A MULTI-DIMENSIONAL INTERVENTION FOR STUDENTS WITH ATTENTION-DEFICIT/HYPERACTIVITY SYMPTOMATOLOGY AND LOW MATH PERFORMANCE:
TARGETING MOTIVATION AND MATH SKILL DEVELOPMENT

A dissertation presented
by

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ABSTRACT TITLE

A MULTI-DIMENSIONAL INTERVENTION FOR STUDENTS WITH ATTENTION-DEFICIT/HYPERACTIVITY SYMPTOMATOLOGY AND LOW MATH PERFORMANCE:

TARGETING MOTIVATION AND MATH SKILL DEVELOPMENT
Students with Attention-Deficit/Hyperactivity Disorder (ADHD) tend to develop an aversive, academic motivational style and commonly demonstrate weaknesses in math fact fluency resulting in lower math performance than the general population. To date, the most commonly-studied math interventions for this student population have included the use of stimulating educational environments and materials to increase student engagement. The current study examined the effectiveness of a multi-dimensional intervention, which combined the implementation of an evidence-based academic intervention, cover, copy, and compare (CCC), with motivation coaching (CCC+MC) that focused on increasing positive self-efficacy beliefs and the use of self-regulated learning strategies associated with strengthening academic motivation. Four male students in the third grade, who met research criteria for ADHD, participated in the study. This study examined the effects of the multi-dimensional intervention on participants’ math fact fluency, motivation, and positive student engagement during math independent seatwork in the classroom in comparison to implementing the academic intervention without motivation coaching (CCC alone) and to baseline conditions without intervention. Results using a single-subject, multiple-baseline design (MBD) demonstrated replication across all four participants regarding increased performance in math fact fluency when motivation coaching was added to the CCC intervention relative to their performance during CCC alone. However, only one participant demonstrated reliable results beyond the chance level. Changes in participants’ self-rated motivation during the multi-dimensional intervention relative to CCC alone were inconclusive. Participant progress in total student engagement (active and passive engagement) was inconclusive regarding whether the benefits from the multi-dimensional intervention generalized to the classroom by improving student engagement during math
independent seatwork compared to CCC alone. The two participants who were observed during the study both demonstrated greater improvement in active engagement when motivation coaching was added to CCC relative to CCC alone.
DEDICATION

To my supportive family, who kept believing in me and waving me onto the finish line.

Thank you, Gene, Christopher, Sean, and Jon.

To my parents (posthumously)

Thanks Mom and Dad, your early encouragement and guidance gave me a valuable head start.
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The impetus and completion of this project are accredited to the encouragement, expertise, and support of the many individuals who I offer my most sincere appreciation and gratitude.

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I would like to thank the students who were participants for this project along with their parents who believed in this study and granted permission for me to work with their sons. The dedication and investment of the students for faithfully showing up for treatment sessions before
and after school and of their parents who made arrangements to make this happen were phenomenal and crucial reasons why this study persevered. In addition, I am so thankful to the principal, assistant principal, and the school district for believing in my project as a means to help some of their students. This project could not have proceeded without the warmth and acceptance that I received from the school community that embraced me, as well as my study.

Last but not least, I extend loving appreciation to my family and friends. You struggled and rejoiced with me each step of the way. To my husband Gene, thank you for your belief in me, your understanding and unwavering love, and for supporting us through an unrelenting interruption in our lives, as I spent endless hours working on my laptop at the kitchen table. To my adult children who I learn more and more from each day, thank you for giving me the courage to advocate for students and showing me the way. To my friends who kept asking how are you and when will you be done, thank you for saying that you were proud and for cheering me on.
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CHAPTER I

