instruction in this study. Implications for

professional development, integrated cognitive strategy instruction, and contributions to existing

literature are discussed.

To my number 1 yellow, Julia Grace.

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CHAPTER 1: INTRODUCTION

Statement of the Problem

According to the recently published, influential final report of the National Mathematics Advisory Panel (2008), increased rigor in mathematics education is essential for informing policy and practice, and mathematics instruction should be informed by high-quality research and teacher experience, both of which were supported by the National Council of Teachers of Mathematics (2011). Although there are critics who are skeptical of the participants, protocols, and specific considerations of the National Mathematics Advisory Panel (Boaler, 2008), many mathematics education researchers welcome increased discussion on the current state of mathematics education in the nation, with the hope that it will allow for increased research opportunities, professional development, and funding for schools, as was the case in reading education following the release of the final report of the National Reading Advisory Panel in 2000. With the sense of urgency for mathematics education reform expressed by this report, it is critical that we have a better understanding of how teachers perceive and students use cognitive strategies in mathematics in order to identify and expand the use of research-based instructional practices that support students' mathematical thinking.

Current mathematics education research describes the use of various effective strategies for supporting students' mathematical thinking and problem solving, many of which reveal strikingly similar cognitive bases to those used in reading education (Bauersfeld, 1995; Borasi & Siegel, 2000; Carpenter, Franke, & Levi; 2003; Ma, 1999; Miller, 1996; Osterholm, 2005; Schneider & Artelt, 2010). In fact, in educational psychology research, strategies such as visualizing, connecting, predicting, and questioning (all readily identified in both mathematics and reading education literature) are not identified as domain-specific to reading or mathematics

because their use can be learned, refined, and applied through self-regulation toward a variety of academic tasks. Due to such strategies being taught in isolation at the university level, however, many pre-service teachers are learning content area pedagogical strategies as domain-specific, which then represents the way they are taught to children. In other words, children have likely come to see strategies (such as those identified) as self-contained within domains rather than as flexible tools to use across disciplines. This may ultimately result in lost opportunities for developing self-regulation of strategy use and promoting knowledge transfer in children across learning domains, including mathematics education, especially at the elementary level of schooling. Further, this segregation of educational research may be limiting opportunities to identify powerful instructional models that could be used to inform policy and practice in schools. Clearly, further research on the connection between math and reading strategies is warranted in order to potentially expose similarities in cognition, which could have research and instructional implications toward the teaching of strategies as either domain-specific or general. The purpose of this study is to investigate elementary students' cognitive strategy use during the reading of mathematical text and identify whether or not teachers perceive cognitive strategies as relevant for use in this same context.

<div align="center">Conceptual Framework</div>

This study assumes a framework of self-regulatory knowledge in which there is a difference between domain-specific and domain-general knowledge and applied strategies for each, with the premise that domain-general knowledge and strategies can be more readily transferred across learning domains (Schraw, 2001). In his taxonomy of knowledge, Schraw (2006) delineated domain-specific knowledge into sub-components of content, task, and the individual person. Considering the problem identified as the impetus for this study, current

applied cognitive strategy instruction seems to be rooted in a domain-specific approach, grounded in the interpretation of content area tasks that lead to the activated use of strategies that have been identified and developed separately within the fields of reading education and mathematics education. Students are trained to access their existing knowledge within the content area and approach the task with the use of taught cognitive strategies. It is significant to note that there has been acknowledgement from research in both domains that motivation and affective factors may also impact this processing, which is consistent with the inclusion of "person" as a component within domain-specific knowledge development (Schraw, 2006).

Review of current research in both academic fields reveals similar strategy sets, however, that are grounded in cognitive processes from self-regulation literature such as questioning, visualizing, connecting, synthesizing, analyzing, and predicting (Hyde, 2006; Duffy, 2002; Harvey & Daniels, 2009; Keene & Zimmerman, 1997). Thus, it seems arguable that rather than teaching these cognitive strategies in a domain-specific approach where they may only be accessed and applied upon students' identification of a relevant, domain-specific task, it may be more beneficial to recognize the underlying metacognitive components of these strategies and teach them in a domain-general format to increase transfer and yield greater efficiency of cognition. It is important to note, however, that for the purpose of this study, despite the researcher's awareness of the domain-general, self-regulatory nature of the mental processes in question, strategies such as visualizing, questioning, connecting, synthesizing, and predicting will be referred to as "cognitive comprehension strategies" to reflect the way that they are currently being represented in the reading education literature and typically perceived as domain-specific to reading in the mathematics education literature.

The development of cognitive strategy instruction models arose in the 1980s in response to the emergence of contemporary models of thinking related to the information processing approach to cognition. Studies revealed that a great deal of classroom instructional time was spent on assigning activities, monitoring student progress, and providing corrective feedback to errors, but not actually modeling or explaining skills, strategies or processes (Pressley & Woloshyn, 1985; Duffy & Roehler, 1986). The fundamental tenets of cognitive strategy instruction were grounded in the viewpoint that aspects of the information processing learning theory such as short-term memory capacity and the retrieval of declarative or procedural knowledge can be modified from an individual's baseline performance based on instructional practices.

Under the premise of the Select-Organize-Integrate (SOI) model, students assume responsibility for discriminating among incoming stimuli to identify significant information, which is then organized around existing knowledge structures and appropriately integrated into students' schemas (Mayer, 1996). While the SOI model provides a framework for understanding how information is processed, it is significant to recognize that metacognitive knowledge can be further developed through classroom instruction, which impacts the efficiency of the select-organize-integrate processes. Critical, synchronized components of thinking that are affected by such instructional practices, and thereby have learning effects, include: strategies, metacognition, content knowledge base, motivational beliefs, and cognitive style (Baron, 1985; Barkowski, Carr, Rellinger, & Pressley, 1990; Nicholls, 1990). Clearly, as students' abilities to engage in the metacognitive processing of information are further developed, an increase in self-regulation is an associated outcome.

Pintrich (2000) identified four phases of self-regulated learning: 1) forethought/planning/activation, 2) monitoring, 3) control, and 4) reaction and reflection. Within each phase are areas for self-regulated learning including cognition, motivation/affect, behavior, and context. Students' behaviors indicating regulation, or lack thereof, can be analyzed using this framework in order to identify a more comprehensive understanding of the process of self-regulation of learning and contributing factors.

The framework of self-regulatory learning provides the lens in this study for how the cognitive, metacognitive, and social-emotional aspects of learning are measured. Students' cognitive and metacognitive strategy use will be identified and analyzed using Pintrich's (2000) phases of self-regulated learning. Additionally, students' cognitive and metacognitive strategy use will be interpreted to possibly expand the activated strategy set during the phases of "monitor" and "control," with considerations toward domain-specific strategy use and an increase in metacognitive functioning.

It is crucial to delineate the meaning of the term "cognitive strategy" and the implications for cognitive strategy instruction in the classroom due to the fact that there is not currently consistent common understanding of the use of this language (Afflerbach, Pearson, & Paris, 2008). In this study, consistent with Rosenshine (1985), cognitive strategies will be considered heuristics that support students' thought processes such that students can then better perform higher-level thinking tasks. These internal processes, such as visualizing, are not components of a task-analysis of higher order learning expectations; thus, using the strategy will not provide the answer or outcome to a higher-order operation. Rather, the cognitive strategies enable students to activate their existing knowledge base and deliberately, yet flexibly, select and utilize mental processes that will enable them to better understand the learning challenges that are presented. It

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is intended that proficient learners will ultimately be able to authentically use cognitive strategies on their own. Therefore, while strategy use may be more concrete during the teaching and learning process (through teacher modeling, guided student practice, etc.), the goal is for learners to apply the strategies mentally through self-regulation, which highlights the metacognitive component of cognitive strategy instruction. This differentiates student self-regulated cognitive strategies (SSR) (Pressley & Woloshyn, 1985) from teaching strategies (specialized instructional methods) which are based on educator-related application, text-based strategies that involve the use of specially developed graphic organizers or modified note-taking formats (Hoffman, 1992; Richardson & Morgan, 1997; Stahl, 2008), and domain-specific task analysis.

Purpose of the Study

The intent of this concurrent mixed method study was to examine teacher perceptions and student applications of cognitive reading comprehension strategy use as applied to the reading and interpretation of a mathematics word problem. Teachers' perceptions of the relevance and application of cognitive reading comprehension strategies to mathematics contexts were investigated through survey methods. Additionally, students' cognitive strategy use was explored by eliciting verbalization of cognition using think aloud protocol and clinical interview probes with purposively selected first through sixth-grade students. An experimental component of this study involved the random assignment of teachers to a professional development book study focused on either a) instructional methods supportive of integrated cognitive strategy instruction in reading and mathematics (treatment group) or b) a review of cognitive strategy instruction in reading (control group). After the professional development book study, teacher survey data was obtained to determine if there was a difference between teachers' perceptions of domain relevance of cognitive reading comprehension strategies based on their book study group

assignment, controlling for the teachers' levels of education, academic major, prior coursework in reading and mathematics education, and pre survey scores. The students' strategy use during individual interviews (both self-reported and researcher-identified) was also used to determine if there was a difference in the students' cognitive reading comprehension strategy use during the reading and interpretation of a mathematics word problem based on their teachers' professional development book study assignment, controlling for students' grade, reading achievement, and mathematics achievement level. Further, students' verbalizations of strategy use during the reading of mathematics text was compared to their cognitive reading comprehension strategy use during the reading of nonfiction and fiction passages to determine if there was a significant difference in strategy use based on text genre.

The reason for combining both quantitative and qualitative data collection methods was to better understand this research problem by converging numeric trends with more detailed perspectives through the qualitative analysis of strategy use and explanation of survey items. While the research questions that follow have been categorized as qualitative or quantitative to more clearly identify the data collection and analysis procedures that were used for each, all data was converged during final analysis to provide a more comprehensive understanding of teachers' perceptions of strategy application and students' cognitive strategy use.

<u>Research Questions</u>

Qualitative

1) Do students use cognitive comprehension strategies during the reading of a mathematics-based text? If so, how?

2) Do first through sixth-grade students use cognitive reading comprehension strategies differently across fiction, nonfiction, and mathematical content-specific text applications?

3) Do reading clinicians identify the use of cognitive comprehension strategies as relevant to mathematical text?

4) Do reading clinicians' perceptions of applied cognitive reading comprehension strategy use in mathematics contexts differ based on participation in the professional development experimental group or control group?

5) Do students' cognitive reading comprehension strategy uses during mathematics text reading, interpretation, and solving differ based on the students' assigned clinicians' participation in either the treatment or control professional development group?

Hypotheses for quantitative questions will be presented in Chapter 3.

<u>Significance of the Study for Theory</u>

This study is derived from problems centering on the isolated development, research, and instructional use of self-regulatory cognitive strategies that are being utilized in domain-specific capacities within reading and mathematics education, specifically at the elementary level. Rather than teaching students to use strategies as they are specifically relevant to synthesize content and tasks presented by domain, a focus on developing metacognitive knowledge within a domain-general framework may increase students' depth of understanding of cognitive strategies, including ways to govern their use and promote knowledge transfer. Schraw and Moshman (1995) identify domain-general knowledge as typically being tacitly acquired and developing later in life; however, given current research in reading education that identifies students as capable to learn and utilize self-regulated strategies to develop metacognition (Schneider &

Artelt, 2010), it may be arguable that such domain-general knowledge could in fact be explicitly

taught to children at the elementary level if the common ground among strategy use in reading

and mathematics education is exposed in this study. Due to the extremely limited research in this

field, however, results of the investigative components of the current study will be needed to

frame future research that may have a greater impact on theoretical development of domain-

general self-regulatory cognitive strategies, as they are taught to and applied by elementary level

learners.

<div align="center">Significance of the Study for Practice</div>

This study offers potential points of significance for practice on two levels: teacher

education and elementary cognitive strategy instruction, specifically considering mathematics and

reading education. Findings could (a) inform faculty of university teacher preparation programs

of reading teachers' perceptions of strategy relevance across domains for elementary students, (b)

inform elementary teachers of students' ability to utilize cognitive reading strategies with

mathematical text, (c) provide a framework for professional development that emphasizes the

underlying similar constructs in current cognitive strategy instruction within reading education

and mathematics education, d) suggest possible implications for integrated cognitive strategy

instruction across the reading and mathematics curriculum, and e) provide a platform in the

literature for faculty of elementary pre-service teachers in domain-specific and foundational

positions to increase their awareness of the underlying components of learning and cognition that

ground current instructional practices regarding cognitive strategy instruction across fields.

CHAPTER 2: REVIEW OF THE LITERATURE

Introduction

In this chapter, I review research on the use of cognitive strategies and self-regulated learning. I begin by situating the interpretation of "cognitive strategies" within educational psychology research. Next, I will review self-regulated cognitive strategy use from domain-specific and domain-general theoretical perspectives. This is followed by a review of applied research on cognitive strategy instruction in reading education and mathematics education literature, through which I identify examples of domain-specific interpretations in each field. The limitations of domain-specific research on strategy instruction will then be discussed, specifically considering the potential impact of applying and integrating strategy instruction through a domain-general approach at the elementary level in particular, with an emphasis on examining students' cognition and promoting self-regulated strategy retrieval and use. Finally, I will review research on the use of interview methods and think aloud protocol with children, including potentials and limitations of this methodology.

A comprehensive literature review is necessary in order to provide a significant framework from which to plan and implement both theoretical and practical research (Boote & Beile, 2005). In order to effectively conduct a thorough review of the research on the role of cognitive strategy instruction as related to self-regulated learning, with specific applications to reading and mathematics education, the review of literature included samples of published research, position papers, professional books, handbooks of research, and other documents from 1931 to present. Only original studies were reviewed (not replications), with the exception of those follow up studies that revealed contrasting conclusions. Keywords used to identify many of the sources identified in the review included: cognitive strategy, self-regulated learning, domain-

specific knowledge, domain-general knowledge, problem solving strategies, comprehension strategies, integrated reading and mathematics instruction, and think aloud protocol. The majority of the studies that were reviewed were empirical in nature, and most used a mixed method research design. Theoretical and conceptual works, in addition to technical documents were also included. Although examples of research on self-regulation, domain-specific, and domain-general strategies were identified from a wide variety of disciplines and applied fields, only literature pertaining to education were included in this review.

<center>Cognitive Strategy Instruction</center>

The development of schema theory in educational psychology (Bartlett, 1932; Rumelhart, 1980) ignited a trend of cognitive strategy instruction in the 1970s and 1980s, in which strategies identified from the analysis of cognition of experts were explicitly taught to students in conjunction with metacognitive monitoring strategies to govern their mental use (Greeno, Collins, & Resnick, 1996; van Dijk & Kintsch, 1983). Initial research was based on educational psychology and reading education literature (Dole, Nokes, & Drits, 2008). Despite extensive research on cognitive strategy instruction to date, the use of the word "strategy" with regard to educational practice and instructional planning no longer has the shared meaning among educators and researchers that it once did. Numerous professional publications for educators that are grounded in cognitive strategy research are readily available in professional libraries across the country (Blachowicz & Ogle, 2001; Harvey & Goudvis, 2007; Keene & Zimmerman, 1997; Oczkus, 2004; Outsen & Yulga, 2002; Stebick & Dain, 2007; Tovani, 2004; Zwiers, 2004); however, there is variance among the characteristics of strategy type, application, related context, and instruction, which is likely in need of synthesis and clarification in current literature. Examples were provided in the Conceptual Framework in the preceding chapter, in which I

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articulated the interpretation of "cognitive comprehension strategy" that was used in this study. In the recently published *Handbook of Research on Reading Comprehension* (2008), Dole, Nokes, and Drits provided an overview of cognitive strategy instruction, which was heavily relied upon for this section of the review of literature in order to examine cognitive strategy instruction from both theoretical and applied perspectives.

The earliest research involving strategy instruction was based on the processes used to solve problems. In line with Polya's (1945) research in mathematics, Newell and Simon (1972) identified processes that learners could use as steps to reach an intended outcome in a variety of settings and tasks. For example, they studied learners' use of strategies such as trial and error and working backwards. This was an example of some of the earliest work around domain-specific strategies, which will be further discussed in the section to follow.

In a review of strategy research, Pressley and Woloshyn (1985) identified cognitive strategies across content domains of reading, writing, study strategies, and mathematics, all of which included mental processes consciously accessed and used by an individual in order to deepen their understanding of a given task. Alexander, Graham, and Harris (1998) further described strategies as procedural, purposeful, effortful, willful, and essential, and they delineated cognitive strategies as only those that support understanding and performance on cognitive tasks; thus, by this definition, instructional strategies and task analysis-related strategies are not considered cognitive in nature. This further illustrates the existing confusion over a lack of common language regarding the term "strategy."

As both theoretical and practical cognitive strategy instruction research evolved, the research area became associated with metacognitive awareness, which described individuals' knowledge, selection, and governing of strategic processes. Strategies were viewed as conscious

and deliberate mental processes, although research suggested that with continued use, cognitive and metacognitive strategies could ultimately be governed and employed with less effort (Pressley & Afflerbach, 1995; Schneider, Dumais, & Shiffrin, 1984).

Pressley (1976), perhaps the most notable contributor to literature on cognitive strategy instruction, measured the effectiveness of training third-grade students to visualize during the reading of text in one of the first studies based on single strategy use. Results from reading comprehension scales revealed that students who received instruction in visualizing text outperformed the control group, regardless of the students' reading achievement level. Brown and Day (1983) and Brown, Day, and Jones (1983) also contributed notable early work across K-20 grades of schooling, examining learners' use of the cognitive strategy of summarizing text. Their findings yielded implications for componential analysis of summarizing for future instruction based on the analysis of mental processes of effective summarizers. Additional single strategy research was conducted throughout the 1980s based on the use of cognitive strategies such as self-questioning and text-based strategies such as story mapping (Singer & Donlan, 1982; Idol, 1987); however, the differences between these two aforementioned strategies yet again illustrate discrepancies regarding the term "cognitive strategy." Some researchers have offered clarification such that cognitive strategies should only describe mental processes whereas other strategy descriptors reference the use of graphic organizers, procedures, and memorable tools that aid in the completion of a given task.

With increased attention to single strategy studies came the focus on multiple strategy sequences and the reciprocal teaching intervention by Palinscar and Brown (1984), which is perhaps the most notable of research on cognitive strategy instruction as applied to reading education. The multi-strategy process of reciprocal teaching involves summarizing, questioning,

clarifying, and predicting for chunked text excerpts in a gradual release model of apprenticeship-style instruction. Throughout their numerous studies comparing reciprocal teaching treatment groups to single strategy treatment and control groups across multiple grade levels, they found conclusive evidence that students who engaged in this instruction consistently outperformed the other experimental groups.

As increased results on the effectiveness of cognitive strategy use were published, there was a shift in research focus to how effective instruction of cognitive strategy use should be planned and delivered. Duffy et al. (1986, 1987) conducted studies to examine how teacher training in strategy instruction impacted the effectiveness of explicit instructional delivery. They found that teachers who received training in strategy instruction demonstrated more explicit strategy lessons, including what the strategy was, why it should be learned, why it was useful, how to use it, and when its use was relevant. This explicit instruction also yielded increased student awareness of the need for strategy use and metacognitive awareness of strategy use, as determined by the analysis of data collected.

As instructional foci on cognitive strategy instruction became more widely published, confusion around the terminology "cognitive strategy" and "comprehension strategy" persisted. Tierney and Cunningham (1984) provided useful distinctions between this vocabulary by describing comprehension strategies as tools that teachers use and teach in order for students to understand text when they are reading. Examples that are widely used and cited in reading education literature currently include the Anticipation Guide (Readence, Bean, & Baldwin, 1989) and Directed Reading-Thinking Activity (Stauffer, 1969), among many others. Cognitive strategies, conversely, were identified as mental strategies used by students that could be transferred across contexts.

Review of the instructional delivery approaches for cognitive strategy instruction revealed that there are many different models documented in the literature, such as the explicit instructional delivery system, the explicit explanation model (Duffy, 2002; Duffy & Roehler, 1987), the cognitive apprenticeship model (Collins, Brown, & Newman, 1989; Stahl, 1997; Palincsar & Brown, 1984), and the implicit or invisible strategy instruction delivery system (Dole, 2000; Vacca & Vacca, 2004). It should be noted, however, that the latter model has been the most widely criticized due to the fact that it involves providing learning experiences in which students are required to use cognitive strategies without teacher modeling or explanation of the strategy usefulness. Critics suggest that this method lacks the supportive metacognitive component, also referred to as conditional knowledge, which readily facilitates strategy retrieval and application for "good strategy users" (Pintrich & De Groot, 1990). For the purposes of this study, based on the literature that was used for the professional development book study (Hyde, 2006; Harvey & Goudvis, 2007), the explicit explanation model was presented to participating teachers/reading clinicians. Using this model, it is important that instruction of cognitive strategies includes explanation of the strategy in order to help students: meaningfully understand the strategies, understand why they are learning them and how they will help, learn how to use the strategies through approximated measures and practice, understand the contexts in which strategies should be retrieved and used, and evaluate strategy use to increase metacognitive awareness (Winograd & Hare, 1988).

<div align="center">Self-Regulated Learning</div>

As an increased awareness of metacognitive processes emerged in educational research and practice in the 1980s, there was a movement focused on the investigation of how some students become masters of their own learning. The construct of self-regulation was developed as

a result, which describes the process through which learners engage in modification of mental skills toward academic task completion (Zimmerman & Schunk, 2001). Self-regulated learning theory assumes that in order for students to transform their mental thoughts into actions, learners must demonstrate initiative, perseverance, and adaptive skills beyond those that are a result of classroom instruction (Borkowski, Carr, Rellinger, & Pressley, 1990). Self-regulated learners plan, monitor, adapt, and evaluate their learning goals, processes, and outcomes. They are active contributors to their learning and take initiative to progress toward goal attainment.

Early research on associated processes of self-regulated learning focused on self-reinforcement, setting standards, student goal setting behaviors, student perceptions of self-efficacy, self-instructing, and self-evaluation. Processes of self-regulation were also often classified separately as domain-general and domain-specific based on the observed self-regulatory behaviors of students in natural and research settings (Bandura, 1997; Zimmerman, 1998). Further, lines of research investigating the use of self-regulatory processes within content domains can be readily identified (Carpenter, Franke, & Levi, 2003; Harvey & Goudvis, 2007; Ma, 1999; Palinscar & Brown, 1984), although most examples focus on student learning and metacognitive awareness outcomes that are based on achievement and performance within the domain. Research describing and supporting each of these categories will now be discussed.

<div align="center">Domain-specific Strategies</div>

There is a large body of research to support that evidence of transfer of strategy use is greatest when similar problems within the same domain are presented as the experimental transfer tasks after a strategy has been introduced in an experimental intervention context (Alvermann, 2002; Fuchs, 2003); thus, a great deal of strategy development and instruction has been based on the use of the domain-specific strategies within each of the standard academic content areas:

reading, writing, mathematics, science. Components of declarative knowledge, procedural

knowledge, and conditional knowledge contribute to the definition of domain-specific

knowledge, from which domain-specific strategies emerged (Alexander & Judy, 1988; Schraw,

2006). Research suggests that very often strategies that are developed for domain-specific use

were developed from a task analysis based on typical academic tasks for that content area, in

which the underlying cognitive processes for the task are identified, and approximated cognitive

tasks toward global task completion are determined (Mayer & Wittrock, 2006). Englert, Raphael,

Anderson, Anthony, and Stevens (1991) reveal an example from writing instruction, in which the

task of writing an essay was broken down into three steps: planning, translation, and reviewing.

To reinforce and capture artifacts from each cognitive sub-task, participating students in this

research were provided with a graphic organizer that was divided into the three sub-task

components. Additional examples of domain-specific strategies can be readily identified in

educational psychology research and content area education research, such as Directed Reading-

Thinking Activity (DRTA) (Stauffer, 1969), Polya's (1957) four phase mathematical problem

solving approach (1. Understand the problem, 2. Devise a plan, 3. Carry out the plan, 4. Check

the solution and reflection on the plan), and "Think Sheets" in writing instruction (Englert,

Raphael, & Anderson, 1992).

Many researchers claim that domain-specific strategies should be used in favor of

domain-general strategies due to the importance of connecting learners' advancing understanding

of content with their strategic processes (Alexander & Judy, 1998). This should not be surprising

since the cognitive task analysis procedures that provide the foundation for many domain-specific

strategies have been based on research focusing on the components of and differences between

cognition of experts and novices in a given domain (Pressley & Woloshyn, 1985). More recently

coined "secondary" domain-specific abilities (Geary, 2007) to differentiate between those domain-specific tendencies inherent at birth, domain-specific strategies are often identified as essential, especially among content experts in academic fields (i.e. mathematicians in the field of mathematics), in order to acknowledge and prepare students for the demands of rigorous content that increase with years of formalized schooling.

Due to the use of elementary student participants in this study, it is important to identify some of the issues that have surfaced in research on domain-specific strategy use among children. Pressley & Harris (2006) describe some of the deficiencies that young children have demonstrated during domain-specific strategy attempts. Research in this area suggests that young children often have difficulty constructing the abstract mediators (Bodrova & Leong, 2007) necessary in order to mentally represent both a strategy idea and the content demands of the context in which they are attempting to use the strategy (Pressley, 1976; Cariglia-Bull & Pressley, 1990). Reese (1962) referred to this processing challenge as a mediation deficiency, which has since been explained through children's limitations of working memory, slower internal cognitive operations, and decreased capacity for cognitive load (Pressley, Cariglia-Bull, Deane, & Schneider, 1987). The results of studies where students' strategy use related to problem solving accuracy improved according to age, either over a longitudinal study or by comparison across age bands, support this claim (Hilden & Pressley, 2007). An additional challenge associated with strategy use dependent on the age of the child stems from evidence of retrieval deficiencies, in which students fail to apply a strategy in a given context, despite showing previously showing evidence of understanding and applying the strategy (Kobasigawa, 1977). This type of deficiency can be even more significant when students are drawing from a large number of taught strategies in different domains, despite their evidence of strategy use during instructional contexts in each

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domain separately. Nonetheless, current instructional literature for practitioners frequently emphasize domain-specific strategy instruction for even the youngest of school-age children, very often with research to support the effectiveness of use; thus, there is evidence to suggest that the strategy use of children is highly complicated. This research will examine and consider the challenges that children face when retrieving and applying strategies during contexts of reading fiction, nonfiction, and mathematical text.

<div align="center">Domain-general Strategies</div>

Domain general knowledge describes knowledge that can be applied in a variety of content areas and maintains relevance regardless of topic. This type of knowledge, also often described as metacognitive knowledge (Flavel, 1981), includes consideration of learners' awareness and regulation of cognition. (Schraw, 2006). To further describe, knowledge or awareness of cognition includes having an understanding of learning strategies in addition to the conditional knowledge of when and how the strategies could be applied to a given setting or task, which is a crucial component of self-regulated learning (Pressley & Woloshyn, 1985). Although one might expect that having a large repertoire of learning strategies would be useful for learners, there is research that indicates that self-regulated learners often use a small set of general strategies in flexible ways across content area demands (Schraw, 2006). Text-based strategies such as identifying the main idea, inferring, skipping or skimming text, and summarizing are examples of some of the strategies that have been found to be useful for learners when intentionally transferred across domains (Duffy, 2002). In fact, there is research to support that several interrelated strategies are often more effective for learners than individual, disconnected strategies, and that the use of four to five strategies for a variety of contexts seems most effective (Rosenshine, Meister, & Chapman, 1996); however, these findings are contingent upon the

development of conditional knowledge which helps learners determine the circumstances in which strategy use can be activated and applied. This research suggests that students need to be taught "why, when, and where" to use strategies with as much deliberate instruction as "how" (Schraw, 2006). In consideration of these findings as relevant to the study at hand, the investigative component into elementary students' cognitive strategy use will give insight as to whether or not students posses strategy knowledge and/or conditional knowledge for strategy use when reading mathematics text.

Regulation of cognition, another component of domain-general knowledge, requires an awareness of self-monitoring and self-governing skills, such as planning, adapting, controlling, and evaluating learning experiences (Kuhn, 1999; Schraw, 2001). There is research that suggests that adults are able to monitor their strategy use at local (i.e. item) and global (i.e. full task) levels (Kuhn, 1999); however, whether or not children can similarly monitor domain-general strategies is unknown. This study will use think aloud protocol and the use of a probing, student self-reported strategy survey to identify if and how students use a set of strategies across domains, which may also offer implications for the presence of local and/or global strategy use.

Additional research challenging the complexity of domain general knowledge construction in children suggests that domain general knowledge, including both knowledge of cognition and regulation of cognition, is often implicit and develops later in life (Alexander, Carr, & Schwanenflugal, 1995). Similar research suggests that adults have a greater awareness of their own mental processes than children or adolescents, and that increases in domain general knowledge may be acquired with little to no awareness (Schraw & Moshman, 1995). There are limited examples, however, in which domain-general instruction aimed at advancing conditional knowledge of when, why, and where to use was found to positively impact students' assertions of

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their own cognition and the effectiveness of strategy use (Schraw, 2001; Schunk & Zimmerman, 1998), upon which this research would build if results suggest that students can describe their cognitive comprehension strategy use across learning domains. In order to better understand recent research-based instructional approaches for the domains of interest in this study (reading and mathematics education), each will now be discussed.

<center>Reading Comprehension Instruction</center>

Hodges (1999) suggests a definition of reading comprehension among others that describes the complex process of constructing meaning from text as the result of the following elements: predicting what is anticipated in the context, confirming the prediction, and integrating information obtained from the text into one's own "schematic bank" (p. 1). A review of literature on reading comprehension instruction reveals that the construct of reading comprehension has become increasingly more robust within the past ten years (Keene & Zimmerman, 1997; IRA, 2011; National Reading Panel, 2000). Archaic models of assessing reading comprehension involved little more than content questions presented at the end of a text reading, whereas current reading comprehension assessments are based on components of strategies for the reading process (pre-reading, during reading, post reading), monitoring of comprehension (Dole, Duffy, Roehler, & Pearson, 1991; Paris, Cross, & Lipson, 1984), and evidence of transactions between the reader and the text (Rosenblatt, 1976). Comprehension instruction is intended to not only teach students strategies for decoding and making meaning of text, but to also help students recognize when their meaning breaks down and apply learned fix-up strategies in order to continue making sense of the text (Block, Gambrell, & Pressley, 2002; IRA, 2011). Current best practices in reading comprehension instruction require teachers to introduce strategies, model and explain their use, and provide time and contexts for students to authentically use the strategies with specific,

constructed feedback. The expectation that self-monitoring strategies can be taught to students in all elementary grades has been validated by recent research (Schwartz & Perfect, 2002), despite previous challenges that self-regulatory monitoring strategies may be too complex for instruction at the primary grades (Schraw & Moshman, 1995). Examples of cognitive strategies that support comprehension, which are currently highly visible in reading education research and practitioner-focused publications include: activating prior knowledge (also described as accessing schema), generating questions, answering questions, visualizing, making connections, summarizing, making inferences, predicting, and clarifying, among others (Harvey & Goudvis, 2007; Harvey & Daniels, 2009; IRA, 2011; Keene & Zimmerman, 1997; Palinscar & Brown, 1985;). Drawing from this research, the cognitive comprehension strategies that will be measured and referenced throughout this study include: predicting, making inferences, visualizing, connecting, generating questions, summarizing, synthesizing, and determining importance.

<div align="center">Mathematics Text Reading and Problem Solving</div>

In the field of mathematics education, and more specifically in the area of problem solving, cognitive strategies have been identified as beneficial to promote problem identification, aid in student representation, facilitate approaches to obtaining a solution, and support the communication of mathematical ideas, including providing clarification if needed (Hiebert et al. 1997; Carpenter, Franke, & Levi, 2003; NCTM, 2000; Borasi & Siegel, 2000; Hyde, 2006). Specific examples include self-explanation (Chi, 2000; Rittle-Johnson & Alibali, 1999; Rittle-Johnson, 2006; Mayer & Wittrock, 2006), visualization (Ma, 1999), and student journaling, among others. Whereas early research on strategy instruction as applied to mathematics instruction and problem solving was often based on task analysis and sequential processes taught and applied for solution discovery, such as identification of key words, working backwards, and

trial and error (Newell and Simon,1972), inaccurate use of these strategies has been widely documented (Lewis & Mayer, 1987; Van de Walle, 2004) and more recent research (Ma, 1999; Jonassen, 2003; Rittle-Johnson, 2006) integrates cognitive processes that support the conceptualization of math problems for students' mathematical understanding, with the expectation that these strategies will enable students to communicate their mathematical thinking. In fact, in their research with undergraduate college students, Hegarty, Mayer, and Monk (1995) found that learners who based their problem solution plan using the direct-translation strategy (also knows as "compute first and think later" (Stigler et al., 1990, p. 15), number grabbing (Littlefield & Rieser, 1993), and the keyword method (Briars & Larkin, 1984)) were not as effective as those students who provided evidence of constructing a mental model of the problem situation. Reform in mathematics education in the past two decades has also called for teachers to better understand students' mathematical thinking. Resnick (1989) suggested that in order to be a good mathematical problem-solver, a learner must acquire habits and skills of good thinkers in general, which may have implication for mathematics education to be a socialization process that emphasizes interpretation, thinking skills, and sense-making over traditional teaching of well-defined, item-specific skills. In a four-year longitudinal study focusing on teachers receiving training to have deeper awareness and interpretations of students' mathematical understanding, Fennema et al. (1996) identified increases in student achievement for conceptual understanding, communication of mathematical ideas, and problem solving skills. Additionally, the *Principles and Standards for School Mathematics* (NCTM, 2000) emphasis the integration of general mental processes such as reasoning, justifying, communicating, and connecting in mathematics instruction. For many, the concept of probing to understand students' thinking in mathematics instruction was in contrast to didactic models of instructional delivery that had become the norm

in many classrooms. This relatively recent emphasis on student cognition, in conjunction with pressing calls for improved and innovative instruction has led some researchers, reformers, and practitioners to consider the use of cognitive comprehension strategies from domain-general perspectives, including visualizing, summarizing, questioning, connecting, predicting, and inferring, which will be further discussed in the section to follow (Pressley & Harris, 2006; Hand, Prain, Lawrence, & Yore, 1999; Lemke et al., 2004).

<center>Sociomathematical Norms</center>

Sociomathematical norms are the implicit, cultural norms that are established in mathematics classrooms, whether intentionally or unintentionally, that contribute to students' intellectual autonomy and developed dispositions in mathematics (Yackel & Cobb, 1996). Voigt (1992) argues that underlying symbolic interactionist theoretical assumptions provide a lens to make sense of students' reasoning processes and social interactions in the development of sociomathematical norms. Thus, implicit notions of behavior among teachers and students (and the varying relationships among all classroom participants) can impact students' perceptions of what it means to "do mathematics," even considering the strategies they use, their willingness to share their mathematical ideas, and their perception of "acceptable" problem solutions (Bauersfeld, 1993). In this study, the perceived sociomathematical norms of the teacher and student participants' previous classrooms were not collected or considered as data; however, it is significant to note an awareness of the potential impact of such on teachers' and students' perceptions of mathematics, despite the determination that examining such would be beyond the scope of this investigative research.

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Applied Research and Literature Across Mathematics and Reading Education

Similarities among the cognitive strategies described in the preceding sections are evident in this literature review due to the integrated focus of this dissertation research; however, these similarities are likely to be unknown and/or unacknowledged by many professionals and researchers in each isolated field. Distinct limitations of the domain-specific research that is being conducted in reading and mathematics education regarding cognitive strategy use include missed opportunities to engage in dialogue and build upon new, relevant findings and the development of disconnected content area curricula in teacher preparation programs. It seems as though evolving research in the fields of reading education and mathematics education, as explored in this chapter, has caused scholars in each discipline to have a much more comprehensive view of contributing factors, underlying constructs, and instructional implications related to content development and cognitive strategy use in their respective fields; yet, there remains a disconnect in dialogue among researchers from these disciplines, and terminology for and instructional applications of cognitive strategies vary in terms of their presentation to pre-service teachers at the university setting and instructionally in the elementary classroom (Borasi & Siegel, 1994).

While there have certainly been numerous examples of research exploring consistencies and potential points of effective integration of instruction among problem solving in mathematics and comprehension in reading education (to be discussed in this section), due to the relatively recent evolution of both of the subject areas, this research is limited in terms of the scope it provides with regard to comprehension and problem solving. Dated research by Monroe & Englehart (1931) identified that reading achievement and mathematics achievement are correlated, and Henney (1964) went further to suggest that specific reading behaviors are irrelevant when considering this relationship; however, given that this frequently referenced

research utilizes an archaic view of reading comprehension and mathematical problem solving, little significance can really be drawn at present. Likely due to the extensive research of math and reading scholars within their own fields, recent research referencing possible points of similarity or integration among the two subjects are often criticized for their limited view of the alternate subject area. For example, many mathematics educators continue to consider and measure reading components of mathematics in more discrete terms, focusing on text vocabulary, phonetic patterns, and syntax without recognition of the intricate developments of comprehension processes and instruction in recent research (Beal, Adams, & Cohen, 2010). Similarly, there is evidence of reading educators whose integrated research only focuses on the discrete elements of mathematics problems (i.e. key vocabulary words in text to signify mathematical operations, accurate use of algorithms, the mediation of written text to numeric expressions), without attention to the complexity of understanding, communicating, and justifying learned and discovered mathematical ideas. Siebert and Draper (2008) provided evidence of this when high school literacy specialists who were working with mathematics teachers to support students' understanding of word problems began to promote the use of memorized mathematical algorithms due to the literacy specialists' lack of curriculum knowledge and pedagogical content knowledge in mathematics. They further describe the limited view that many literacy educators have of "text," suggesting that these educators must expand the way that they currently conceptualize text to include charts, labels, mathematical word problems, etc. in order to provide relevant support to content area teachers.

There seems to warrant research that will identify the effects of integrated reading and mathematics cognitive strategy instruction, specifically focusing on those strategies that are currently being developed in the separate literature in a domain-specific capacity (under the

implicit premise that each strategy set must be situated in the context of the subject area) (Hart, Petrill, Thompson, & Plomin, 2009). Rather, it may be possible to reveal the domain-general potential of these strategies, which could have positive implications for metacognitive awareness if a more compact set of strategies is developed for elementary learners that offers more flexible, transferrable applications. This is one way in which results of this study are intended to contribute to the existing literature in the field.

Some fruitful examples of research focused on the integration of reading and mathematics strategies, from which the inspiration for this research was drawn, will now be reviewed. For this reason, these examples of research will be presented with greater detail. Additionally, examples that contain evidence of strategy instruction revealing consistencies across reading and mathematics education (whether explicitly identified by the researchers or those that I identify based on my pedagogical content knowledge across these domains) will be highlighted.