Introduction

Background

A description of Attention-Deficit/Hyperactivity Disorder (ADHD) and how it impacts student functioning is provided to demonstrate the need for comprehensive academic interventions for children affected with the disorder. ADHD is a psychiatric disorder characterized by a persistent pattern of inattention and/or impulsivity/hyperactivity, which is noticeably more frequent and severe compared to others of the same age. To meet diagnostic criteria for ADHD according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; American Psychiatric Association [APA], 2000), some of the attention and/or hyperactive-impulsive symptoms must be present before the age of seven and impairment must occur across at least two settings (i.e., home, school, or work). In addition, impairment must be observed in social, academic, or occupational functioning (American Psychiatric Association). According to the DSM-IV-TR, individuals may be classified as meeting criteria for one of three sub-types of ADHD based on the preponderance and clustering of 18 symptoms (i.e., nine inattentive and nine hyperactive/impulsive) of ADHD (see Appendix A for a list of ADHD symptoms). A diagnosis of ADHD, Predominantly Inattentive Type (ADHD-I) requires the presence of at least six of the nine inattention symptoms, and a diagnosis of ADHD, Predominantly Hyperactive-Impulsive Type (ADHD-HI) requires a minimum of six of the nine hyperactive/impulsive symptoms. To meet criteria for ADHD, Combined Type (ADHD-C), at least six of nine symptoms of both inattention and impulsivity/hyperactivity must be present (APA, 2000).
ADHD, the most common childhood disorder in the United States, has an estimated prevalence between three to seven percent of the childhood population (American Psychiatric Association, 2000) with a world-wide prevalence of eight to twelve percent in children (Faraone, Sergeant, Gillberg, & Biederman, 2003). The Center for Disease Control (CDC) National Survey of Children's Health report indicated that, in 2003, approximately 4.4 million youth ages four to 17 years old were reported to have a history of ADHD by a healthcare professional. As of 2003, 2.5 million youth between the ages of four through 17 years were, at that time, receiving medication treatment for this disorder (CDC, 2003). Approximately three to five percent of elementary-age students are identified with ADHD (American Psychiatric Association).

ADHD-C (50 to 75% of cases) is the most frequently diagnosed ADHD sub-type, followed by ADHD-I (20-30%) and ADHD-HI (15%; American Psychiatric Association, 2000). More boys than girls are affected with ADHD, as noted in both clinically-referred and non-clinically referred studies with the disorder three to five times more likely diagnosed in boys than girls in clinic samples, and a ratio of two to one in school-based samples (Szatmari, 1992; America Psychiatric Association; Barkley, 2006). ADHD symptoms typically are first noticed during the preschool years. The disorder persists into adolescence in 70–80% of cases clinically diagnosed in childhood (Barkley; Barkley, 1981; Weiss & Hechtman, 1993). Between 30–50% of individuals with ADHD experience significant symptoms persisting into adulthood (Barkley, Fisher, Edelbrock, & Smallish, 1990; Klein & Mannuzza, 1991; Weiss & Hechtman). ADHD can be viewed as a life-long disorder requiring individualized and developmentally appropriate treatment.
**Associated Features of ADHD**

Over the course of development, ADHD is associated with greater risks for low academic achievement, poor school performance, grade retention, and placement in special education (Barkley, DuPaul, & McMurray, 1990). Further, individuals with ADHD demonstrate a higher rate of school suspensions and expulsions, poor peer and family relations, anxiety and depression, aggression, conduct problems and delinquency, early substance experimentation and abuse, and driving accidents and speeding violations than typically developing peers (Barkley, Guevremont, Anastopoulos, DuPaul, & Shelton, 1993). Academic underperformance (i.e., work productivity in the classroom) and low academic achievement are reported in most clinic-referred cases (Barkley, 2006). Poor school performance is attributed to failure to compete work and limited academic engagement in school (DuPaul & Stoner, 2003). Academic underachievement may contribute to early substance abuse, dropping out of high school, inconsistent career and job achievement, and poor marriage and family relationships (Barkley). Thus, the effects of ADHD on academic achievement stand out as a crucial area to study.