Borasi & Siegel (1997, 2000), a mathematics educator/researcher and literacy specialist/researcher pair, conducted qualitative inquiries into the development of a collaborative relationship to interweave the disciplines, which evolved into numerous studies about the impact of making explicit connections between the content for students. Borasi, Siegel, Fonzi, and Smith (1998) investigated the impact of teaching transactional strategies from reading education literature in four high school mathematics courses in order to increase students' reasoning abilities and foster communication among students. Each of the four strategies taught, 1) Say something, 2) Cloning an author, 3) Sketch to Stretch, and 4) Enacting came from then-recent literature in reading education, and the first three strategies were categories as transactional reading strategies, based on the work of Rosenblatt (1978). The Say Something strategy (Harste,

Short & Burke, 1988) was an open-ended, comprehension monitoring strategy in which two students read a text together and determined reader-selected stopping points to pause their reading and discuss their reactions and/or confusions about the text (i.e. summarize, clarify, connect, etc.). Similar to Reciprocal Teaching (Palinscar & Brown, 1984), the Say Something strategy involves chunked text and multiple strategy application; however, this strategy use is not sequenced, and the student pairs rather than the teacher determine text chunks. The Cloning an Author strategy (Harste, Short, & Burke, 1988) also uses chunked text, although this strategy requires that the readers write important ideas from the text read, which will later be sorted and labeled by relationship and connections among text concepts. The Sketch to Stretch strategy (Harst, Short,& Burke, 1988) employed is similar to Cloning the Author; however, rather than writing the main ideas identified from the text, students visually depict their thoughts. The foundation for this strategy suggests that a reader's interpretation of the text mediates the transfer from a sign system of written print to visual art, thereby allowing for text comprehension and deeper understanding. The fourth strategy of enacting involves students acting out their interpretations of the given text. Each of these strategies was introduced to four participating teachers of a Math Connections high school course, which was a part of a larger project entitled "Reading to Learn Mathematics for Critical Thinking" (Borasi & Siegel, 1994; Siegel & Fonzi, 1995). This project, developed to examine the impact of the integration of reading strategies

and mathematical text in an applied mathematics sequence for ninth through eleventh-grade students, infused philosophical and historical readings with connected mathematics experiences. The authors anticipated and encouraged that the participating teachers use these four strategies flexibly in their classrooms based on individual interpretation and student response. Students' strategy use was observed, and transcripts, field notes, and student work artifacts were analyzed

to identify mathematics episodes in which the strategies were used. Findings revealed that regardless of which of the four strategies were used by students in each mathematical episode, there was evidence of students actively engaging in communication about mathematical ideas. Evidence of student reasoning after use of a given reading strategy was identified in sixteen out of eighteen episodes. Evaluation of the use of the enacting strategy revealed that students most often enacted the mathematical text prior to reading the solutions to problems that were presented by the authors of the students' texts, without prompting to do so. Borasi et al. suggest that this is congruent to the use of enacting in reading education literature in which students use the strategy to facilitate their predictions of text events. Conclusions from this research suggest that instructional strategies from reading education may be fruitful to reform mathematical education, specifically considering the impact on supporting students' reasoning and communication skills in mathematics; however, this study relies on philosophical and historical mathematical text that is not typically integrated in traditional K-12 mathematics curricula. Thus, it is not possible to determine whether the use of such text was the impacting factor toward evidence of students' reasoning and communication increases over the introduction of the four reading strategies. There is also no insight as to whether the reading strategies would be supportive of students' comprehension of word problems and other problem solving applications that are more typical examples of text in mathematics curricula. Further, this dissertation research aims to consider the use of cognitive comprehension strategies that students can use mentally and flexibly, rather than more prescriptive, text-based instructional strategies from this study that are less likely to be accessed and applied in authentic math application beyond academic contexts.

Schurter (2002) sought to identify whether instruction in comprehension monitoring impacted high school students' success in mathematical problem solving and the frequency of students' metacognitive strategy use. In a quasi-experimental study involving three high school sections of a developmental math course, students received one of three instructional approaches. The control group, taught by a teacher that was not a contributor to this research, received instruction in mathematics problem solving that was considered standard as related to the course syllabus. The first treatment group, taught by the researcher, received integrated instruction in mathematics problem solving and comprehension monitoring that was based on a set of researcher-provided questions entitled "Self-Check Your Understanding" that were modeled by the instructor during all problem solving examples. The second treatment group, also taught by the researcher, received integrated instruction in comprehension monitoring described for the first treatment group in addition to mathematics problem solving heuristics using Polya's (1945) four step process. Measures and analysis were in place to establish homogeneity of the three course sections considering problem-solving performance as measured by a course pretest and metacognitive techniques used by the students determined by a Metacognitive Inventory Questionnaire (O'Neil & Abedi, 1996). Findings revealed that students who received instruction emphasizing the use of comprehension monitoring strategies performed better during math problem solving than students who did not receive instruction in comprehension, as did students who received instruction in both problem solving steps (Polya, 1957) and comprehension monitoring strategies. There was no difference between the students in these two instructional treatment groups, however. Significant limitations of this research include the sample of students and selection of instructors. All sections of students who participated in this study were identified as below grade level with respect to their mathematics achievement level, which is why they were

registered for the math courses that were accessed for the research. The researcher was the instructor for both of the instructional treatment groups that outperformed the control group; therefore, it is difficult to determine if the difference in student performance is due to the quality of instruction provided by the different instructors or the treatments that were introduced in this study. Further, the metacognitive component of the comprehension instruction is based on self-check questions that were provided and prompted by the instructor, which suggests a limited interpretation of metacognition with regard to self-regulated learning. While this research does aim to meaningfully integrate reading comprehension research with math problem solving instruction, these limitations do not offer conclusive evidence of the effectiveness of such. In addition, the author did not consider whether or not students were already demonstrating evidence of metacognitive comprehension strategies during their math problem solving prior to the introduction of the instructional treatments.

Xin, Wiles, & Lin (2008) conducted a study to identify whether the use of story mapping, a strategy that has been used in reading education research and practice (Boulineau et al., 2004), impacted fourth and fifth-graders' arithmetic word problem solving. The participants in the study were students who were either identified or at risk for mathematics learning disabilities. The findings revealed increases for all participants when performance from baseline problem solving measures to post-intervention probes was compared, controlling for student achievement and baseline scores. The authors attribute the use of story mapping, referred to frequently as word problem story grammar, for facilitating students' representations of mathematical relations inherent in the word problem story. Compared to a control group cohort that was taught specific rules for determining arithmetic operations, students in the intervention group were able to articulate their representations of the word problem stories and describe the mathematical

thinking that enabled them to identify a solution. The students in the intervention group also demonstrated mental representation behaviors that were sharply different from the "number grabbing" approaches that were evident when observing most of the students during the baseline measure. A clear limitation of this research, however, is the limited sample size of five students, and the fact that all of the students in the research study either qualify or in the early stages of identification for accommodations due to an existing learning disability. Although, the authors cite existing research (Boulineu, et al., 2004; Domino et al., 1990; Gardill & Jitendra, 1999; Idol & Croll, 1987) that suggests that story mapping techniques in reading education have been proven to be beneficial for students with and without learning disabilities, so it is possible that the same is true for story mapping in mathematics contexts. Repeating the experiment of this study with additional student populations would provide insight into this inference.

Also examining students' comprehension of mathematical text, Osterholm (2005) conducted research with high-school and college students to identify differences in their reading comprehension across three different text sets: historical text, mathematical text without symbols, and mathematical text with symbols. Controlling for students' mathematics achievement level, Osterholm obtained results that revealed similarities in the students' reading comprehension of the historical text and mathematical text without symbols; however, there was a significant, negative difference in their comprehension of the mathematical text with symbols. Challenging a body of research that suggests that students' mathematical knowledge is a greater contributor to mathematical understanding when compared to reading comprehension, Osterholm inferred that the explicit teaching of reading comprehension for mathematical texts with symbols is warranted.

Examining the impact of reading comprehension on mathematical problem solving achievement of second-grade students, Ozdemir (2009) investigated whether participation in a

treatment group in which students engaged in daily summarizing and clarifying of mathematical word problems contributed to higher problem solving achievement than participating in a control group that received instruction limited to solution finding. The results revealed positive, significant treatment effects; however, obvious limitations of this research do exist. The study, which took place over four months, does not clearly describe the instruction provided in the control group, and mathematics educators and researchers are likely to interpret instruction focused on "solution finding" to be based on instructional strategies that are not currently recommended for mathematics instruction (which were previously discussed). Further, beyond mathematical ability, no other co-variables were identified or controlled, such as reading achievement and students' strategy use prior to the experimental instruction.

In a study involving college students, Nietfeld and Schraw (2002) investigated whether or not prior knowledge and training on monitoring strategy use had an impact on students' monitoring accuracy. Working from existing findings in the literature that supported the positive impact of prior knowledge and training of monitoring on student performance, they conducted two experiments to isolate the impact of prior knowledge and strategy monitoring instruction on monitoring accuracy. The findings of experiment 1 revealed that prior mathematics knowledge related to probability was positively related to both performance and monitoring accuracy. Further, the results of experiment 2 indicated that strategy training to build a greater understanding of strategy monitoring was also positively related to performance and accuracy; however, these results were not supported in a follow-up assessment one week after the training was provided. This provides implications related to the sustainability of monitoring skills outside of instructional experiences, which also relates to previous research describing the challenges that learners face building conditional knowledge of how, when, and where to use learned cognitive

strategies (Schraw, 2006). Interestingly though, the findings also revealed that general mathematics achievement and domain-specific self-efficacy in mathematics were not related to the accuracy of strategy monitoring in either experiment. These findings support the parameters of the current study, such that students' prior knowledge, monitoring behaviors, and monitoring accuracy were identified through the experiment procedures; however, students' domain-specific self-efficacy in mathematics was neither measured nor considered for analysis.

Gourgey's (1998) informal research examined similar metacognitive functioning during reading and mathematics tasks to expose some of the common cognitive and metacognitive demands across the content areas. For example, she identifies self-regulatory behaviors such as clarifying, connecting, self-questioning and inferring as relevant to the reading of text and the reading and solving of mathematics problems. In her informal classroom observations of her own students (grade level was not provided), she drew the following conclusions: 1) students were taught to improve the proficiency of their metacognitive awareness through repeated guided instruction, although students without previous experiences of thinking metacogntively were often resistant at first, and 2) increased metacognitive functioning suggests improvement in self-efficacy and domain-specific affect. The latter was further illustrated by case examples of students who initially demonstrated behaviors of abandoning strategy use and effort upon task difficulty; however, after metacognitive instruction, these students employed self-questioning techniques in reading and mathematics contexts. Although this publication is useful in identifying points of integration across subject areas for both cognitive and metacognitive instruction, it's lack of data and empirical evidence likely hinder the interpretation and credibility of the reported findings.

In a descriptive article, van Garderen (2004) articulates how to use a modified version of Palinscar and Browns' (1984) reciprocal teaching strategy sequence, in which elementary students can be taught to clarify, question, summarize, and plan during the reading of mathematical word problems. The gradual release of responsibility model, consistent with Palinscar and Brown's original strategy instruction delivery, was used as the instructional model of choice in this article. While van Garderen uses a case study model to frame this article on integrated strategy instruction, obvious limitations include 1) a lack of empirical data and supportive research, likely because there is none, and 2) poorly supported mathematics strategies, such as the keyword approach (Briars & Larkin, 1984), as the novel "Plan" component of the modified reciprocal teaching sequence. This suggestion of an antiquated strategy would likely invalidate the suggestions within this article in the eyes of mathematics educators who are aware of the severe limitations that such strategy types hold; thus, it provides an example of how important it is that professional writing and research that makes the potentially beneficial attempt to braid strategies within reading and mathematics education needs to be based on current, well-developed understandings of pedagogy in both fields.

A practitioner article by a first-grade teacher (Miller, 1996) describes a classroom-based program entitled "Learning to Think through Reading and Math" that was designed to provide students with daily examples of word problems that were teacher-written to include vocabulary and words comprised of phonetic elements that had been previously taught in the reading curriculum of the given grade level. After receiving support from the guidance of an educational researcher/consultant, Miller realized that although her students were often accurately answering mathematics word problems presented in the textbook and regular curriculum assessments, when probed to explain the problems, most of the students could not communicate their mathematical

solutions. In addition to creating problems that she knew the students should be able to decode and understand (at least textually) based on their previous classroom instruction, Miller added a communication component to the program that required students to either write, draw, or turn to a partner (each response assigned on a different day) to explain their understanding of the presented math word problem. Miller described observations of her students' that included increased communication about mathematics in the classroom, more sophisticated justifications of solutions and mathematical ideas, and greater student-reported self-efficacy, the last of which she also observed herself from reduced examples of students abandoning mathematics problems that they interpreted to be too challenging. Again, as in the examples of Gourgey (1998) and van Garderen (2004), these findings are not supported with experimental data yielding significant results; however, the presence of this literature in the field indicates the interest and practitioner-identified relevance of considering how instruction in reading and mathematics might be supported through integrated instructional approaches, especially at the elementary level.

Hyde (2006) also developed a practitioner-focused book identifying the consistencies in strategy use advocated by reading and mathematics educators (i.e. consider prior knowledge, visualize, ask questions, determine important information, etc.). He is currently engaged in investigative research (not yet published at the current date) with pre-service teachers at his educational institution, and is exploring ways to measure their perceptions of cognitive strategy integration across reading and mathematics contexts. His book, *Comprehending Math* (2006), was used as the reading material for the professional development book study treatment group in this research.

Shulman (1999) identified "generativity" as a foundation of professional scholarship, in which researchers demonstrate the ability to purposefully expand on the existing research in a

field. Therefore, in order for educational research to be considered relevant, researchers in education need to be able to access previous research findings and build upon them. This does not characterize the current practices across mathematics and reading education, in which research themes, methodologies, and instruments are frequently being developed without comparison between fields. Further, this applied content area research does not often link to recent literature in educational psychology, in which the phases of cognition and constructs of self-regulated learning are being theoretically developed and advanced.

<u>Think Aloud Protocol</u>

Although verbal reporting procedures have been used extensively in educational research throughout history, Ericsson and Simon (1993) have been identified by many as the pioneer researchers in refining and improving data collection measures that include the use of protocol data in psychology and other fields of social science. The verbalization elicitation techniques employed in this study were carefully determined based on a review of Ericsson and Simons' work, as described below.

Ericsson and Simons' (1993) research relies on information processing theory models of cognition, in which internal states are successively transformed based on processes of short-term and long-term memory capacities and functions; however, it is only those ideas that are brought to the short term memory based on cognitive processes (whether from initial sensory input or long term memory retrieval) that are to be captured through verbalizations and analyzed in research.

In order to capture the thoughts in an individual's short-term memory, it is necessary to ask participants to engage in think aloud behavior, during which they are encouraged to verbalize their internal cognition. It is important to consider the state in which ideas are contained in short term memory. For example, thoughts that are already verbal in nature (such as inner speech) are

already encoded in verbal form and simply must be verbalized orally; however, thoughts that are encoded in non-verbal forms (such as visualized images) must be verbally recoded by an individual before they can be expressed orally. In early studies exploring this phenomenon, Ericsson and Simon (1979) only found differences in the speed of processing when it was necessary for individuals to recode mental images to verbalizations during think aloud protocol.

Ericsson and Simon further identified verbalizations by assigning a leveling system to describe the source and potential effects of the thoughts expressed during think aloud protocol. Level 1 verbalizations involve directly and simultaneously articulating inner speech as outer speech. Utterances (such as grunts, sighs, etc.) are also classified as level 1 verbalizations. Level 2 verbalizations involve thoughts that require recoding from their original sensory form (such as mental images and scents to verbal descriptions). Level 3 verbalizations, however, require individuals to explain what they were thinking after real-time verbalizations have been captured. Thus, the individual provides an explanation of what they were thinking (and often, why). It is crucial to delineate the difference between Level 3 verbalizations from Level 1 and 2 verbalizations because the Level 3 think alouds can be impacted by changed comprehension, memory, and/or learning simply by participants providing a retrospective account of their mental thought (Chi, 2000; Rittle-Johnson & Alibali, 1999; Rittle-Johnson, 2006).

Further refinement of think aloud protocol using this methodology and research suggests the use of warm-up exercises in order to prepare participants to think aloud during an experimental task. Warm-ups also allow the researcher to determine whether or not the think aloud protocol is understood and followed by the participants prior to the experimental task in which the results will be analyzed (Ericsson & Oliver, 1988). Examples of warm-up procedures

recommended by Ericsson and Simon include arithmetic problems and narrative reading passages.

Additional research by Ericsson and Simon indicates that there are specific variables that, if properly controlled, can enhance the validity of verbal protocols. These variables include: the inclusion of verbal information only, the requirement of conscious processes (rather than unconscious or subconscious processes), novel/engaging tasks, the task involves higher-level verbal processes that take more than a few seconds, but less than 10 seconds to complete, an emphasis on problem solving, and criteria that individuals can use in decision making. For the purposes of this study, the experimental tasks were found to meet all of these criteria.

Conclusion

To summarize, the weaknesses of previous research on the overlap and potential effects of integration of cognitive reading comprehension strategies with elementary mathematics text include (a) limited researchers' content knowledge of advances and current research-based practices in both reading and mathematics education, specifically pertaining to cognitive strategy instruction, which restricts the interpretation of qualitative data (b) domain-specific research questions and study publications within reading education and mathematics education, fostering a lack of dialogue among scholars in each field, (c) an increased focus in written, text-based strategies rather than cognitive strategies that provide more authentic implications for use for proficient readers and problem solvers, (d) limited use of elementary student participants, (e) a lack of focus on teacher perceptions of domain specificity of cognitive strategies and cognitive strategy instruction, (f) the need for further research examining perceptions about strategy integration for mathematics and reading with both pre-service and in-service teachers, and (g) the need for purposively selected teacher research participants who have comparable subject area

content knowledge and pedagogical content knowledge in both reading education and math education. In this study, I will address these weaknesses by conducting a mixed method study with a purposively selected sample to investigate pre-service and in-service reading teachers' perceptions of cross-domain relevance of cognitive reading comprehension strategies, specifically related to mathematical text applications. In addition, first through sixth-graders' cognitive strategy use will be investigated to identify whether or not they utilize reading comprehension strategies during the text reading and interpretation of mathematical text, in addition to whether or not they use the strategies different across multiple genres. Further, this study will seek to determine whether or not there is a difference in teacher perception of reading strategy relevance to math text and student strategy use based on the clinicians' participation in a professional development book study focusing on instructional methods for cognitive strategy integration (either integrated on domain-specific to reading education).

Findings could (a) inform faculty of university teacher preparation programs of teachers' perceptions of strategy relevance across domains for elementary education programs, (b) inform elementary teachers of students' ability to utilize cognitive reading strategies with mathematical text, (c) provide a framework for professional development that emphasizes the underlying similar constructs in current cognitive strategy instruction within reading education and mathematics education, and d) suggest possible implications for integrated cognitive strategy instruction across the reading and mathematics curriculum.

CHAPTER 3: METHODOLOGY

The purpose of this study was fourfold: First, I was interested in whether or not (and if so, how) students use cognitive comprehension strategies when they are reading mathematical text.

The second purpose was to investigate whether or not students use cognitive strategies differently during the reading of fiction, nonfiction, and mathematics-specific text. The specific cognitive strategies of interest in this study were: Predicting, Visualizing, Determining Importance, Synthesizing, Connecting, Generating Questions, Making Inferences, and Summarizing. The third purpose was to examine if teachers perceive these identified cognitive strategies to be domain-specific to reading tasks, specifically considering whether or not they find them relevant to the reading of mathematics-based text. The fourth purpose was to investigate whether an experimental professional development offering could impact teachers' perceptions of the domain relevance of cognitive strategies to the reading of mathematical text and to explore whether or not potential changes in teacher perception of domain relevance could impact their instruction, further measured by their individual student's self-reported cognition during the reading of mathematical text. Hypotheses related to these purposes are provided.

<div align="center">Research Hypotheses</div>

The first purpose of the study addresses the question, Do students use cognitive comprehension strategies during the reading of a mathematics-based text, and if so, how? Students' cognitive comprehension strategy use was determined using think aloud protocol during one-on-one elementary student interviews, during which each child read a mathematics word problem that was presented. Transcripts of the interviews were created and analyzed to identify evidence of strategy use. Because this question is qualitative in nature, a hypothesis was not constructed. Rather, the transcripts were analyzed to identify themes and subthemes (Ryan & Bernard, 2003), which will be presented in the next chapter.

The first two hypotheses are related to the second purpose and address the question, Do first through sixth-grade students use cognitive reading comprehension strategies differently

across fiction, nonfiction, and mathematical content-specific text applications? Students'
cognitive strategy use was measured using the Major Point Interview for Readers (MPIR) during
each of the three text applications.

Hypothesis 1.   The students' MPIR scores from the reading of fiction will differ

                     significantly (at the .05 level) from the MPIR scores from the

                     reading of mathematical text.

Hypothesis 2.   The students' MPIR scores from the reading of nonfiction will

                     differ significantly (at the .05 level) from the MPIR scores from

                     the reading of mathematical text.

The third hypothesis is related to the third purpose of the study, and addresses the
question, Do reading clinicians identify the use of cognitive comprehension strategies as relevant
to mathematical text? Reading clinicians' scores on the Pre Survey of Cognitive Strategies
determined their identification of the relevance of cognitive comprehension. Sub scores for the
identification of strategies as relevant to reading comprehension in general (fiction and non-
fiction text) and reading comprehension specifically related to mathematics text were obtained for
each clinician.

Hypothesis 3.   Clinicians' sub score for recognized reading strategies for

                     fiction/non-fiction will differ significantly (at the .05 level) from

                     the sub score from recognized reading strategies for mathematical

                     text on the Pre Survey of Cognitive Strategies.

Two hypotheses relate to the fourth purpose of the study, addressing the questions: (a) Do
reading clinicians' perceptions of applied cognitive reading comprehension strategy use in
mathematics contexts differ based on participation in the professional development treatment

group or control group? (b) Do students' cognitive reading comprehension strategy uses during mathematics text reading and interpretation differ based on the students' assigned clinicians' participation in either the treatment or control professional development group? Reading clinicians' sub scores from recognized reading strategies for mathematical text on the Post Survey of Cognitive Strategies determined their perceptions of applied cognitive strategy use in mathematics contexts. Elementary students' cognitive strategy use during mathematics text reading was measured by the MPIR given during the follow up individual researcher interviews conducted with each student at the end of the study.

Hypothesis 4.   Sub scores from recognized reading strategies for mathematical text on the Post Survey of Cognitive Strategies of the treatment group will differ significantly and positively (at the .05 level) from the control group, when educational level, academic major, number of reading education courses, number of mathematics education courses, and sub scores from the Pre Survey of Cognitive Strategies are controlled as covariates.

Hypothesis 5.   The MPIR score from the reading of mathematics text for the students whose clinicians participated in the treatment group will differ significantly and positively (at the .05 level) from the that of the students whose clinicians participated in the control group, when student reading achievement and student mathematics achievement are controlled as covariates.

This study used a concurrent triangulation strategy of design for research procedures, in which quantitative and qualitative data were collected at the same time at the research site with the identified student and reading clinician participants.

<div align="center">Participants</div>

Forty-two elementary students and thirty-four college student reading clinicians participated in this study. The elementary students who participated were from a suburban community located in the southeast United States. The students were enrolled in a summer reading program that was organized by a southern state university's reading faculty to provide motivational literacy experiences and differentiated reading instruction over a two-week period. The students ranged from incoming first-graders through sixth-graders who were enrolled in public schools in one of the two geographically neighboring school districts to the public university program site. Students from all schools in the neighboring districts were invited to participate, and scholarships were provided as needed to prevent cost from being a deterrent to participating in the program. Of the participating students, 40 percent were females and 60 percent were males. About 79 percent of the student participants were Caucasian, 7 percent were Black, 7 percent were Asian, 5 percent were Hispanic, and 2 percent were Middle Eastern. About 43 percent were incoming primary students, whereas 57 percent were incoming intermediate students (for the following school year). Data from all of these students was collected for research question 1; however, data was only analyzed from elementary students who were paired with a participating clinician for research questions 2-5. Thus, eight students participated in only the student-researcher interview component of the study. Of the students participating in all aspects of the study, 53 percent were male and 47 percent female. Considering additional demographics, 73 percent were Caucasian, 9 percent were Black, 9 percent were Asian, 6 percent were Hispanic,

and 3 percent were Middle Eastern. About 53 percent of those participating in all components were incoming primary students, and 47 percent would be entering intermediate grades in the following school year. Based on the content area assessments conducted (to be further explained in this chapter) 91 percent of the fully participating students were on or above grade level in mathematics and 79 percent were on or above grade level in reading.

This summer program site was purposively selected based on the access that it provided to a) both pre-service and in-service teachers who were nearing completion of coursework that provides a state-certified reading endorsement that will differentiate the teachers as reading teacher leaders in their respective districts, and b) elementary students representing first through sixth grade who were tutored by the reading clinicians, receiving differentiated instruction provided on a one-to-one ratio. The college students who participated in this study were enrolled at the public university of the program site in one of the following academic programs: a) undergraduate elementary education, b) undergraduate exceptional education, c) graduate elementary education, or d) graduate reading education. The graduate students were comprised of a) current teachers of grades kindergarten through eighth grade who were completing the academic program on a part time basis while teaching and b) pre-service teachers who were admitted to graduate school full time immediately after earning their undergraduate degrees. The undergraduate students were in the last two semesters of their teacher preparation programs. All college students, hereby referred to as reading clinicians, were concurrently enrolled in a required reading practicum course, whether at the undergraduate or graduate level. All sections of this course that were taught in the summer semester of 2010 were recruited for this study. Most students (82%) agreed to participate. The reading clinicians collected initial reading achievement data and anecdotal records of elementary student reading behaviors, which were used for analysis

in this study; however, this was part of their curriculum requirements in the reading practicum course. I taught one of the sections of the reading practicum courses that were recruited for participation in this study. All data collected from university students (reading clinicians) during the course term were kept in a locked filing cabinet and were not analyzed until after the semester was over and student grades were submitted in order to protect students from the possibility of any unintentional instructor bias.

<div align="center">Measures</div>

<div align="center">Elementary Student Achievement Profiles</div>

According to the objectives of the reading practicum course, the reading clinicians were required to conduct a comprehensive battery of assessments in order to determine their assigned elementary student's reading achievement levels. Of the battery of instruments used, data collected for consideration in this study included that from: 1) Developmental Reading Assessment (DRA) (Beaver, 1996) to identify (a) independent and instructional reading levels, (b) descriptors of student comprehension of text, including ease and detail of retelling, predicting ability, and connection-making ability, and (c) descriptors of oral reading including accuracy, rate, and prosody, and 2) Major Point Interview for Readers (MPIR) (Keene, 1995) (APPENDIX A) used for the reading of a fiction and non-fiction passage. Additionally, the Classroom Mathematics Inventory for Grades K-6 (Guillaume, 2005) was administered in order to determine a baseline of each student's mathematics achievement level. The results from this battery of pre-assessments were later used for triangulation purposes when comparing students' cognitive reading comprehension strategy use during the open-ended mathematics application. They were also used to identify reading and mathematics achievement levels for each student as above, on, or below grade level. These variables were controlled during the analysis of data collected for

research question five. Each instrument used for the construction of the Elementary Student Achievement Profiles will now be further described.

Developmental Reading Assessment (DRA)

The Developmental Reading Assessment (Beaver, 1996) is a set of criterion-referenced, informal reading inventories designed for use in K-8 classrooms, separated by two separate assessment kits for grades kindergarten through third-grade and fourth-grade through eighth-grade. The assessment is conducted during individual reading conferences with students, during which behaviors such as reading strategy use, oral reading, silent reading, reading skill activation, metacognition, and motivation are assessed at various components of the assessment. The assessment is intended to identify students' independent and instructional reading levels based on specific criteria considering reading accuracy, fluency, and text comprehension. Test-retest reliability coefficients range from .92 to .99 for each of the grade levels of the assessment (Pearson Learning Group, 2003). Scoring reliability was determined by observer agreement (.80 inter-rater reliability calculated across students, text levels, and rating scale items).

Major Point Interview for Readers (MPIR)

The Major Point Interview for Readers (Keene, 1995) was developed in response to a lack of formalized procedures for assessing children's use of comprehension strategies during the Public Education and Business Coalition Reading Project. The assessment consists of a prompted text-based think aloud with seven subsections related to cognitive strategy use: Using Schema, Inferring, Asking Questions, Determining Importance, Monitoring Comprehension, Visualizing, and Synthesizing. The scoring rubric for each item is based on evidence of articulation of strategy use and the extent to which the student utilizes the strategy to support their comprehension.

Classroom Mathematics Inventory for Grades K-6

The Classroom Mathematics Inventory for Grades K-6 (Guillaume, 2005) is an informal classroom assessment tool that was designed for pre-service and practicing elementary teachers to identify students' instructional levels of mathematics achievement across a variety of mathematics curriculum strands, including: number, extended work with number, geometry, algebra, measurement, data analysis, statistics, and probability. The instrument includes scripted protocols and manipulatives in order to assess students' understanding of mathematical processes, including conceptual understanding and computational performance within each content strand. The inventory is designed for individual administration that requires between 15-30 minutes for completion. Each instrument item is assessed as mastered, partially mastered, or not mastered based on the evaluation indicators provided, which allows for an instructional level of mathematics achievement to be determined. Field-testing for reliability and validity included one hundred seventeen teachers, comprised of pre-service and in-service teachers. Students included in the field study represented genders, a mix of language backgrounds, all grade levels relative to the instrument, and a variety of student needs including students with exceptionalities such as gifted and talented, speech disorders, learning disabilities. Field test teachers submitted individual analyses of the inventory, which were applied to the revision and refinement of the following: number and extended number items, clarity in organization, and indicators for evaluation. Mathematics, mathematics education, and elementary education professors further provided content reviews.

Elementary Student Interviews

In this study, I conducted two one-on-one interviews with each student, during which the students a) engaged in a verbalization warm-up exercise, according to think-aloud protocol

(Ericsson & Simon, 1993), b) were presented with a grade-specific mathematics word problem and asked to solve (while continuing to share their thoughts aloud with the researcher), and c) answered the question prompts provided by the MPIR. The first interview took place within the first two days of the reading program in which students were enrolled, and the second interview was within the last two days. The schedule created for student interviews ensured that the duration between the first and second interview was the same for each student.

As recommended by Ericsson & Simon (1993), two verbalization warm-up exercises were used to prepare students for the prompt to think aloud during the experimental task: a narrative text and an arithmetic-based mathematics problem. The narrative text was grade-specific (matched for each student participant), and obtained from the supplemental text kit from the Developmental Reading Assessment (Beaver, 1996). The arithmetic problem presented to each student was taken from the Classroom Mathematics Inventory for Grades K-6 (Guillaume, 2005) from the corresponding grade level for each student. For all students, an equation was selected from the "Number" strand of the assessment regarding whole number operations that correlated to the grade level for the school year that the student had just completed. Following the verbalization exercise, the students were presented with the experimental mathematical text and asked to read and continue saying what they are thinking in their head (using the specific script provided in Procedures to follow). The mathematical text that was presented to students during this part of the study was (a) also selected from the Classroom Mathematics Inventory for Grades K-6 (Guillaume, 2005), (b) a word problem related to whole number operations, and (c) checked with the validity measures that follow. Construct validity was assessed via content validity and face validity checks. Content validity was confirmed through the use of the Classroom Mathematics Inventory for Grades K-6 as the problem source, which has been listed as

an approved diagnostic and progress-monitoring assessment on numerous state-adopted

assessment lists and referenced in recent mathematics education research (Bailey, 2010). Further,

the technical notes describing the development of the instrument reveal that the curriculum

standards of the state in which this study took place (among others) were reviewed for content

selection as well as comparison to the National Council of Teachers of Mathematics (NCTM)

content standards to determine congruence of emphasis. During the mathematics word problem

selection process, I consulted an elementary mathematics education professor to ensure face

validity of the selected text. Further, convergent validity was examined to ensure that the word

count, text difficulty, syntax, etc. of the text passage was appropriate based on the grade level of

the readability of the word problem text and the readability of the grade level passages from the

DRA measure used (Beaver, 1996). The Flesch-Kincaid (1948) grade level test in Microsoft

Word was used during the pilot study to modify the grammar, syntax, and vocabulary of the

mathematics word problems used in this study so that they aligned with the readability of the

DRA text levels and represented on-grade level text difficulty, matched for each student based on

the grade level they had just completed.

<center>Surveys of Cognitive Reading Strategies</center>

The reading clinicians completed both pre and post surveys over the course of this study.

The Survey of Cognitive Reading Strategies (APPENDIX B), adapted from Barry's Teaching

Strategies Survey (2002), was administered on the first and last day of the professional

development book study (treatment and control), and included three separate sections. On the Pre

Survey of Cognitive Reading Strategies, section 1 included a question eliciting identification of

cognitive strategies that are relevant to text reading. A listing of twenty strategies were included

as options for each question, with eight of the responses identified as point-earning due to the

<center>50</center>

cognitive nature of the strategy: Predicting, Visualizing, Connecting, Self-Generated Questioning, Determining Importance, Synthesizing, Making Inferences, and Summarizing. Distractor strategies included a listing of instructional strategies and text strategies that are classroom or text-based, rather than descriptive of cognitive strategies. Section 2 included a question eliciting identification of cognitive strategies that are relevant to text reading, specifically considering mathematical text. The optional responses were the same as outlined for Section 1. Due to the electronic mode of delivery, each section had to be completed in sequence before the participant could continue on to the next. Section 3 obtained demographic information about the participant, including age, gender, teaching experience, level of education, and number of reading education and mathematics education courses taken at the college level. On the Post Survey of Cognitive Reading Strategies, sections 1 and 2 were the same as the Pre Survey. Section 3, however, provided a listing of the strategies that each clinician had individually identified for both section 1 and 2 on the post survey and prompted for a written explanation of differences between strategy use in "typical" reading contexts (qualifier of "fiction and non-fiction") and mathematical contexts, if any.

Procedures

Pilot Studies

A pilot study was implemented prior to the study with six elementary students to confirm: a) the selection of the problem solving task, specifically focusing on the text and content, b) the effectiveness of the wording of the think aloud protocol script at eliciting student verbalizations, and c) the effectiveness of the practice tasks at familiarizing students with the think aloud protocol. The math word problems, selected from the Classroom Mathematics Inventory for Grades K-6 (Guillaume, 2005), were examined during the pilot study to check for text readability

levels and to ensure that they were based on appropriate mathematics content for elementary

students from the state in which the study was conducted. The initial assessment of the text

readability levels revealed that of the twelve math word problems selected (two for each grade

level, first through sixth for the pre and post interviews) only six were aligned with the

appropriate grade level, as measured by the Flesch-Kincaid grade level test. The remaining six

were modified through several iterations involving adjustment to syntax and vocabulary difficulty

(lower tier vocabulary words were replaced as synonyms as needed), until they were

appropriately aligned to each respective grade level according to the Flesch-Kincaid grade level

test. The content demands of the word problems were compared to the specific state mathematics

curriculum standards for appropriateness, and the students' descriptions of familiarity of the

content during follow-up pilot study interviews were considered to confirm the selections. The

wording of the think aloud protocol script was refined during the pilot study after two students

asked the question, "I don't think I know what you mean," seeking clarification regarding the

request to "tell me everything that passes through your mind." This was the original wording

from the Ericsson & Simon (2003) think aloud script, which was modified to "tell me everything

that you are thinking about in your head" for the actual study, and proved to be more effective

with students. All students who participated in the pilot study verbalized during both of the

practice tasks and the word problem task, thus the practice tasks of narrative text reading and

arithmetic solution generating were retained for the actual study.

An additional pilot study was implemented with eight pre-service and eight in-service

teachers in order to determine the effectiveness of the survey items that were intended to identify

teacher perceptions of comprehension cognitive strategy relevance to mathematics. The survey,

adapted in the pilot study for consideration in this study, was presented in an electronic format

that presented all of the questions simultaneously. This presentation mode was modified for the study after analysis revealed that many of the teachers revisited the first question regarding strategies for reading comprehension after they were prompted with the second question regarding reading strategies for mathematics text but before they answered the question. This suggests that rather than considering a unique response to the second question, these specific teachers were reviewing their response to the first question and using it to inform how they would answer the second. For the actual electronic survey presentation in this study, each question was presented sequentially without the option to return to previous questions that had already been answered. In follow-up interviews, all teachers reported that the survey included clear, easily understood directions, and that they felt confident that their answers reflected their thoughts and opinions regarding each question that was asked.

<u>Data Collection</u>

Organizing the Study

This study began approximately 4 weeks into the semester during which the reading clinician participants were enrolled in the reading practicum course that was accessed for this research. At this time, the university reading program for elementary students closed registration, and enrolled students were randomly paired with the undergraduate and graduate reading clinicians by the program director. As part of the practicum course, the reading clinicians met with the elementary student program participants for two days during the week prior to the elementary summer program start date. As part of their course requirements, the reading clinicians individually administered the DRA, Motivational Reading Assessment, and additional assessments required for their course (not included in this study). This data collection took place in individual diagnostic clinic spaces at the program site location. During the individual sessions

between the clinician and elementary student, I obtained consent from the student's parent(s) for participation in the study for the duration of the reading program.

Procedures Involving Reading Clinicians

At the next reading practicum course meeting, I gave the reading clinicians an overview of the research study and sought their participation. After obtaining consent, the reading clinicians were randomly assigned to one of two professional development book studies, which met five times during a period of two weeks, over the same duration as the reading program that the elementary students were attending. Meetings lasted one hour each. Random assignment was determined by designating a number to each of the reading clinicians using an ascending numerical assignment based on a roster of the clinicians, organized alphabetically by last name. A random number generator was then used to select the clinicians (half of the entire sample of clinicians) who were assigned to the experimental group. All remaining students were assigned to the control group. Descriptive statistics for the reading clinician participants, presented according to treatment group, are reported in Table 1.

Table 1: Descriptive Statistics for Nominal and Ordinal Variables of Reading Clinicians

	Control		Treatment	
Measure	%	*N*	%	*N*
Gender				

Female	94%	16	94%	16
Male	6%	1	6%	1
Academic Level				
Undergraduate	29%	5	29%	5
Graduate	71%	12	71%	12
Academic Major				
Elementary Ed.	41%	7	6%	1
Exceptional Ed.	18%	3	29%	5
Reading Ed.	41%	7	65%	11
Number of Reading Education Courses				
Three	65%	11	35%	6
Four	35%	6	65%	11
Number of Math Education Courses				
Two	100%	17	82%	14
Three	0%	0	6%	1
Four	0%	0	12%	2

Both groups engaged in a facilitated book study, with the treatment group using

Comprehending Math: Adapting Reading Strategies to Teach Mathematics, K-6 (Hyde, 2006) and

the control group using *Strategies That Work: Teaching Comprehension to Enhance*

Understanding (Harvey & Goudvis, 2007). When the reading clinicians met on the morning of

the first day of the summer reading program, their individual professional development seminar

group assignment and meeting schedule was provided. The groups met on different days, and I

kept the books between meetings to control for contamination threats to internal validity,

specifically diffusion of treatments.

On the first scheduled book study meeting for each group, the reading clinicians took the Pre-Survey of Cognitive Reading Strategies independently in a computer lab before reading and discussing the first assigned chapter with the group. Consistent with Birchak et al. (1998), the following procedures were used to support the teacher study groups at each meeting: 1) a structure was provided that included reading time, personal reflection, facilitated discussion, and planning for the next meeting, 2) group roles of facilitator, time keeper, and record keeper were assigned for the following meeting, and 3) a facilitator planning sheet (APPENDIX E) was provided and completed by the group. On the first day, both groups asked if they could form smaller subgroups to discuss their readings, which I allowed. This practice remained in effect for each of the five meetings for both of the groups, with the subgroups always remaining the same. All members of the group had perfect attendance at the book study meetings. At the end of the last book study meeting, each reading clinician completed the Post-Survey of Cognitive Reading Strategies in a computer lab, after which they received the book from the study and classroom and office supplies for compensation for their participation.

Procedures Involving Elementary Students

During the first two days of the program, I conducted individual interviews with each participating elementary student, using the think aloud protocol previously described to elicit students' verbalizations during two practice tasks and the experimental task of reading and solving a mathematics word problem. The interviews were conducted in an empty diagnostic classroom at the program site where students were also working with their assigned reading clinician for much of the duration of the reading clinic. This location was selected to provide familiarity for the students during the problem solving session, thereby controlling for threats to ecological validity. Student assent was obtained at the beginning of each individual meeting.