Neuropsychological and behavioral features of ADHD can negatively impact the capacity to process information and executive functioning involving attention, working memory, and planning/organization. In turn, these learning challenges can contribute to students with ADHD experiencing limited academic competency and success in school. For example, these students characteristically display difficulties with processing incoming information attributed to inconsistent attention, which makes decoding and encoding new information difficult (Ratey, 2002). Attention is needed to maintain consistent, mental effort during task performance and to inhibit thoughts and actions. Sustained attention is specifically problematic for students with ADHD (Ratey). An estimated 90% or more of students with ADHD experience academic
difficulties: underachievement, variability of performance, and/or learning disability (Fisher & Beckley, 1999). Approximately 30% of students with ADHD performed below the predicted academic level for their age and cognitive ability, which is documented across academic subjects in reading, math, and spelling (Barry, Lyman, & Kingler, 2002). The academic difficulties of children and adolescents with ADHD are significant. They typically include failure to complete homework, poor comprehension of material, poor study skills, low test and quiz grades, poor preparation for class, disruptive behavior, peer conflict, and conflict with teachers (Evans, Pelham, & Grudberg, 2004; Hinshaw, 1992; Robin, 1998; Zentall, 1993). Emotional self-control is often problematic for students with ADHD, especially when expressing negative emotion. These students become easily frustrated when tasks are challenging or situations are not as expected (Walcott & Landau, 2004).

**Rationale and Significance of the Problem**

Students with ADHD commonly perform poorly in math. Higher rates of math learning disability are reported among students diagnosed with ADHD (31%) compared to the general population (6-7%). In addition, it has been estimated that one quarter of students with math learning disabilities also have ADHD (Mayes, Calhoon, & Crowell, 2000). Students with ADHD commonly exhibit difficulties with working memory compared to students without ADHD. Working memory has been shown to affect computational performance, the completion of math problems involving multiple steps, and the solution of math word problems for students with ADHD (Pickering & Gathercole, 2004). Difficulties with selective attention, working at a faster rate, shorter visual scans of visually detailed information, and attention to irrelevant verbal or visual information have been associated with decreased math performance for students with ADHD (Zentall, 2007). The attention problems of students with ADHD contribute to careless
errors in aligning numbers, attending to calculation signs, carrying numbers in addition, and cancelling numbers in subtraction (Zentall). Delays in math fact acquisition are common and chronic for students with ADHD (Zentall, 2007; Zentall, 1990; Zentall, Smith, Lee, & Wieczorek, 1994). Low math fact fluency has been linked to difficulties with sustained attention during repetitious tasks, which could affect the ability to learn and recall math facts automatically (Zentall, 2007; Sergeant, Geurts, Huijbregts, Scheres & Oosterlaan, 2003). Considering the math problems of many students with ADHD and the effects of ADHD symptomatology on overall academic performance, the chance of these students developing lower self-efficacy with regard to academic performance is likely. According to Schunk (1996), one’s self-evaluation of academic capability affects subsequent motivation and skill acquisition. Investigating the influence that motivation has on academic achievement for students with ADHD is an important area of study for determining effective interventions for this disorder.

**ADHD and Motivation**

Student motivation has a major influence on academic achievement. Motivation is reflected in physical activity (i.e., effort, persistence, and other overt actions), and mental activity (i.e., cognitive actions such as planning, rehearsing, organizing, monitoring, making decisions, solving problems, and assessing progress; Schunk, Pintrich & Meese, 2008). These physical and mental properties of motivation are directed towards attaining goals. Motivation is the process where goal-directed behavior is initiated and sustained (Schunk et al., 2008). There is a recent trend in motivation research that suggests motivation and cognitive factors interact and have a joint influence on student achievement and learning, as reflected in the social cognitive model of motivation (Pintrich & Schunk, 2002). The social cognitive model’s influence on understanding motivation stresses the importance of an individual’s perceptions and beliefs as mediators of
behaviors (Pintrich & Schunk, 1996). Motivation can strengthen self-efficacy, self-regulation, learning, and performance, and these factors can strengthen motivation (Schunk et al.).