Afterward, following think aloud research protocol (Ericsson & Simon, 1993), I instructed each student to: "Read this text out loud. Think and tell me everything that you are thinking about in your head when you are reading and thinking about what you read." This script, confirmed from effective elicitation of verbalization during the pilot study, was intended to elicit verbalization of student thoughts based on levels 1 and 2 (Ericsson & Simon, 1993), in which "explication of the thought content" was prompted, yet new information was not brought into the subject's attention during the task in a way that would modify their attempt at the problem. The first practice example, as described, was an oral reading of a narrative passage. While this first passage was used to familiarize the student with the think aloud protocol, the oral reading was also analyzed to identify the students' reading rate and accuracy. This data was used for triangulation purposes to identify each student's reading achievement level as on, above, or below grade level. The second practice example was taken directly from the previous research of Ericsson & Simon (1993) on the use of think aloud protocol, and involved a basic arithmetic problem. Again, the primary function of this task was to familiarize students with the think aloud protocol. After each student completed the two think aloud practice tasks, the mathematics word problem was presented. The think aloud protocol script was repeated, thus students were not informed that the experimental text presented was mathematical in nature. Unlimited amounts of time were provided for the student to read, think aloud, and solve the word problem presented. After students verbalized that they were finished, I read the script for the Major Point Interview for Readers (MPIR) (Keene, 1995) and asked each of the open-ended question items. Accuracy of the mathematics problem was not discussed. The problem solving session with each student was audio-taped from the beginning of the practice tasks to the final completion of the MPIR, based on the students' assertion that they had shared everything they were thinking about.

After the completion of each individual elementary student initial interview, a trained research assistant individually administered the Classroom Mathematics Inventory for Grades K-6 (Guillaume, 2005) to each student. As previously described, this assessment was used to identify a mathematics achievement score that was reported as on, above, or below grade level in each student's achievement profile. This descriptive data was considered during the data analysis phase of the study.

Throughout the two-week reading program, the elementary students worked individually with their assigned reading clinician and participated in motivational literacy-based activities. During the last two days of the summer program, I repeated the procedures for the individual elementary student interviews using different practice narrative texts, arithmetic problems, and experimental word problems from the same sources as the first interview. The second section of the Major Point Interview for Readers (MPIR) (Keene, 1995) was used, as is appropriate for this specific measure when a follow-up text is read by the student.

<u>Data Analysis Procedures</u>

Preliminary analyses to investigate the reliability of the scores for the elementary students' strategy use on the MPIR were conducted and will be reported in the following chapter. Next, descriptive statistics were calculated for all of the elementary students' MPIR scores and the teachers' scores on the Pre and Post Survey of Cognitive Strategies. The tests of the four quantitative research questions framing this study were then conducted. The transcripts of the students' verbalizations during the individual interviews were then analyzed to identify themes and subthemes, including both core and peripheral elements (Ryan & Bernard, 2003), to address the first and only qualitative research question in this study.

The first and second hypotheses, related to the second research question, involved students' use of cognitive strategies across fiction, nonfiction, and mathematical text. This hypothesis was tested with one-way repeated-measures ANOVA using MPIR scores from readings for each of the genres as the within subjects factor and the students' grades as the between subjects factor.

The third hypothesis was related to the third purpose of this study addressing whether or not reading clinicians recognized the use of cognitive comprehension strategies as relevant to the reading of math text. Reading clinicians' sub scores from the pre survey measure for strategies identified for reading comprehension in general (fiction/nonfiction) were compared with the sub scores for strategies identified for reading mathematical text using a dependent t test.

The fourth and fifth hypotheses related to outcomes of the treatment and control group and were both tested with one-way analyses of covariance (ANCOVAs). Testing of the fourth hypothesis was based on the comparison post math sub scores of the Survey of Cognitive Strategies across treatment groups, controlling for the clinicians' academic major, level of schooling, number of reading and mathematics education courses taken, and pre math sub scores. Clinicians' survey comments were used to further justify the quantitative findings. Testing of the fifth hypothesis was conducted using the MPIR scores from the elementary students' reading of mathematical text, obtained during the second individual student-researcher interviews. Student scores were compared based on the treatment group to which their individual reading clinician was assigned.

CHAPTER 4: RESULTS

Descriptive Statistics

Reading Clinicians

Descriptive statistics for demographic variables of the reading clinicians were reported in

Table 1 in Chapter 3. Means and standard deviations by group for the sub scores for

identification of cognitive strategies for fiction/nonfiction text and for mathematical text are

reported in Table 2.

Table 2: Means and Standard Deviations for the Pre and Post Survey of Cognitive Reading
Strategies Sub Scores

Survey Sub Score	Control			Treatment		
	Mean	Std. Dev.	*N*	Mean	Std. Dev.	*N*
Pre Treatment Sub Scores						
Fiction/Nonfiction Text	6.47	2.03	17	6.94	1.34	17
Mathematical Text	3.00	1.97	17	4.00	2.09	17
Post Treatment Sub Scores						
Fiction/Nonfiction Text	7.82	.53	17	7.71	.69	17
Mathematical Text	4.00	2.15	17	6.59	1.70	17

Scores could range from 0-8 on each sub section. The mean score for the cognitive

strategies identified for the reading of mathematical text on the pretest was slightly above the

midpoint of the scale in the treatment group and slightly below the midpoint in the control group.

Both the control and the treatment group demonstrated prior knowledge of cognitive

comprehension strategies for fiction and nonfiction texts with pretest means in the uppermost

twenty-five percent of the possible score range.

Despite random assignment into the treatment and control groups in this study, differences between groups were evident at the pretest. For example, as reported in Table 2, the mathematical text pre survey sub score mean of the treatment group was one point higher than the mean of the control group, which was actually the same mean as the post survey sub score of the control group. Independent samples *t* tests were conducted on the sub scores for strategies generated for fiction/nonfiction text and mathematical text to check for significant group difference prior to the experimental treatment. Neither of the pretest differences were significant: the test of mean differences on fiction/nonfiction text strategies identified was $t(32) = -.796$, p = .432, and the test of mean differences on mathematical text strategies identified was $t(32) = -1.435$, p = .161.

Elementary Students

Descriptive statistics for students' grade level, reading achievement level, and mathematics achievement level are depicted in Table 3. As described in the previous chapter, students' reading achievement levels were determined by a comprehensive battery of assessments, including the DRA, with an added timed reading to identify oral reading fluency rate and accuracy. From these reading assessments, both independent and instructional reading levels were determined. Students' independent reading levels are reported as on or above grade level in the table below. Those students who had an independent reading level below grade level were between four months to one year below the end of year target for their given grade level. These students' results were still fully included and considered in this study, however, because it is highly typical for an elementary classroom to be comprised of students of varying reading abilities. The mathematics achievement level was determined using the Classroom Mathematics Inventory for Grades K-6 (Guillaume, 2005). Students who achieved mastery of 90 to 100

percent of the presented items were considered on or above grade level since the items presented were taken from the corresponding grade level from the academic year that participating students had just completed. There was not wide variance in scores among the elementary students, however, as even the lowest mastery percentage scored on this assessment was only 75 percent.

Table 3: Elementary Students' Reading and Mathematics Achievement Levels by Grade Level

Grade Level	*N*	Reading Achievement	Mathematics Achievement
		Percent On or Above Grade Level	Percent On or Above Grade Level
1	8	62.5	100
2	5	60	60
3	11	81.8	90.9
4	1	100	100
5	2	100	100
6	1	100	100

Research Question 1: Students' Cognitive Strategy Use During Think Aloud

The purpose of prompting students to think aloud during their individual interviews was to identify if and how students use cognitive comprehension strategies during the reading and interpretation of mathematical word problems. Students' verbalizations during the individual interviews were transcribed and analyzed using the following theme identification techniques: repetitions, similarities and differences, cutting and sorting, theory-related material, word lists, and initial stages of metacoding. In the early stages of transcript analysis, repetitions, similarities and differences, theory-related material, and word list techniques were used to identify major themes. Later stages of analysis to generate expanded themes and subthemes relied on cutting and sorting and metacoding techniques.

The use of think aloud protocol has proven effective for a large body of research focused on cognition for both adults and children (Jourdenais, Ota, Stuaffer, Boyson, & Doughty, 1995; Hannu & Pallab, 2000; Meyers, Lytle, Palladino, Devenpeck, & Green, 1990; Van Oostendorp & Goldman, 1999). There are limitations to the use of think aloud procedures with primary students (Laing & Kamhi, 2002; Wade, 1990; Magliano & Millis, 2003), however, which was considered in this study. Students' verbalizations in response to the warm up exercises designed to familiarize them with the think aloud protocol were examined to compare whether or not the absence of verbalizations with the experimental text was due to the limitation of the think aloud protocol or the possible lack of strategy use during the context. Of the forty-two students who participated in the study, about 90 percent expressed verbalizations identified as think aloud behavior during one or both of the warm up exercises. Thus, it was assumed that the protocol was effective in eliciting students' expression of their mental thoughts, which was necessary in order to investigate the first research question. The identification of themes and subthemes from the transcript analysis are presented in Table 4.

Table 4: Theme List for Student Think Alouds During Reading & Interpretation of Mathematical Text

			Expanded Themes and Subthemes from Phase 2 Analysis
I.			Identification of text as mathematical
	A.		Student response indicator
		1.	Abandons strategy use
		2.	Suspends strategy use until prompted
		3.	Continues to verbalize strategy use
II.			Cognitive Comprehension Strategy Applied
	A.		Uses Schema/Accesses Prior Knowledge
		1.	Expressed but does not support meaning
		2.	Expressed and supports clarification
		3.	Expressed and explained through understanding
	B.		Makes an Inference
		1.	Expressed but does not support meaning
		2.	Expressed and supports clarification
		3.	Expressed and explained through understanding
	C.		Asks a Self-Generated Question about the Text
		1.	Expressed but does not support meaning
		2.	Expressed and supports clarification
		3.	Expressed and explained through understanding
	D.		Determines Importance
		1.	Expressed but does not support meaning
		2.	Expressed and supports clarification
		3.	Expressed and explained through understanding
	E.		Monitors Comprehension
		1.	Expressed but does not support meaning
		2.	Expressed and supports clarification
		3.	Expressed and explained through understanding
	F.		Visualizes the Text
		1.	Expressed but does not support meaning
		2.	Expressed and supports clarification
		3.	Expressed and explained through understanding
	G.		Synthesizes
		1.	Expressed but does not support meaning
		2.	Expressed and supports clarification
		3.	Expressed and explained through understanding
III.			Mathematics Heuristic Applied
	A.		Key Word Strategy
	B.		Expression of Conceptualizing
	C.		Flexible/Multiple Strategies Employed
IV.			
	A.		Negative
		1.	Related to mathematical nature

	2.	Related to reading of text
B.		Neutral
C.		Positive
	1.	Related to mathematical nature
	2.	Related to reading of text

Note. Individual students were used as units of analysis.

Analysis of student verbalizations and responses to MPIR items revealed that upon recognition of the experimental text as mathematical in nature, many students demonstrated a metacognitive shift in the governing of strategies retrieved and applied for the remainder of the reading, text interpretation, and problem solving. Most instances of this metacognitive shift indicated one of the following behaviors: a) abandoning the use of cognitive comprehension strategies in favor of mathematics problem solving heuristics that were interpreted as instructionally taught in school (based on students' verbalizations during the strategy execution) and seemingly identified by the student as unrelated to the cognitive comprehension strategy(ies) that was/were being utilized just seconds prior, b) abandoning the use of cognitive comprehension strategies because the student self-reported recognition that the text was "math," (seemingly warranting the most recently accessed cognitive strategy as irrelevant to the reading of mathematics text) without any verbalized strategy replacement. Examples of student verbalizations representing each of the described behaviors are provided in Table 5. As seen by the examples, most math heuristics applied were based on the identification of "key words."

Table 5: Student Verbalizations Upon Recognizing that the Text is Mathematical in Nature

Cognitive Comprehension Strategies Abandoned for Taught Mathematics Heuristics	Cognitive Comprehension Strategies Abandoned without Replacement
"I'm thinking about the beanbag, um, they're doing this toss and whoever hits the right place wins- I've done this before (*making connections*)…(continues reading)… Oh wait, this is math, I just need to find the numbers" (<u>key word strategy</u>)	"I am imagining the girls at the table with a lot of watermelon that they are going to share (*visualizing*)- I wonder if they are going to share it equally or fight about it (*student-generated questioning*)…(continues reading)...Ok, well, this is math…(continues reading)…17."

"Wow, this would really be a lot of snow in one place (*visualizing, connecting*)…(continues reading to second sentence)…Hmm, so I should find the numbers and plus them since it says "all"" (key word strategy)

"Ok, so Nancy is playing this bean bag game, so there must be other people playing it with her too (*making connections*)…(continues reading)…so, since I see that there are numbers down here on this part, I think I can just read those and not this anymore…so, like I mean I probably don't need any of this story."

I just don't get it, like, how many lights are going to be hung each hour- that's the next thing I should read about" (*student-generated questioning*)…(continues reading)…"Oh, well, I guess it's going to be multiplication since it says "each", so it doesn't matter if I thought I should have known the lights for the hour. I'll just find the numbers and multiply them…right?" (key word strategy)

"Well, that reminds me of potatoes and ABCs because it says "ABC" for the farm name (*visualizing, connecting*)…(continues reading)….and now I know that it's gonna be math (points to number in text) so all I do is listen for the answer to come to my mind…ok, yeah, but it's just not coming today."

Note. All verbalizations included above came after the student began reading the word problem text (not included here); student verbalizations are provided, but not the excerpt from the transcript where the students are reading the text. Examples of cognitive comprehension strategy use are indicated within and after student responses in columns 1 and 2 in italics. Examples of mathematics heuristics applied are indicated after student responses in column 1 as underlined text.

Although the primary focus of this question was on the cognitive comprehension strategy use during the reading of the mathematics word problems, evaluation of the mathematical accuracy of students' word problem solving indicated that approximately 90 percent of students correctly answered the word problem presented across both problem solving sessions. While it may be arguable that comprehension strategy use is not necessarily needed if 90 percent of students were able to accurately solve the problems presented, there are two considerations that relate to this finding. First, the problems that were presented to each student were aligned with the grade level that each child had just completed during the previous school year; thus, the problems were not intended to include new or development mathematics concepts. Second, it is arguable that while the students may have been able to solve the problems presented without the use of cognitive comprehension strategies, they will in all likelihood encounter more

complex problems during their progression in schooling, for which more complex thinking and reasoning skills will be required in order to have deeper comprehension of the tasks presented.

<center>Research Question 2: Students' MPIR Means Across Text Genres</center>

The underlying premise of this study is that self-regulated cognitive strategy instruction may be beneficial for elementary students in order to promote flexible use of cognitive strategies during the reading of all text, regardless of domain-specificity, and thereby enhance students' metacognition. Due to the investigative nature of this relatively new research, however, it was necessary to identify if students use cognitive strategies differently during the reading of fiction, nonfiction, and mathematics specific text prior to the introduction of integrated and/or domain-general strategy instruction (which will be discussed as an implication of this research in the chapter to follow). To investigate this question, a one-way within-subjects ANOVA was conducted with text genre as the within subjects factor and MPIR scores as the dependent variable. The means and standard deviations for MPIR scores are presented in Table 5.

Table 6: Means and Standard Deviations for Students' MPIR Scores

Text Genre	*M*	*SD*
Fiction	15.68	3.10
Nonfiction	15.39	3.37
Mathematical	11.43	1.93

The results for the ANOVA indicated a significant genre effect, Wilks's $\Lambda = .25$, $F(2, 26) = 38.96$, p < .01, multivariate $\eta^2 = .75$. Follow-up pairwise comparisons were conducted, and two of the comparisons were significant, controlling for familywise error rate across the three tests at the .05 level, using the Holm's sequential Bonferroni procedure: 1) Fiction and Mathematical

Text and 2) Nonfiction and Mathematical text. Both of the *p* values for these comparisons were .000, meeting the significance test by comparison of the Bonferroni correction of α=.017 and α=.025 for the pairs, respectively. Hypothesis 1 was therefore supported based on the students' significantly higher MPIR scores on average during the reading of fiction text compared to mathematical text. Similarly, Hypothesis 2 was supported due to the significantly higher MPIR mean scores from the reading of nonfiction text as compared to the MPIR mean scores from the reading of mathematical text.

<div align="center">

Research Question 3: Clinicians' Recognition of Strategy-Relevance to Fiction/Nonfiction and Mathematical Text
</div>

To determine whether or not the reading clinicians identified the use of cognitive comprehension strategies as relevant to mathematical text, two sub scores on the Pre Survey of Cognitive Reading Strategies were compared: strategies identified for typical (fiction/nonfiction) text and strategies identified for mathematical text. A dependent *t* test was conducted to evaluate whether clinicians identified more strategies as relevant to fiction/nonfiction than mathematics text specifically. The results indicated that the mean for strategies identified for fiction/nonfiction text ($M = 6.71$, $SD = 1.72$) was significantly greater than the mean for strategies identified for mathematical text ($M = 3.5$, $SD = 2.06$), $t(33) = 8.56$, $p < .01$. The standardized effect size index, *d,* was 1.47, which is considered to be a large effect. These findings support Hypothesis 3 because the clinicians recognized a significantly different average number of cognitive comprehension strategies as relevant to reading fiction/nonfiction text than the average number recognized as relevant to the reading of mathematical text. Though not specified in the original hypothesis, the clinicians recognized more strategies on average for fiction/nonfiction than mathematics text, which aligns with the anticipated outcome, as expressed in descriptions of this study in Chapters 1 and 2.

<u>Research Question 4: Clinician's Post Survey Scores by Treatment Group</u>

After participation in the randomly assigned professional development book study groups, all participants were given the Post Survey of Cognitive Reading Strategies. To evaluate the hypothesis that participants in the treatment group would identify more strategies as relevant to mathematics than the control group, controlling for pre survey sub scores, academic major, level of school, and number of previous reading and mathematics education coursework, a one-way analysis of covariance (ANCOVA) was conducted. The independent variable included two options for the professional development book study group: treatment group focusing on integrated reading and mathematics cognitive strategy instruction and control group focusing on cognitive strategy instruction in reading education alone. The dependent variable was the sub score for cognitive strategies identified as relevant to the reading of mathematical text from the Post Survey of Cognitive Reading Strategies. Covariates included the sub score for cognitive strategies for math from the Pre Survey of Cognitive Reading Strategies, academic major, level of schooling, number of reading education courses taken, and number of mathematics education courses taken. A preliminary analysis evaluating the homogeneity-of-slopes assumption indicated that the relationship between each of the covariates and the dependent variable did not differ significantly as a function of the independent variable: pre survey score, $F(2, 23) = 1.78$, $MSE = 3.92$, $p = .19$, partial $\eta^2 = .13$; academic major, $F(1, 23) = .00$, $MSE = 3.92$, $p = .99$, partial $\eta^2 = .00$; number of reading education courses, $F(1, 23) = 1.11$, $MSE = 3.92$, $p = .30$, partial $\eta^2 = .05$; number of mathematics education courses, $F(2, 23) = .56$, $MSE = 3.92$, $p = .58$, partial $\eta^2 = .05$. The ANCOVA was significant, $F(1, 27) = 8.38$, $MSE = 33.64$, $p < .01$. The strength of the relationship was very strong, as assessed by a partial η^2, with the treatment factor accounting for 24 percent of the variance of the dependent variable, holding constant the pre survey sub score for

strategies identified as relevant to mathematics, academic major, number of reading education courses, and number of mathematics education courses. Therefore, subjects in the treatment group identified more strategies as relevant to mathematics text on average than did the control group, which supports Hypothesis 4. The adjusted mean for the treatment group was $M = 6.40$ and the adjusted mean for the control group was $M = 4.19$. A post-hoc power analysis revealed a power score of .80, which is the standard acceptable power statistic accepted by the research community.

An additional component of the Post Survey of Cognitive Reading Strategies required the clinicians to provide an explanation of differences (if any) between strategy use for those strategies identified by the clinician as relevant to both reading of fiction/nonfiction and mathematical text. The strategies that were cited most frequently as relevant to both text genres were questioning, predicting, visualizing, synthesizing, and connecting. Examples of clinician responses to this question are provided in Table 6.