A review of the literature reveals a crucial link between motivation and academic achievement. Zimmerman, Bandura, and Martinez-Pons (1992) proposed an academic achievement model whereby positive or negative self-efficacy beliefs influence a student’s level of goal setting and use of self-regulated learning strategies, which in turn contribute to positive or negative academic achievement. Subsequently, a student’s academic success generates positive or negative self-efficacy beliefs. This cycle continues to regenerate positive or negative influences on student motivation and academic achievement. Factors associated with strengthening motivation, such as academic self-efficacy and self-efficacy for using self-regulated learning strategies influence academic goals students set for themselves and the levels of academic achievement they reach (Zimmerman et al.). Given that self-efficacy and self-regulated learning are believed to strengthen academic motivation, interventions focused on increasing positive self-efficacy beliefs and the use of self-regulated learning strategies could conceivably increase academic motivation and student performance, as well.

Neuropsychological and behavioral features associated with ADHD can negatively impact components of motivation, such as self-efficacy beliefs and self-regulated learning, as well as executive functions (i.e., attention and working memory). Thus, students with ADHD frequently struggle with completing schoolwork and are at risk for developing lower academic competency and inconsistent success in school compared to typical peers. Low motivation is often cited as the reason for academic failure and dropping out of school for students with ADHD (Barkley, 2006; Ruschko, 1996).
There is converging evidence that students with ADHD exhibit an academic motivation deficit. Olivier and Steenkamp (2004) found that students with ADHD tend to focus on avoiding failure rather than achieving success in achievement-related situations, thus displaying an *aversive motivational style*. Studies focused on the cognitive-motivational belief system of children with ADHD (Hoza & Pelham 1995; Milich, 1994; Licht, 1993) suggest that intrinsic and neuropsychological factors are involved. Students with ADHD display an external locus of control (Elliott, 1997), low perceived self-efficacy (Dunn & Shapiro, 1999), low perceived competence in the scholastic and behavioral domains (Hoza & Pelham, 1995), impaired self-regulation and goal-directed persistence (Barkley, 1998), and abnormally high reward thresholds (Brim & Whitaker, 2000). In light of the impact of ADHD symptomatology on multiple factors associated with academic performance, consideration should be given to developing multi-dimensional interventions that focus on increasing motivation, as well as skill mastery to support school success for students with ADHD.

Motivation has been linked to academic achievement for students with ADHD as an academic enabler. An *academic enabler* is defined in the literature as promoting “attitudes and behaviors that allow a student to participate in, and ultimately benefit from academic instruction in the classroom” (DiPerna, Volpe, & Elliott, 2002, p. 294). Motivation influences study skills and student engagement, which in turn directly influence academic achievement (Volpe, DuPaul, & DiPerna, 2006). Motivation mediates achievement and therefore should be explicitly taught together with academic skills to maximize a student’s learning and performance (Volpe et al.). The complex relationship between ADHD and academic achievement suggests that practitioners and researchers need to be aware of the need for multi-dimensional interventions designed to target more than one skill or symptom in addition to the conventional interventions, which focus
on one target and academic outcome (DuPaul, 2007). Math interventions designed to target motivation (i.e., academic self-efficacy and self-regulated learning) in addition to academic skills could conceivably help students with ADHD increase academic engagement and feelings of academic competency along with strengthening motivation and academic performance.

Computer, peer, and self-monitoring interventions typically presented with incentives are common treatments used to improve attention and math fact fluency and accuracy in students with ADHD (Zentall, 2007). Several studies have demonstrated that these interventions were responsible for increased attention and work production and some improvement in math fact fluency (Zentall, 2007; DuPaul & Eckert, 1998). However, many of these studies did not measure improvement in academic achievement, relying on classroom productivity data or measures of academic engagement. Short durations of treatment interventions and the absence of follow-up assessments and/or treatment integrity were also problematic (DuPaul & Eckert, 1998). The majority of these intervention-outcome studies relied on providing stimulating environments or materials (i.e., peers, competitive computer games, color coding, and music; Zentall, 2007), rather than strengthening student skills and motivational factors beyond improved attention and productivity. Limited effectiveness of math interventions has led some researchers to look beyond simply providing academic supports and contingency reinforcements. An area needing further study is determining how to package cognitive (i.e., working memory, attention, etc.), educational, and motivational interventions in order to influence improvements in math achievement for students with ADHD (Royer & Walles, 2007).
Statement of Problem

A large percentage of students with ADHD exhibit low math performance. Zentall et al. (1993) found that these students typically display chronic difficulties with math fact fluency not explained by lower IQ scores or slow physical responding. Students with ADHD typically exhibit difficulties with sustained attention to repetitive stimuli, which is necessary to develop math fact fluency (Sergeant et al., 2003). These problems may contribute to the slower retrieval of math facts and the greater within-session performance variability of students with ADHD (Bennett, Zentall, Giorgetti-Borucki, & French, 2006). The majority of school-based intervention studies for students with ADHD have focused mainly on reducing disruptive behavior and other symptoms of ADHD (DuPaul & Eckert, 1995). Math fact fluency interventions for students with ADHD reported in the published literature include computer-, peer-, and self-monitoring interventions (usually with incentives), which have focused on improving sustained attention through the use of highly stimulating environments and materials to increase student engagement (i.e., competitive computer games, colored-coded materials, etc.; Zentall, 2007). To date, math interventions for students with ADHD have not been multi-dimensional in nature, where intervention is specifically designed to increase both student motivation and academic skill mastery. The current study evaluated a multi-dimensional intervention that focused on improving students’ motivation and math fact fluency by developing automaticity with math facts and coaching positive academic self-efficacy and the use of self-regulated learning, factors associated with strengthening academic motivation. Depending upon the personal characteristics of the individual participants in this study, other motivational factors, such as increasing positive self-talk and developing an internal locus of control, were incorporated within individualized coaching protocols, as well. A multi-dimensional intervention of this kind was expected to better
address underachievement in students with ADHD by targeting academic skills combined with motivation, which is a core deficit commonly associated with ADHD.

**Purpose of the Study**

Given the complexity of deficits experienced by students with ADHD, the purpose of the present investigation was to determine whether a multi-dimensional intervention targeting academic skills combined with motivation could effectively improve academic motivation and math performance for students with ADHD. Math is a subject area where students with ADHD commonly exhibit academic underachievement. Students with ADHD and low math performance often make careless mistakes, exhibit poor accuracy and fluency characterized by inefficient recall of math facts, and/or demonstrate weaknesses in math problem solving. For students with ADHD, low academic performance often is accompanied with an aversive motivational style resulting from repeated failure and limited success. Research has suggested that motivation is supported by student self-efficacy beliefs regarding competencies for understanding and completing academic work along with the use of self-regulated learning strategies. Providing students with coaching directed at increasing positive self-efficacy and self-regulated learning coupled with academic skill mastery was expected to strengthen student performance and achievement beyond focusing on skill mastery alone.