Table 7: Clinicians' Descriptions of Differences Between Strategy Use Applied to Fiction/Nonfiction and Mathematical Text

Strategy Relevance Identified for Both Text Genres	Control Group Participant Comments	Treatment Group Participant Comments
Student-Generated Questioning	"The students will be asking questions about numbers rather then comprehension of reading"	"Strategy use would be similar in both contexts, where students are generating a variety of questions including wonder questions, questions of the author, and questions related to the main components of the math problem (similar to the main elements of fiction and/or the main idea of nonfiction)"
Predicting	"Predicting in math will involve estimation, not prediction of text"	"Predicting during the reading of math text involves levels of complexity, considering predictions of the content that the author will provide, anticipation of mathematical processes and end results (larger, smaller, etc.),

Strategy Relevance Identified for Both Text Genres	Control Group Participant Comments	Treatment Group Participant Comments
Visualizing	"For visualizing with math, I would have the student drawing pictures to represent problems" "Students need to picture scenes in reading and pictures shapes in math"	"Visualizing is the same in math and reading"
Synthesizing	"Synthesizing in math would simply be writing down the key words/terms that give specific direction"	"Synthesizing in reading and math are the same processes. Students don't use them in different ways."
Connecting	(No students in this group recognized the Connecting strategy as relevant to across text genres)	"The process of connecting when reading math and when reading other nonfiction and fiction is actually the same and VERY important so that students can access their prior knowledge and experiences in order to have a deeper understanding of the text and draw on knowledge that will support additional strategies (such as making inferences and synthesizing).

and even predicting how to use this in the "real world""

Research Question 5: Students' MPIR Means by Treatment Group of their Assigned Clinician

After the reading clinicians completed their participation in the randomly assigned professional development book studies, their assigned elementary student tutees submitted to an additional one-on-one student-researcher interview in order to investigate cognitive comprehension strategy use during the reading and interpretation of a presented mathematics word problem. Students' MPIR scores were compared based on the treatment group to which

their individual reading clinician was assigned. To evaluate the hypothesis that the average MPIR scores of students whose clinicians were assigned to the treatment group would be greater than the average of students whose clinicians were assigned to the control group, an analysis of covariance (ANCOVA) was conducted. The independent variable was the professional development assignment of the students' clinicians (treatment or control group), and the dependent variable was the mean MPIR scores for each group. Covariates included students' mathematics achievement level, reading achievement level, and initial MPIR scores from the reading of the mathematical text during the first student-researcher interview. For the purpose of this analysis, achievement level was limited to "below grade level" or "on or above grade level" for each domain. A description of the measures and procedures used to determine achievement level was provided in the previous chapter. A preliminary analysis evaluating the homogeneity-of-slopes assumption indicated that the relationship between two of the covariates (mathematics achievement and reading achievement) and the dependent variable did not differ significantly as a function of the independent variable: mathematics achievement, $F (2, 20) = .53$, $MSE = 2.61$, $p = .60$, partial $\eta^2 = .05$; reading achievement, $F (2, 20) = .48$, $MSE = 3.92$, $p = .63$, partial $\eta^2 = .05$. The interaction between students' grade levels and the MPIR score was statistically significant though, indicating a violation of homogeneity of regression slopes; therefore, the one-way analysis of covariance was conducted with the exclusion of the students' grade levels as a co-variable. The ANCOVA was not significant, $F (1, 24) = .32$, $MSE = 3.37$, $p = .58$, partial $\eta^2 = .01$; thus, Hypothesis 5 was rejected. A post-hoc power analysis revealed a relatively low observed power score of .515, which suggests that the small sample size of this study yielded insufficient power of the test. This impact must be considered in the interpretation of the results, as the

insufficient power may have caused a lack of statistical difference, rather than a lack of difference

between the groups. Implications of these findings will be further discussed in the next chapter.

CHAPTER 5: CONCLUSIONS AND DISCUSSION

The purpose of this dissertation research was to investigate elementary students' cognitive comprehension strategy use during mathematics text applications and examine teachers' perceptions of the relevance of these strategies to their mathematics instruction by addressing the weaknesses in previous research by a) using think-aloud protocol to identify students' strategy use through self-reported measures and researcher-identified trends, b) investigating teachers' recognition of strategies as relevant to reading and mathematics instruction, c) imposing an experimental treatment intended to impact and increase teachers' awareness of the relevance of cognitive comprehension instruction to mathematics instruction, and d) examining if changes to teachers' perceptions of cognitive comprehension strategies as domain-general impacts their students' strategy use during the reading of a math text in the timeframe provided in the study. Five research questions and five hypotheses addressed this purpose, focusing on characteristics of students' strategy use across text genres, differences between teachers' identification of strategies for reading across text genres, and treatments effects from the randomly assigned professional development for teachers' determined by the clinicians' recognition of strategy relevance to mathematics text and their assigned student's strategy use.

For clarity, the discussion of the results will be divided into three sections. In Part 1, I will summarize the results of research questions 1-2- the investigation of students' strategy use during the reading of mathematics text and a comparison of students' strategy use across text genres, integrating implications of the results for practice. Then, I will review limitations of this component of the research and provide suggestions for further research. In Part 2, I will address the results of the analyses of research question 3, focusing on teachers' initial perceptions of cognitive comprehension strategy use as significantly more relevant to fiction and nonfiction text

reading than mathematical text. Implications for policy and practice will be described, and limitations and suggestions for further research will also be provided. Finally, in Part 3, I will summarize the results of research questions 4-5, addressing the impact of the assigned professional development on teachers' perceptions of comprehension strategies as relevant to mathematics and their students' strategy use. The discussion will be presented in the same order as Parts 1 and 2, as described.

<u>Part 1: Elementary Students' Cognitive Comprehension Strategy Use</u>

The first two research questions were based on elementary students' cognitive comprehension strategy use. Research question 1 was: Do students use cognitive comprehension strategies during the reading of a mathematics-based text, and if so, how? A hypothesis was not constructed for this question due to its qualitative nature; however analysis of interview transcripts was provided in the previous chapter, and implications of the results will be further discussed in this section. Research question 2 was: Do first through sixth-grade students use cognitive reading comprehension strategies differently across fiction, nonfiction, and mathematical content-specific text applications? Both of the hypotheses for this question were supported. The students' MPIR mean scores from the reading of both fiction and nonfiction differed significantly and positively than the MPIR mean scores from the reading of mathematical text. Additionally, there was no significant difference between the MPIR scores from the reading of fiction and nonfiction texts.

Analysis of the transcripts of students' recorded interviews during which think aloud protocol were implemented reveals that nearly all students demonstrated an efferent stance (Rosenblatt, 1974) when reading and interpreting the mathematics text once they identified the text as mathematical in nature. Prior to their recognition of the text as a math word problem,

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those students who demonstrated consistent cognitive comprehension strategy use during the reading of fiction and non-mathematical nonfiction were also initially using the strategies during the reading of the word problem. When they identified the text as mathematics-related, however, most students extinguished the strategy use in process and either referred to learned mathematics heuristics or ceased to express any strategy use for the remainder of the unprompted portion of the think aloud. Although this could actually be interpreted as domain-general strategy use, in which students analyzed the problem presented and selected a strategy that they considered to be relevant to the context, it does indicate that they did not perceive the continued use of reading comprehension strategies to be relevant to a mathematical task. A conceptualization of Pintrich's (2000) Framework for Phases of Self-Regulation, provided in Figure 1, will be used to further interpret students' verbalizations and behaviors during the individual interviews, in which cognition, behavior, and context are identified as areas for self-regulated learning.
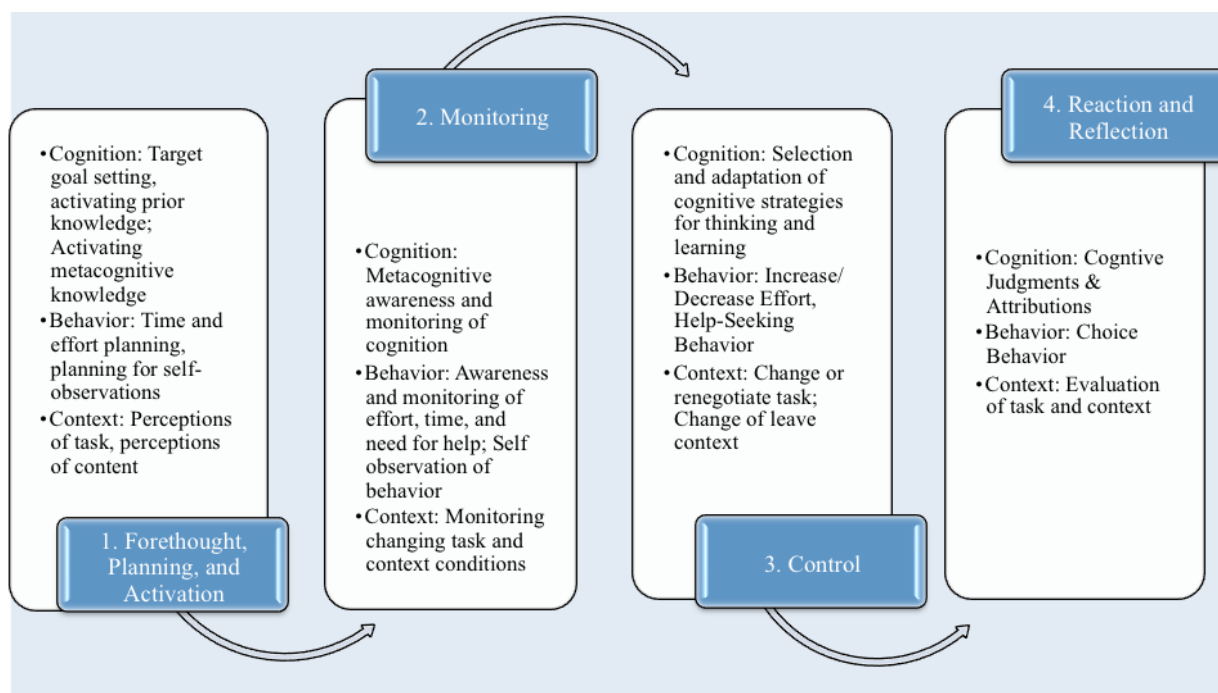
Figure 1: Phases for Self-Regulated Learning (Pintrich, 2000)

Based on this widely supported framework (Azevedo, 2009; Green, Moos, Azevedo, & Winters, 2008; Schunk, 2005), the phase of "forethought, planning, and activation" was demonstrated by most students who verbalized any and/or all of the following behaviors: target goal setting based on their perceptions of the task (evidence provided by continued verbalizations after the warm-up protocols, signifying students' understanding of their role in the think aloud process), activation of prior knowledge (evidence provided by text-to-self connections provided by many of the participating students), and activation of metacognitive knowledge activation (evidence provided by a) students' verbalized strategies, including recognized and unrecognized, and b) verbal indicators of self-efficacy with consideration of task difficulty). The next phase of "monitoring" involved students' awareness of cognition, including their affect. Examples of this phase were provided by students' continued strategy use prior to the recognition of the text as mathematical in nature. The think aloud research protocol may have even caused the students to engage in self-observation of this behavior, which Pintrich identified as a further exemplification of the phase. The contextual component of this phase involves students' monitoring the changing task and context conditions, which was clearly illustrated by the students' recognition of the text as mathematical in nature once they reached an indicator in the text that incited their verbalization of such (most often numeric components). Pintrich's next phase, "control" describes cognition based on the selection and adaptation of cognitive strategies for learning and thinking. The behaviors identified for the control phase include anticipation that the learners will demonstrate any of the following: persistence through increased effort, discontinued use of strategies through decreased effort, or help-seeking behavior. At this phase, many of the student participants either shifted to the use of one or more mathematics heuristics or abandoned strategy use altogether (at least as determined by the analysis of verbalizations). Some students also demonstrated help-

seeking behaviors, which were demonstrated by the raised tone of their inflection during verbalizations provided during word problem interpretation (tone is being used here to describe the particular modulation of the voice to express meaning). Pintrich's final phase, "reaction and reflection" involves choice behaviors of evaluating the task, evaluating the context and reacting based on affect. Some of the students' verbalizations can be qualified as evaluating the task when they sought to determine whether or not their math solution was correct (whether asking me or checking their work). Others were perhaps evaluating the context by asking me if they did the right thing by thinking aloud when they were reading, as instructed in the protocol warm ups. Lastly, some of the students demonstrated affective reactions through Level 1 verbalizations including sighs and expressions of satisfaction of completion. Most of the students who demonstrated relief upon completion had also demonstrated evidence of affect-related responses that could be interpreted as negative upon recognizing that the text was mathematical in nature at the monitoring level.

There were consistent student behaviors demonstrated that could be classified as exemplars for Pintrich's phases for self-regulated learning. Given the identified similarities between cognitive strategies that are currently suggested for instruction in reading education and mathematics education literature (as revealed in Chapter 2), however, the students' significant cognitive shifts (including contextual strategy extinction with or without replacement of less transactional text strategies) upon recognizing that the text was mathematical do not seem warranted. I am suggesting that students who were effectively visualizing text, making connections to their own lives, and generating questions about the context could have continued to do so even after they recognized that the text was a math word problem; yet, it appears that they did not consider that to be a viable option. Similarly, interpretation of the results of research

question 2 (which examined the differences between students' strategy use across text genres using MPIR scores as a repeated measure) further suggests that students do not recognize that the cognitive strategies that they are able to use effectively to deepen their understanding of fiction and nonfiction text could also be applied to mathematical contexts.

These findings offer significant contributions to the existing literature on the use of self-regulated, domain-general strategies, specifically considering their use in children. A large body of existing research suggests that students will not or cannot transfer domain-general strategies across disciplinary contexts (Alverman, 2002; Fuchs, 2003); however, there is evidence from the results of this study that students are capable of doing so based on the initial strategy usage during the reading of mathematical text. Although these strategies were not fully supported throughout the reading of the mathematical text, current research supports the need for students to receive instruction to develop conditional knowledge of strategy use, including when, how and why to use strategies in different contexts. Due to the fact that additional findings of this study (further discussed in Part 3 of this chapter) suggest that teachers do not currently perceive cognitive comprehension strategies as relevant to the reading of mathematical text (though we also now know that these perceptions can be impacted with targeted professional development), it is highly unlikely that the elementary student participants in this study have ever received instruction or engaged in conversation related to how they could use cognitive comprehension strategies such as visualizing, connecting, questioning, summarizing, etc. during the reading of math text. This suggests, consistent with research, that if students were to receive such instruction on conditional knowledge, it is highly likely that their cognitive comprehension strategy use during the reading of mathematical text could be self-regulated and sustained throughout. To expand upon the findings in this study, additional research should examine just that, including whether or not

strategy knowledge and/or conditional knowledge, as related to the reading of mathematical text, impacts students' verbalized reports of cognitive comprehension strategy use. An additional significant contribution of these findings to the existing research on domain-general knowledge is based on the evidence that first through sixth-grade children had the ability to readily articulate their metacognitive processes during the reading of mathematics, fiction, and nonfiction text. This challenges assertions (Schraw & Moshman, 1995) that domain general knowledge is typically acquired in adults and is often implicit and/or passively known. A possible explanation for why the children in this study were able to discuss their metacognitive awareness without difficulty could be based on the recent increased focus on metacognition in reading education, from which students may have had experience monitoring the strategies discussed in this study. Nonetheless, if our expectations of children's abilities to discuss their mental processes of functionality, control, and evaluation are not limited, there are significant implications regarding future research and educational applications that can be considered, across domains of educational psychology, mathematics education, and reading education.

These findings may also have practical implications in favor of integrated strategy instruction in elementary classrooms so that students who are able to effectively use cognitive strategies while they are reading fiction and nonfiction text can transfer their strategy use to the reading of mathematics related text. The vast literature on transfer of cognitive strategy use (Perkins & Salomon, 1989; Welch, 2009) reveals that transfer is highly contingent upon a variety of factors, however, including: students' perceptions of strategy effectiveness, methods of initial strategy instruction, and contexts in which guided practice and independent practice were facilitated, among others. The latter two factors may also rely heavily upon teachers' understanding of cognitive strategy use and instruction and, in the case of this study, their

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perceptions of the domain relevance of cognitive comprehension strategies to mathematical text, which will be discussed further in Part 2 of this chapter. These interpretations are graphically represented in Figure 2, as related to Pintrich's (2000) phases for self-regulated learni
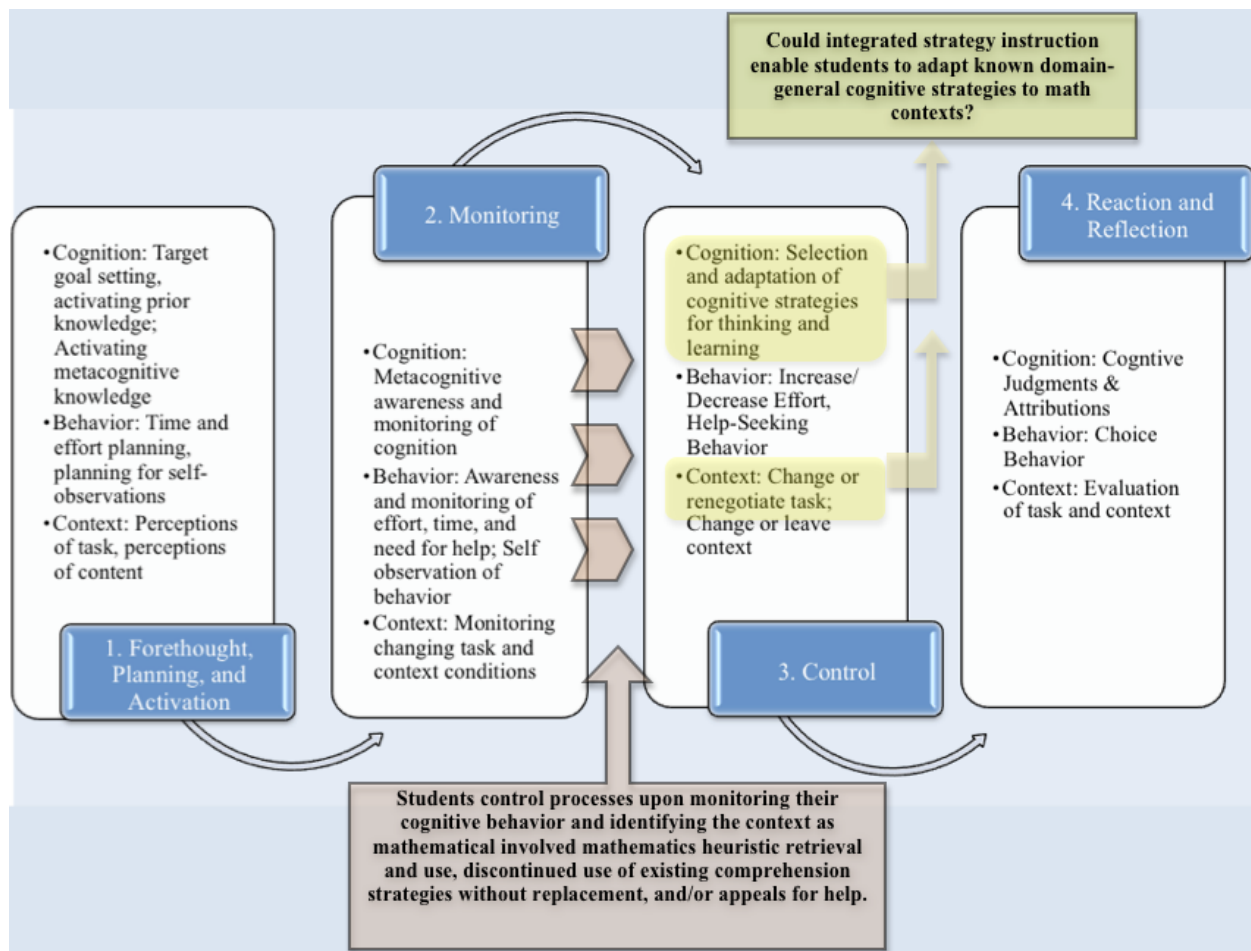
Figure 2: Interpretation of Students' Cognitive Behaviors Using an Adaptation of Pintrich's Phases for Self-Regulated Learning (2000)

Findings revealed that the most frequently accessed mathematics heuristic demonstrated by the students was based on the use of key words in the text, which students used in conjunction with identified numerical components of the word problem in order to construct a numerical equation. This strategy, however, does not require students to fully conceptualize the problem being presented, which can often lead to incorrect strategy use and answer responses (Garofalo

& Lester, 1985; Damon & Lerner, 2006). Current professional development materials for elementary teachers often deemphasize this strategy for mathematics instruction; instead promoting strategies such as visualizing, which require students to construct representations of the problem in order to plan, implement, and identify a solution (NCTM, 2011). Further, strategies such as visualizing, questioning, and connecting, summarizing, making inferences/predicting, and synthesizing, all endorsed by the National Council of Teachers of Mathematics, have a theoretical base in literature on self-regulatory learning and metacognitive processing. Thus, students could be taught to deliberately retrieve and apply these strategies while evaluating task and context conditions and governing their own mental processes, which relates to Pintrich's (2000) cognition area for the control phase in which students select and adapt cognitive strategies for learning and thinking.