**Procedures**

The current investigation was designed to examine the effectiveness of a multi-dimensional intervention targeting math fact fluency and motivation. The multi-dimensional intervention integrated the implementation of an empirically-validated math intervention, *cover, copy, and compare* (CCC; Skinner, McLaughlin, & Logan, 1997), with motivation coaching to increase math fact retrieval, motivation, and on-task classroom behaviors of students with high
levels of ADHD symptomatology and low math performance. The multi-dimensional intervention (CCC + MC) was compared to the academic intervention without motivation coaching (CCC alone) and baseline conditions in a yoked, MBD across participants. Four third-grade students meeting research-criteria for ADHD-C and demonstrating low math performance were chosen to participate in the study. Originally, each participant’s math fact fluency, motivation levels, and on-task behaviors during math independent seatwork (ISW) were measured during baseline (no treatment). Subsequently, each participant was administered each of the two comparison interventions. An attempt was made to control for order effect by alternating the order of treatment phases across participants. The first and second students in the first MBD received CCC alone followed by the multi-dimensional intervention. The first and second students in the second MBD received the interventions in the opposite order: the multi-dimensional intervention first followed by CCC alone. Comparisons were made between intervention and baseline conditions using baseline logic and the calculation of effect sizes. Due to notable carryover effects when CCC + MC was implemented before CCC, that order of interventions was eventually dropped from the study along with the data from the two participants who had received that intervention sequence. Two participants were later added to the study to replace the two participants not retained in the study. These additional participants received the initial intervention sequence, CCC alone, then CCC+MC, similar to the remaining two participants from the earlier part of the study.

**Research Questions**

1. Does implementing a multi-dimensional intervention targeting both math fact fluency and motivation facilitate greater improvement in math performance for students with high
levels of ADHD symptomatology and low math performance relative to an academic intervention targeting math fact fluency alone?

Hypothesis: A multi-dimensional academic intervention targeting math and motivation deficits commonly found in students with ADHD was expected to facilitate greater improvement in math performance compared to an academic intervention, which solely focused on math fact fluency without targeting motivation.

2. Will students with students with high levels of ADHD symptomatology and low math performance demonstrate an increase in motivation in response to adding motivation coaching designed to address their individual motivational weaknesses to an academic intervention?

Hypothesis: Students with ADHD commonly demonstrate a core deficit in motivation resulting in low perceived self-efficacy regarding academic competency. These students frequently demonstrate a tendency towards avoidance of achievement-related activities to address their fear of failure and reduce negative feelings resulting from repetitive academic failure and low expectation of success. Explicitly focusing on enhancing motivation by increasing positive self-efficacy beliefs via coaching to set manageable goals and work towards goal attainment, linking effort and persistence to successful outcomes, replacing automatic negative thinking with positive self-talk, and increasing the use of self-regulated learning were expected to improve academic motivation for students with students with high levels of ADHD symptomatology.

3. Will improvements in student engagement expected from the implementation of a multi-dimensional intervention directed at improving math skills and motivation generalize to the classroom setting during math ISW?
Hypothesis: Students with high levels of ADHD symptomatology and low math performance, who received a multi-dimensional intervention fostering skill development and improvement in motivation, were expected to increase on-task behaviors during math ISW in their classroom.

Research Benefits

A major goal of this investigation was to develop an effective multi-dimensional intervention, which addressed the cognitive, educational, and motivational factors of low math performance in students with high levels of ADHD symptomatology. Objectives of this research were to facilitate measurable improvements in math fact mastery and motivation as reflected in substantial increases in math fact fluency; motivation as perceived through indices of positive, academic self-efficacy and increased use of self-regulated learning strategies; and improvement in positive on-task behaviors during math ISW. Additional potential benefits included improvements in task persistence and work completion coupled with sustainability of the effects of this intervention. The hope was for the effects from positive outcomes associated with this multi-dimensional intervention to generalize to other subject areas beyond math. Positive results from this study were expected to extend the literature on ADHD by supporting the combination of academic remediation with motivation coaching as a potential strategy to reduce the effects of symptoms associated with this disorder.
CHAPTER II
Literature Review
The Effects of ADHD