This study relied heavily on the use of individual student interviews (during which think aloud protocol was used) and the MPIR (Keene, 2005) to collect data about students' strategy use during the reading of fiction, nonfiction, and mathematical text. Examples of students' self-reported strategy use and researcher-coded strategy use from verbalizations were considered in the results and discussion of this study. There were limited reliability statistics available prior to the use of the MPIR in this study; however, it was selected due to the a) strong content and construct validity reported by classroom teachers and literacy specialists across the country in numerous field tests and b) alignment with the cognitive comprehension strategies of interest for this study. Since this study has provided reliability coefficients based on the use of the instrument with the student participants, additional research on the use of the instrument is warranted, including inter-rater reliability coefficients from the use of the scoring rubric. Also, due to time constraints, I was not able to conduct follow-up interviews with students regarding their MPIR

responses or their verbalizations during the interviews. Future research that includes these procedures may yield richer Level 3 verbalizations, further illuminating students' cognition and metacognitive awareness (or lack thereof). Additional analysis of the transcripts using metacoding transcript analysis procedures may also reveal more information about students' strategy-governing processes during the reading of mathematics text.

The use of think aloud protocol in this study was carefully implemented based on research procedures prescribed by Ericsson & Simon (1993); however, there are still limitations based on the use of verbalizations to identify the cognition of children, who may not fully understand how to engage in think aloud protocol. Using a larger sample of students in the future would allow stratified sampling procedures such as identifying only those students who demonstrate the ability to think aloud in warm up exercises as participants in the experimental component of the study. It is important to note that the limitations of examining student cognition will still persist due to the nature of the research, however. Additionally, there was a potential for contamination effects from the MPIR that was administered at the first and second student interviews, although the follow-up version of the instrument was used to reduce the potential effects.

Lastly, the population of elementary students that were recruited to participate in this study was limited due to the need for access to other features of the purposively selected reading program site (including access to first through sixth grade students, conditions allowing for random pairing of reading clinicians to students, conditions allowing for random pairing of reading clinicians to treatment groups, and access to pre-service and in-service teachers with varied levels of background knowledge and education). The student participants were enrolled by their parents who had the means to register their child(ren) and provide daily transportation to and from the program site. These are resources that may not be available to all children's families;

thus, follow-up studies conducted at a school site with randomly selected elementary students may include a sample that is more representative of the general elementary school population.

Based on the findings of this study, additional research should be conducted to determine how students respond to instruction that integrates cognitive comprehension strategies (specifically predicting, connecting, summarizing, generating questions, making inferences, synthesizing, visualizing, and determining importance). Clinical interviews might be considered to investigate more about students' control processes of selecting and adapting strategies after they have monitored changing task and context conditions. Instructional interventions based on integrated strategy instruction during reading and math lessons, with text genre examples used from both domains, would also provide an interesting follow up to the findings of this study.

Part 2: Reading Clinicians' Initial Perceptions of Domain-Relevance of Strategies

The third research question was based on whether or not the reading clinicians identified the use of cognitive comprehension strategies as relevant to mathematical text. Two sub scores on the Pre Survey of Cognitive Reading Strategies were compared: strategies identified for typical (fiction/nonfiction) text and strategies identified for mathematical text. Hypothesis 3 was supported because the reading clinicians identified significantly more cognitive comprehension strategies as relevant to the reading of fiction or nonfiction text than they did for the reading of mathematical text. Possible scores on the survey ranged from 0-8, depending on how many cognitive comprehension strategies were identified, of the twenty strategies that were presented as options on the survey (distracters included text-based strategies, instructional strategies, etc.). The reading clinicians' not only identified significantly more cognitive strategies on average for reading fiction/nonfiction text compared to mathematics text, but they also identified more strategies in general for that question item than they did for the mathematics-related item. This

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suggests that the clinicians had greater prior knowledge about the content and approach to teaching strategies in typical reading lesson contexts compared to mathematics reading applications. Explanations for the significant mean differences in item responses may be based on a variety of factors. One explanation may be that the clinicians' considered their own educational experiences in K-12 schooling when answering the questions, which were likely heavily rooted in domain-specific instruction based on the age of the participants and a comparison of educational trends during their schooling. Research suggests that often teachers, especially those new in their careers, rely more heavily on memories of instructional practices from their K-12 education than the instructional theories and practices that were demonstrated in their teacher preparation programs (Kagen, 1992). These patterns of instructional planning have been previously reported both explicitly and implicitly when examining teachers' considerations during the planning process (Grossman, 1989). Another possible explanation could be based on the instruction in reading education and mathematics education that the clinicians received during their pre-service, undergraduate teacher preparation programs. Due to the disconnect across reading and mathematics education literature (exemplified in Chapter 2), university faculty in these fields were likely to be unaware of the similarities of relevant cognitive strategy instruction within each discipline, thus the connections may not have been readily included in their instructional planning and delivery. Additionally, it is highly unlikely that the textbooks and other reading materials to which the clinicians were exposed during their teacher preparation programs and professional development experiences (for the in-service teachers) illustrated similarities among the use of cognitive strategies in reading and mathematics contexts since the underlying research base across these domains remains highly disjointed to date. Integrated, applied research on this topic, such as the study presented in this dissertation, will be useful to inform teacher

educators about both the current state of teachers' perceptions and students' cognitive strategy use

patterns. Literature synthesizing the similar, self-regulatory cognitive bases that are currently

being advocated by national educational organizations (NCTM, 2011; IRA, 2011), common core

standards, state standards, and recent research in each content area (as discussed in Chapter 2)

will also be useful in aligning the university-based teacher educators from these content areas

who have some of the earliest opportunities to inform future teachers' instructional perceptions

and practices.

The Pre Survey of Cognitive Reading Strategies that was used in this study was adapted

from Barry's (2002) Survey of Teaching Strategies and pilot tested prior to implementation in this

research. The length of the instrument is a limitation, however, based on the inclusion of only

two survey items, one measuring each construct (beyond the items designed to identify student

demographics). Due to the emerging nature of integrated research in reading and mathematics

education, there were no other instruments that could be used in this study, although, the

development of a tool that measures teachers' perceptions of cognitive comprehension strategy

instructional relevance to other learning domains is warranted, especially given the recent

increased focus on content area reading strategies (Vaca & Vaca, 2004) and disciplinary literacy

(Shanahan & Shanahan, 2008). Another limitation of this component of the study was that

teachers' perceptions were only obtained from the survey instrument, rather than additional

methods such as analysis of their own practice, observations of others, the use of classroom

vignettes, etc., all of which may have offered more insight into what teachers were thinking about

domain-general strategy instruction compared to domain-specific applications. Follow-up,

applied research could be based in the classroom and include interviews with individual

participants beyond survey measures alone to gain deeper insights into their understandings and

applications of strategy instruction for elementary learners. As described for the population of

students that were recruited for this study, the population and sample of reading clinicians in this

study is not necessarily representative of the elementary teacher population at large. In fact, some

of the in-service teachers/graduate students were middle school teachers, and many of the

clinicians were graduate students in the reading education program, which is not indicative of the

typical reading background knowledge that would be expected of an elementary teacher. That

said, despite their advanced coursework, many of these clinicians still demonstrated limited

understanding of the relevance of cognitive comprehension strategy instruction and use to

principles of self-regulated learning, the interpretation of text, and metacognitive awareness.

Thus, additional research with a more representative sample of teachers may reveal even greater

differences in perceptions of relevance of strategy use for the reading of mathematics text.

<u>Part 3: The Impact of the Experimental Professional Development on Clinicians' Perceptions of Strategy Relevance and Students' Strategy Use</u>

This section will offer a discussion of the impact of the randomly assigned professional

development book studies based on two of the research questions and hypotheses from this study.

Research question 4 focused on whether or not reading clinicians' perceptions of applied

cognitive reading comprehension strategy use in mathematics contexts differed based on their

participation in the professional development treatment group or control group. The mean scores

of clinicians in the treatment group were significantly greater than the mean scores of the control

group on the sub score of strategies recognized for mathematics text on the Post Survey of

Cognitive Reading Strategies, which supported Hypothesis 4. Research question 5 investigated

whether or not students' cognitive comprehension strategy use during the second reading of math

text was significantly different as a result of their assigned clinician's participation in the

treatment or control group, controlling for reading achievement, math achievement, and MPIR

scores from the initial interview. MPIR scores were obtained during the second reading of mathematics text with each student, but the means scores from each group were not found to be different from each other based on the treatment group of the assigned clinician. Thus, hypothesis 5 was rejected.

The results from this component of the study suggest that it is possible to impact reading clinicians' perceptions of domain-relevance of cognitive comprehension strategy use, specifically as applied to the reading of mathematical text. Potentially confounding variables of academic major, level of schooling, courses in reading education, courses in mathematics education, and pre survey sub scores were all controlled, and the findings still suggested significant and strong treatment effects. Although $\alpha = .05$ for Hypothesis 4, the actual p-value from analysis of the comparison among groups was less than .01, indicating considerably strong effects. These results offer implications for future professional development of pre-service and in-service teachers in the areas of integrated content area instruction, domain-specific cognitive strategy instruction, and tenets of self-regulated learning. Prior to the assigned intervention, as described in the previous section of this chapter, the participating reading clinicians' mean scores of strategies identified as relevant to fiction/nonfiction reading were identified as significantly different when compared to mathematical text reading specifically. This suggested that prior to the intervention, the reading clinicians demonstrated increased awareness of strategy relevance to fiction/nonfiction compared to mathematics text. After only a two-week period, during which the clinicians read assigned literature on either integrated cognitive strategy instruction in reading and math or literature to deepen their understanding of specific cognitive comprehension strategies, the clinicians in the treatment group perceived the strategies with increased relevance to mathematics than their peers from the control group. Explanatory survey responses from both groups (highlighted in Table 7)

were also indicative of the difference in perceptions between the two groups. The clinicians from the treatment group provided more explanation about the salient features of each strategy, as described in their responses, and they linked the strategy use descriptions to deeper comprehension of text and the importance of understanding the mathematical content and processes inherent in word problem texts.

These findings offer significant contributions to the existing literature by revealing a little-discussed lack of awareness on teachers' parts of the underlying similarities of cognitive demands of reading fiction, nonfiction, and mathematical text. Further, this study reveals that even once we are able to identify that teachers have these limited viewpoints, it is possible to quickly and effectively impact their assertions about the relevance of cognitive comprehension instruction across domains. Additional research to build upon this contribution should center on obtaining a deeper understanding of how these changes in perceptions of strategy use can be used to impact changes in classroom discussion, because many may wonder why there were no significant differences in student strategy use based on their assigned clinician's book study group, even though the clinicians demonstrated a difference in perception of strategy relevance according to treatment group? Several explanations can be offered. First, extensive research on conceptual change in teachers reveals that even when teachers recognize a change in their theoretical or pedagogical beliefs, there is not always change in their planning and/or delivery of instruction (Duschl & Gitomer, 2006). Thus, in the short timeframe in which the reading clinicians' in this study participated in professional development that yielded different outcomes of belief, there were no specific interventions provided to support the teachers in connecting their perceptions of strategy relevance to their instruction of strategy use with students. Secondly, it is possible that the reading clinicians had already constructed instructional plans for the allotted

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time with their students prior to the completion of the book study, in which case they did not have an opportunity to make changes to their instructional practices based on their professional learning. Considering further, due to seemingly limitless confounding variables related to student learning (motivation, self-efficacy, prior knowledge, achievement levels, previous instruction, physiological/emotional/social needs, etc.) it would be difficult to identify the cause for differences among groups looking at students' strategy use had they even existed during the reading of math text. Nonetheless, the findings of this study suggest significant implications for future research on how teachers' perceptions of strategy relevance can not only be changed, but used to impact and improve their instruction.

As previously discussed, the survey-based nature of this research is a limitation because it relied on the clinicians' interpretation of the instrument and self-reports of explanations without the opportunity to provide follow-up explanations due to time constraints. An additional component of this research was originally going to include each reading clinician observing the one-on-one student interview with the researcher behind a double-sided mirror to identify whether or not the clinician and researcher identified the students' strategy use consistently. The clinicians would also have identified themes from the students' verbalizations and the clinicians' recognition of the students' metacognitive processes, strategy use, adaptive behaviors, etc. would have provided deeper insights into their own understanding of cognitive strategy use, self-regulated learning, and metacognitive awareness. This component was eliminated from the study at the onset due to time and logistical constraints of the research site; however, it could be included in future research in order to add additional data based not only on teacher perceptions of strategy use, but recognition of student strategy use. Also, if an additional or modified survey instrument was used in future research, it would be possible to conduct dependent t analyses to

compare pre and post test means in addition to comparing the post survey means between groups, which would provide more insight about the participants learning as a result of the treatment groups.

An additional limitation is based on the time during which treatment effects were measured. The clinicians demonstrated a difference in strategies by treatment group after a two-week period during the summer, which is a time when they were not working under the pressures and constraints that teachers' experience during a typical school year. Therefore, it is difficult to determine whether or not the treatment effects are sustainable over time (with or without ongoing professional development) and whether or not the same results would be obtained if the professional development were delivered over the same time frame during the regular school year. Follow up research with participants could be conducted to identify the presence or absence of long-term differences according to treatment, including but not limited to interviews, classroom observations, and a review of individual professional development plans.

APPENDIX A
MAJOR POINT INTERVIEW FOR READERS (MPIR) AND SCORING RUBRIC

The rubric that follows the MPIR is designed to permit teachers to quantify student growth in use of a given strategy. Each number represents twenty percent of the overall scale. The rubric has been a useful way to quantify and describe a student's growth to parents and administrators.

Public Education & Business Coalition
Reading Project
Major Point Interview for Readers

Text-Based Assessment and Think-Aloud

I want you to read several pages of this book. [Alternative for children who are not voice/print matching: I want you to tell me as much as you can about the first few pages of this book. Be sure to tell me if you recognize any of the words.] I will stop you every once in a while. [Identify logical stopping places roughly every third or fourth page in picture books, and every two to three paragraphs in longer text.] Then tell me exactly what you are thinking about. Tell me what you were thinking about *as you read* the story (or text). The important thing is that you pay attention and remember, so that you can tell me what you were thinking about while you read the piece. You can tell me anything the book makes you think about, any problems you had while reading it, and what you think it is about.

Strategy Use Interview

Now I want to ask you some questions about what you think about while you read.

Uses Schema
1. When you read that story (text) did it remind you of anything you know about? What? Why did it remind you of? [If response is no] Did it remind you of any experiences or things that have happened?

2. Are there things you know about or things in your life that help you to understand this book? How does that help?
3. We have just discussed (talked about) what this book reminds you of. [Restate child's response.] What do you understand now that you didn't understand before?

Infers

[Select an event or fact that would call for a conclusion or interpretation. Refer to the event or fact when asking questions under number 2 below.]

1. [For narrative text] Can you predict what is about to happen? Why did you make that prediction? Can you point to (or identify) something in the book that helped you to make that prediction? [Or] What do you already know that helped you to make that prediction?
2. What did the author mean by _____? What in the story (text) helped you to know that? What do you already know that helped you to decide that?
3. We have just discussed (talked about) predicting and inferring. [Restate child's response.] What do you understand now that you didn't understand before?

Asks Questions

1. What did you wonder about (or question) while you were reading this story (text)?
2. What questions do you have about this book now? (or wonder about now?)
3. We have just discussed (talked about) the questions you asked. [Restate child's response.] What do you understand now that you didn't understand before?

Determines What Is Important in Text

1. Are there some parts of this story (text) that are more important than the others? Which ones? Why do you think they were the most important?

2. What do you think the author [name author] thought was most important so far in this story (text)? Why do you think so?
3. We have just discussed (talked about) important parts of the story. [Restate child's response.] What do you understand now that you didn't understand before?

Repeat Think-Aloud with Subsequent Text

Monitors Comprehension/Uses Appropriate Fix-Up Strategies
1. Did you have any problems while you were reading this story (text)? What could you do to solve the problem?
2. When you are reading other stories (texts) what kinds of problems do you have? What are all the ways you solve the problems?
3. We have just discussed (talked about) problems you have. [Restate child's response.] What do you understand now that you didn't understand before?

Visualizes and Creates Mental Images While Reading
1. When you were reading this story (text) did you make any pictures or images in your head? Tell me everything you can about that picture or image you made while you were reading just now. Do the pictures or images that you just told me about help you to understand the story (text) better? How?
2. [If no response] Can you think of a story where you made your own pictures or images in your head? Tell me everything you can about that picture or image. Do those pictures or images help you to understand the story (text) better? How?
3. We have just discussed (talked about) the pictures or images you make in your head. [Restate child's response.] What do you understand now that you didn't understand before?

Synthesizes
1. If you were to tell another person about the story (text) you just read, and you could only use a few sentences, what would you tell them?
2. Think about what you have just said about the story. What do you understand now that you didn't understand before?

Keene, 1995

Public Education & Business Coalition
Reading Project
Major Point Interview for Readers
Scoring Rubric

There is an overall criterion to bear in mind: When the reader can go beyond explaining his or her thinking and begins to articulate how using a strategy helps him or her to comprehend better, the response should be scored at least a 4.