Core Deficits

Students with ADHD experience symptoms associated with two core deficit areas: inattention and hyperactivity/impulsivity. The DSM-IV-TR lists eighteen specific symptoms used to diagnose each of the three specific types of ADHD (American Psychiatric Association, 2000; see Appendix A for a list of ADHD symptoms according to the DSM-IV-TR). Nine symptoms listed in the DSM-IV-TR are used to diagnose a deficit in attention, a minimum of six are required to be explicitly displayed by the person to receive the diagnosis, ADHD-I. Six of nine symptoms related to a deficit in hyperactivity/impulsivity are required for a diagnosis of ADHD-HI, and in the case of ADHD-C, six symptoms of inattention and six symptoms of hyperactivity/impulsivity are required to support a deficit in both attention and hyperactivity/impulsivity (American Psychiatric Association). ADHD-HI has been identified as a developmental precursor to the combined type and was found predominately among preschool children (Applegate et al., 1997). The combined and inattentive types have been diagnosed more prevalently in the school-age population. The inattentive type in school-age children was identified at a later age than the behavior pattern of the hyperactive/impulsive type according to parental report (Hart, Lahey, Loeber, Applegate, & Frisk, 1995).

Inattention. Reviewing the definition of attention helps to describe the influence of pervasive inattention, a major deficit attributed to ADHD. Attention can be operationally defined as noticing and processing incoming stimuli, which includes filtering out perceptions, balancing multiple perceptions, and attaching emotional significance to these perceptions (Ratey, 2002).
Active attention is voluntary, guided by alertness, concentration, interest, curiosity and effort, and is used to select and focus on what is important at the moment (Ratey). Individuals with ADHD exhibit the greatest difficulty with factors of attention related to persistence of effort, which is sustaining attention to tasks, often referred to as “vigilance” (Newcorn et al., 2001). Difficulties with persistence are most evident in situations that require students with ADHD to sustain attention to boring and repetitive tasks (Barkley et al., 1990).

Barkley (2006) proposed two types of sustained attention: Goal-directed and contingency-shaped. Goal-directed persistence is a form of sustained attention, which is intrinsically reinforced and relies on self-regulation of motivation and effort. Removal of extrinsic reinforcement does not affect sustained responding (Barkley). Contingency-shaped, externally-regulated sustained attention relies on immediate contingencies available within the task or setting. Reinforcements are provided externally and removal of external reinforcement leads to extinction of sustained responding (Barkley). Barkley hypothesizes that goal-directed persistence and not contingency-shaped sustained attention is impaired in students with ADHD. This explains why children with ADHD can sustain their attention to video games or other activities they find externally reinforcing but cannot readily sustain attention to mundane tasks such as homework and chores, which rely on internal regulation and motivation.

The main ramification of inattention is distractibility, often a major issue for students with ADHD. Distractibility is the increased chance that a student will respond to unrelated events and stimulation not associated with a given task (Amen, 2001). The degree to which distraction is problematic for students with ADHD depends on the cognitive loading or demands for working memory inherent in a given task and the demand for executive functions (shifting, organizing, and analyzing; Amen). Having a short attention span and becoming easily distracted
can impact many aspects of school, such as steadily attending during lecture-style teaching, working in small groups, losing concentration while reading or completing class assignments, and performing inconsistently on tests. In addition, poor attention can lead to forgetfulness, procrastination, trouble shifting attention, unusual study habits, and difficulties dealing with timed-test situations (Amen). Students with ADHD commonly forget to bring books home, leave clothing in school, and do not turn in homework. Time management issues impact the successful completion of long-range assignments, which are often left to the last minute and poorly organized. Difficulties shifting attention can impact a student with ADHD’s ability to take notes (i.e., shifting from the paper to the teacher and back), as well meeting the demands of shifting classes and teachers (Amen). Despite the best of intentions, intellectual ability, or academic potential, the effects of inattention and distractibility can seriously impede academic performance and school success for children with ADHD.