Thinks Aloud
1. No response, random thoughts unconnected to the text
2. Disconnected thoughts relating more to the pictures than text
3. Thinking is tied to text events/text content; beginning inferences, may be inaccurate in relation to text, more tied to personal experience; may identify problems (word level) during reading
4. Generates questions, identifies problems, infers, elaborates text events with own experience, may make predictions about overall book meaning
5. Clearly expresses own thinking, may speculate about theme, discusses how own thinking supports or inhibits comprehension

Uses Schema

1. No response/schematic connection
2. Can talk about what text reminds him or her of, but cannot explain; reference to schema may not be clearly connected to text
3. Relates background knowledge/experience to text
4. Expands interpretation of text using schema; may discuss schema related to author, text structure; may pose questions based on apparent discrepancies between text and background knowledge
5. Explains how schema enriches interpretation of text; talks about use of schema to enhance interpretation and comprehension of other texts; connections extend beyond life experience and immediate text

Infers

1. No response/inference
2. Attempts a prediction or conclusion, inaccurate or unsubstantiated with text information
3. Draws conclusions or makes predictions that are consistent with text or schema
4. Draws conclusions and/or makes predictions and can explain the source of the conclusion or prediction
5. Develops predictions, interpretations, and/or conclusions about the text that include connections between the text and the reader's background knowledge or ideas and beliefs

Questions

1. No questions/irrelevant questions
2. Poses literal question(s)
3. Poses questions to clarify meaning
4. Poses questions to enhance meaning of text (critical response; big idea), may explain how posing questions deepens comprehension

5. Uses questions to challenge the validity of print, author's stance, motive, or point of view

Determines What Is Important in Text
1. No response, random guessing, inaccurate attempt to identify important elements
2. Identifies some elements (primarily pictures) as more important to text meaning
3. Identifies words, characters, and/or events as more important to overall meaning—makes some attempt to explain reasoning
4. Identifies at least one key concept, idea, or theme as important in overall text meaning, and clearly explains why
5. Identifies multiple ideas or themes, may attribute them to different points of view, discusses author's stance or purpose and its relation to key themes and ideas in the text

Following a Second Reading and Think-Aloud

Monitors Comprehension
1. Little or no conscious awareness of reading process
2. Identifies difficulties—problems are often at word level; little or no sense of the need to solve the problem; does not articulate strengths; identifies need to concentrate; says sound it out
3. Identifies problems at word, sentence, or schema level; can articulate and use a strategy to solve problems, usually at the word or sentence level
4. Articulates and uses more than one strategy for solving problems; focuses on problems at the schema (more global) level
5. Identifies problems at all levels; uses a variety of strategies flexibly and appropriately given the context and the problem

Visualizes

1. No response
2. Describes some visual or other sensory images; may be tied directly to text or a description of the picture in the text
3. Describes own mental images, usually visual; images are somewhat elaborated from the literal text or existing picture
4. Creates and describes multisensory images that extend and enrich the text
5. Elaborates multisensory images to enhance comprehension; can articulate how the process enhances comprehension

Synthesizes

1. Random or no response; may give title
2. Identifies some text events; random or nonsensical order
3. Synthesizes with some awareness of event sequence: beginning, middle, end
4. Enhances meaning in text with synthesis; may incorporate own schema; uses story elements to enhance the synthesis, may identify key themes
5. Succinct synthesis using internalized story/genre structure, identifies key themes; may articulate how synthesizing promotes deeper comprehension

Retelling

1. Random response; may be related to story (text); may give title
2. Retelling reveals beginning awareness of event sequence
3. Uses story elements (character, setting, conflict, sequence of events, resolution) and/or genre structure to organize a relatively accurate retelling (beginning, middle, end)
4. Story elements/genre structure clear in an accurate retelling; refers to interactions between story elements

(how problem affects character, how setting changes problem, etc.)

5. Uses all story elements/genre structure and inferences to capture key themes in piece; points out interrelationships between elements; talks about how the overall meaning is influenced

Keene, Goudvis, Schwartz (1995)

APPENDIX B
PRE AND POST SURVEY OF COGNITIVE READING STRATEGIES

Note: This format is modified to view as a hard copy. Survey was administered electronically.

PRE SURVEY

1. Check any of the cognitive strategies below that you recognize AND consider to be beneficial to aid in the reading comprehension of text for 1st grade through 6th grade students.

___ Anticipation Guide
___ KWL (Know/Want to Know/Learned)
___ DRTA (Directed Reading Thinking Activity)
___ Think-Alouds
___ Reciprocal Teaching
___ Summarizing
___ Picture Walks
___ Student-Generated Questioning
___ Connecting (Text-to-Self, Text-to-Text, Text-to-World)
___ Predicting
___ QAR (Question-Answer Relationships)
___ QtA (Question the Author)
___ Discussion Web
___ Activating Prior Knowledge (Using Schema)
___ Retelling
___ Synthesizing
___ Visualizing
___ Determining Importance
___ Making Inferences
___ Text Coding

2. Check any of the strategies below that you recognize AND consider to be beneficial to aid in the reading and interpretation of mathematical word problems by 1st grade through 6th grade students.
___ Anticipation Guide
___ KWL (Know/Want to Know/Learned)
___ DRTA (Directed Reading Thinking Activity)
___ Think-Alouds
___ Reciprocal Teaching
___ Summarizing
___ Picture Walks
___ Student-Generated Questioning
___ Connecting (Text-to-Self, Text-to-Text, Text-to-World)
___ Predicting
___ QAR (Question-Answer Relationships)
___ QtA (Question the Author)
___ Discussion Web
___ Activating Prior Knowledge (Using Schema)
___ Retelling
___ Synthesizing

___ Visualizing
___ Determining Importance
___ Making Inferences
___ Text Coding

3. What is your gender?

___ Male
___ Female

4. What is your date of birth? (MM/DD/YYYY)

_____

5. What is your current student status?

___ Undergraduate student
___ Graduate student
___ Non-degree seeking

6. What is the focus of your academic program?

___ Elementary Education
___ Exceptional Education
___ Reading Education
___ Other

7. Which of the following courses in reading education and/or math education have you taken in
your college career? (check all that apply)

___ Mathematics Methods (i.e. MAE 4326 or equivalent)
___ Mathematics Content for Educators (i.e. MAE 2801 or equivalent)
___ Mathematics Diagnosis and Remediation
___ Other Mathematics Education Courses
 ___ How many? Please list the course name/topic: _____
___ Reading Foundations (i.e. RED 3012 or equivalent)
___ Diagnosis and Intervention in Reading (i.e. RED 4519 or equivalent)
___ Reading Practicum (i.e. RED 4942, RED 6846, or equivalent)
___ Other Reading Education Courses
     ___ How many? Please list the course name/topic: _____

POST SURVEY

1. Check any of the cognitive strategies below that you recognize AND consider to be beneficial

to aid in the reading comprehension of text for 1st grade through 6th grade students.

___ Anticipation Guide
___ KWL (Know/Want to Know/Learned)
___ DRTA (Directed Reading Thinking Activity)
___ Think-Alouds
___ Reciprocal Teaching
___ Summarizing
___ Picture Walks
___ Student-Generated Questioning
___ Connecting (Text-to-Self, Text-to-Text, Text-to-World)
___ Predicting
___ QAR (Question-Answer Relationships)
___ QtA (Question the Author)
___ Discussion Web
___ Activating Prior Knowledge (Using Schema)
___ Retelling
___ Synthesizing
___ Visualizing
___ Determining Importance
___ Making Inferences
___ Text Coding

2. Check any of the strategies below that you recognize AND consider to be beneficial to aid in the reading and interpretation of mathematical word problems by 1st grade through 6th grade students.
___ Anticipation Guide
___ KWL (Know/Want to Know/Learned)
___ DRTA (Directed Reading Thinking Activity)
___ Think-Alouds
___ Reciprocal Teaching
___ Summarizing
___ Picture Walks
___ Student-Generated Questioning
___ Connecting (Text-to-Self, Text-to-Text, Text-to-World)
___ Predicting
___ QAR (Question-Answer Relationships)
___ QtA (Question the Author)
___ Discussion Web
___ Activating Prior Knowledge (Using Schema)
___ Retelling
___ Synthesizing
___ Visualizing
___ Determining Importance
___ Making Inferences
___ Text Coding

3. You identified the following strategies as beneficial to aid in the reading comprehension of varied text, including mathematics word problems (strategies identified in questions 1 and 2 are listed below with a field for an extended response to the right of each one). In the space provided to the right of each strategy, please describe if there is a difference between the strategy use with "typical" reading texts (i.e. fiction and non-fiction) and mathematics-specific text.

(Note: if no strategies overlapped for questions 1 and 2, this question was omitted from the electronic form of the survey).

Strategy Listed

APPENDIX C
PROFESSIONAL DEVELOPMENT BOOK STUDY:
SCHEDULE & READINGS

Experimental Group: Instructional Methods Supportive of Integrated Cognitive Strategy
Instruction in Reading and Mathematics

Text: *Comprehending Math: Adapting Reading Strategies* (Hyde, 2006)

Meeting	1	2	3	4	5
Assigned Reading	Introduction & Chapter 1: Asking Questions	Chapters 2 & 3: Making Connections & Visualization	Chapter 4: Inferring & Predicting	Chapters 5 & 6: Determining Importance & Synthesizing	Chapter 7: Braiding Mathematics, Language, & Thinking

Control Group: Cognitive Strategy Instruction for Reading Comprehension as Applied to Fiction
and Nonfiction Text

Text: *Strategies That Work: Teaching Comprehension to Enhance Understanding* (Harvey &
Goudvis, 2007)

Meeting	1	2	3	4	5
Assigned Reading	Introduction & Chapter 7: Questioning	Chapters 6 & 8a: Making Connections & Visualizing	Chapter 8b: Inferring	Chapters 9 & 10: Determining Importance in Text & Synthesizing	Chapter 11: Strategy Instruction in Context

APPENDIX D
BOOK STUDY OVERVIEW FOR TREATMENT GROUPS

DATES, TIMES, AND MEETING LOCATIONS LISTED HERE

- **Surveys:** Pre-Survey on Day 1, Post-Survey on Day 5

- **Books & Readings:** Books and/or daily readings will be distributed at each book study meeting (you will be keeping them on the last day). Reading assignments will be posted on the board at each meeting and you can begin to read when you enter. You are welcome to take notes while you read (in preparation for the group discussion), but it is not mandatory. The reading time will be 15-20 minutes, depending on the length of the text.

- **Discussions:** We will use the Teacher Study Group Notes Organizer (Birchak et al, 1998) provided. All group members are asked to contribute to the discussion. The facilitator will help to encourage participation and keep the discussion focused to the topic for the day. The notekeeper will record all thoughts discussed by the group and stop from time to time during the discussion to read the notes and confirm that the ideas expressed by the group were accurately captured. The timekeeper will ensure that you stop at least 5 minutes prior to the group ending time for book collection and clean up.

- **Compensation:** You will receive your compensation items on the last day of participation in the book study.

- **Researcher Contact Information:** (e-mail & cell phone number included here)

<div align="center">

THANK YOU FOR PARTICIPATING!

</div>

APPENDIX E
BOOK STUDY GROUP NOTES ORGANIZER
(ADAPTED FROM TEACHER STUDY GROUP NOTES ORGANIZER (Birchak et al., 1998)

Reading: _____ Date: _____

Study Focus for the Day: _____

Facilitator: _____

Notetaker: _____

Timekeeper: _____

Group Text Notes:

Group Reading Responses (use back for more space if necessary):

Next Meeting Day: _____ Location: _____
Facilitator: _____
Notetaker: _____
Timekeeper: _____

APPENDIX F
THINK ALOUD PROTOCOL SCRIPT

Today I am going to ask you to read for me and solve some math problems, but I want you to try

to tell me everything that you are thinking when you are reading. So, you know how sometimes

you can hear what you're thinking inside of your head? (wait for response) If you hear something,

I want you to stop reading and say it out loud to me. Then you can keep reading again until you

hear or think about something else.

Does that make sense? (wait for response)

Let's practice it.

(Narrative Text Practice) Take a look at this story called (read title). Start to read the first page

and stop and tell me anything you are thinking while you are reading.

(Arithmetic Problem Practice) Now, let's try a math problem.

Point to a problem on this page that you can do. (Wait for child to point to problem) Now, while

you solve the problem, tell me everything you are thinking.

Ok, I think you've got it.

(Experimental Text) Now, please look at this (present word problem text). I want you to do the

same thing you just practiced. Tell me everything you are thinking in your head as soon as you

are thinking it.

APPENDIX G
READABILITY (FLESCH-KINCAID) SCORES FOR MATHEMATICS WORD PROBLEMS
FROM ELEMENTARY STUDENT INTERVIEWS

	Interview 1	Interview 2	Corresponding DRA Text Level Used for Think Aloud Practice
Grade 1	1.9	1.8	18
Grade 2	2.9	2.9	28
Grade 3	3.8	3.9	38
Grade 4	4.9	4.9	40
Grade 5	5.7	5.8	50
Grade 6	6.8	6.9	60

Note: Grade levels indicated are for the upcoming school year; study was conducted at the beginning of the summer after the participating student just completed the previous grade. Hence, the readability of the text was adjusted to align.

APPENDIX H
SAMPLE WORD PROBLEM TEXT
(MODIFIED FROM THE COPYRIGHTED PROBLEM USED IN THE STUDY)

Patty has a basket of shamrocks to share with her friends at a St. Patrick's Day party. There are 450 shamrocks in the basket and there are 15 people at the party. Patty wants to share the shamrocks so that each person gets the same amount.

How many shamrocks will each person get?

APPENDIX I
IRB HUMAN SUBJECTS PERMISSION LETTER

The Role of Cognitive and Metacognitive Reading Comprehension Strategies in the Reading and Interpretation of Mathematical Problem Solving Text Applications

Informed Consent

Principal Investigator(s):	*Taylar Clements*
Faculty Supervisor:	*Michele Gill, PhD*
Investigational Site(s):	*UCF Summer Enrichment Programs in Literacy*
	Teaching Academy
	University of Central Florida

Introduction: Researchers at the University of Central Florida (UCF) study many topics. To do this we need the help of people who agree to take part in a research study. You are being invited to take part in a research study which will include about 80 people at UCF. You have been asked to take part in this research study because you are a student in a Reading Practicum Course that will be working with students at a UCF site-based reading program. You must be 18 years of age or older to be included in the research study.

The person doing this research is Taylar Clements of the College of Education, Department of Teaching and Learning Principles. Because the researcher is a doctoral student, she is being guided by Dr. Michele Gill, a UCF faculty supervisor in the College of Education, Department of Educational Studies.

What you should know about a research study:
- Someone will explain this research study to you.
- A research study is something you volunteer for.
- Whether or not you take part is up to you.
- You should take part in this study only because you want to.
- You can choose not to take part in the research study.
- You can agree to take part now and later change your mind.
- Whatever you decide it will not be held against you.
- Feel free to ask all the questions you want before you decide.

Purpose of the research study: The purpose of this study is to investigate how students use reading strategies during math problem solving and how reading clinicians perceive strategies to be related to different content areas. There is currently very limited research in this area, so this study will contribute to the field and potentially identify areas to possibly integrate cognitive strategy instruction.

What you will be asked to do in the study: Outside of your regular course requirements for the reading practicum, you will be asked to complete two surveys and participate in a free professional development book study. The first survey will be given to you in class during a regular class meeting for your reading practicum. You will then be a part of a professional development book study, where you meet on five different dates during the UCF Reading Clinic to read and discuss your thoughts and ideas about the book content. You will not be asked to read outside of the book study meeting time, and the books will be provided for you. The book study times have been scheduled during the UCF Reading Camp, for which you are already required to attend for your course. Your professor has given permission for you to participate in the book study during the five meeting days and times. On the last day of the book study, you will take a second survey. You do not have to answer every question or complete every task on the survey. You will not lose any benefits if you skip questions or tasks.

Location: The researcher will come to you during class to administer the first survey. The professional development book study and second survey administration will take place in the Teaching Academy in one of the UCF Summer Enrichment Program classrooms (to be determined and communicated to you).

Time required: We expect that you will be in this research study for a two and-a-half week period. The first survey, given in your class, will take about 10 minutes to complete. You will then participate in the book study that meets five times between June 14 and June 25, for one hour for each meeting. On the last day, you will take the second survey, which should take about 10 minutes to complete. This survey will be taken during the last book study session (and does not take additional time afterward).

Benefits: You may receive the following benefit for participating in this study:
1. Instructional strategies to use in your current or future classroom
2. Professional development experience that can be documented on your resume

Compensation or payment: Compensation for your participation will be:
1. Free book for your professional library
2. A tote bag filled with office and teaching supplies and professional resources
3. Five (5) free children's books for your future or current classroom library
4. A coupon for twenty-five (25) free books for your classroom library during your first year of teaching

If you participate in initial survey, but do not complete the book study and second survey, you will receive compensation items 1 and 2 listed above.

Confidentiality: We will limit your personal data collected in this study to people who have a need to review this information. We cannot promise complete secrecy. If you are enrolled in the Reading Practicum course for which the instructor of record is the researcher of this study, any data collected will be kept in a locked filing cabinet in the office of Dr. Michele Gil, and the researcher will not have access to it until the semester is over and grades have been submitted to the registrar's office.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints, or think the research has hurt you, talk to Taylar Clements, Graduate Student, College of Education, (407) 823-4088 or by e-mail at tbclemen@ mail.ucf.edu or Dr. Michele Gill, Faculty Supervisor, College of Education at (407) 823-1771.

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901. You may also talk to them for any of the following:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You want to get information or provide input about this research.

Your involvement in this study indicates your consent to participate. Please keep this document for your records.

The Role of Cognitive and Metacognitive Reading Comprehension Strategies in the Reading and Interpretation of Mathematical Problem Solving Text Applications

Informed Consent

Principal Investigator(s):	*Taylar Clements*
Faculty Supervisor:	*Michele Gill, PhD*
Investigational Site(s):	*UCF Summer Enrichment Programs in Literacy*
	Teaching Academy
	University of Central Florida

How to Return this Consent Form: To give consent, please fax (407- 823-1296) attn: Taylar Clements or scan and e-mail (tbclemen@mail.ucf.edu) this form by **Monday, June 7**[th]

Introduction: Researchers at the University of Central Florida (UCF) study many topics. To do this we need the help of people who agree to take part in a research study. You are being asked to allow your child to take part in a research study which will include about 80 people at UCF. Your child is being invited to take part in this research study because he or she is enrolled in a UCF Summer Enrichment Program in Literacy. The person doing this research is Taylar Clements of the College of Education, Department of Teaching and Learning Principles. Because the researcher is a doctoral student, she is being guided by Dr. Michele Gill, a UCF faculty supervisor in the College of Education, Department of Educational Studies.

What you should know about a research study:
- Someone will explain this research study to you.
- A research study is something you volunteer for.
- Whether or not you take part is up to you.
- You should allow your child to take part in this study only because you want to.
- You can choose not to take part in the research study.
- You can agree to take part now and later change your mind.
- Whatever you decide it will not be held against you or your child.
- Feel free to ask all the questions you want before you decide.

Purpose of the research study: The purpose of this study is to investigate how students use reading strategies during math problem solving and how reading clinicians perceive strategies to be related to different content areas. There is currently very limited research in this area, so this study will contribute to the field and potentially identify areas to possibly integrate cognitive strategy instruction.

What your child will be asked to do in the study: Beyond the regular Reading Adventure Camp and/or Reading Clinic activities, your child will meet with the researcher two times for approximately ten minutes each. The first time your child meets with the research will be during the first week of the

1 of 4

Permission to Take Part in a Human Research Study

program. The researcher will present your child with a math word problem and ask him/her to read it out loud and describe anything that he/she is thinking during the oral reading. After reading the problem, the research will ask your child questions related to reading strategies that he/she may have used. Your child does not have to answer every question or complete every task. You or your child will not lose any benefits if your child skips questions or tasks. This same process will be repeated during the second week of the program.

Location: The research will take place in the regularly scheduled classrooms for the Reading Adventure Camp or Reading Clinic in the Teaching Academy at UCF.

Time required: We expect that your child will be in this research study for a total of 20 minutes: two (2) ten-minute sessions conducted on different days.

Audio taping: Your child will be audio taped during this study so that the researcher can revisit the strategies that your child used during the reading. If you do not want your child to be audio taped, discuss this with the researcher. If your child is audio taped, the tape will be kept in a locked, safe place. The tape will be erased or destroyed after a transcript of your child's comments has been made.

Compensation: Your child will be given a children's book for participating in this study.

Confidentiality: We will limit your personal data collected in this study. Efforts will be made to limit your child's personal information to people who have a need to review this information for your child's safety. We cannot promise complete secrecy. Organizations that may inspect and copy your information include the IRB and other representatives of UCF.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints, or think the research has hurt your child talk to: Taylar Clements, Graduate Student & UCF Instructor, College of Education, (407) 823-4088 or by e-mail at tbclemen@mail.ucf.edu or Dr. Michele Gill, Faculty Supervisor, College of Education at (407) 823-1771.

IRB contact about you and your child's rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901. You may also talk to them for any of the following:
- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You want to get information or provide input about this research.

UCF IRB Version Date: 01/2010

Permission to Take Part in a Human Research Study

Your signature below indicates your permission for the child named below to take part in this research.

DO NOT SIGN THIS FORM AFTER THE IRB EXPIRATION DATE BELOW

_____
Name of participant

_____   _____
Signature of parent or guardian   Date

❑ Parent
❑ Guardian (See note below)

_____
Printed name of parent or guardian

Assent   ❑ Obtained (Your child's permission to participate will be obtained from them during their meeting with the research)

Note on permission by guardians: An individual may provide permission for a child only if that individual can provide a written document indicating that he or she is legally authorized to consent to the child's general medical care. Attach the documentation to the signed document.

UCF IRB Version Date: 01/2010

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