**Hyperactivity/impulsivity.** A second core deficit of ADHD involves hyperactivity/impulsivity, which represents poor inhibition and associated hyperactivity (Burns, Boe, Walsh, Sommers-Flanagan, & Teegarden, 2001). Impulsivity often associated with ADHD involves limited behavioral control related to poor executive functioning, poor sustained inhibition, and difficulties delaying gratification or deferring a response (Barkley, 1985). Impulsivity can cause problems in school, by not thinking answers through or looking at all the options, and making inappropriate comments before thinking of the impact on others (Amen, 2001).

Hyperactivity is related to impulse control and involves symptoms of developmentally inappropriate, high levels of over activity observed as excessive movement or vocal expression. These would include restlessness, fidgeting, gross motor movements, and noise making and
excessive talking (Barkley, 2006). Young students in school display restlessness by getting out of their seat, fidgeting with objects, irritating or talking with students near them, wandering around the classroom, and interrupting teacher instruction. Adolescents and adults demonstrate restlessness through constant movement, such as leg shaking or shifting body postures in their seats (Amen, 2001). The hyperactivity of individuals with ADHD often creates turmoil, disruption, and distraction for others around them (Amen). The behavioral manifestations of hyperactivity/impulsivity deficits associated with ADHD are annoying to others and could conceivably interfere with successful social integration in a classroom setting, which likely impacts academic performance, as well.

The core deficits of ADHD can have a broader influence on the development of more serious behaviors, putting these children at risk for behavioral and academic difficulties. Students with ADHD experience a higher-than-average risk for oppositional defiance against authority, ineffective social connections with peers, and negativistic behaviors such as lying, stealing, and fighting (Barkley, 1990). Additionally, most of these students struggle scholastically, as seen in their characteristically, low academic achievement and poor school performance (DuPaul & Stoner, 1994). Follow-up studies on children with ADHD into adolescence and adulthood reveal a higher incidence of grade retention, placement in special education classrooms, and high school incompletion compared to peers (Barkley et al., 1990). School failure and dropping out of school are frequently linked to a lack of motivation for children with ADHD (Barkley, 2006; Ruschko, 1996). Thus, research needs to focus not only on the behavioral manifestations of ADHD, but also address low academic achievement and poor scholastic outcomes along with low motivation often associated with this disorder. In the past, most treatment outcome studies did not take place in classroom settings and focused primarily on increasing attention, student
engagement, and decreasing disruptive behaviors (DuPaul & Eckert, 1995). Given the prevalence and extent of academic problems inherent in ADHD, research endeavors must direct more attention towards school-based intervention studies. The current study was developed from a review of the literature on academic achievement and motivation for students with ADHD.

Academic Achievement and Performance in ADHD

Achievement defined. Gaining a clear understanding of what is meant by achievement in general is helpful before discussing the effects of ADHD on academic achievement and the value of designing specific academic interventions to accommodate ADHD. Atkinson (1964) defined the need for achievement as striving for success in a situation where one self-evaluates one’s performance in relation to a standard of excellence. People experience satisfaction from excelling at something or demonstrating competence (McClelland, 1990). The need for achievement is a learned drive triggered by two achievement motivational dispositions: hope for success and fear of failure (Atkinson). When expectancy of success is high, the individual is more likely to approach and engage in achievement tasks. In contrast, the motive to avoid failure is an instinctive attempt to avoid shame and humiliation in response to failure. Thus, individuals expecting to fail would avoid engaging in achievement tasks (Atkinson). Performance expectations, perceptions regarding the cause of achievement outcomes, and self-perceptions of competence are important factors in achievement (Zimmerman, 2000). The perception of academic achievement within the context of the aforementioned achievement constructs suggests that students are prone to engage in academic tasks and strive to do well if they have experienced success in the past, perceived their effort and abilities as responsible for their success, and learned to view themselves as having a likely chance of being successful with future academic tasks. The scenario just described would be very different for a student who experiences limited
academic success, develops a universal expectation of not doing well, and attributes any personal success to luck or causes outside of themselves. In all likelihood, this student will avoid academic tasks to protect themselves from shame and demoralization, and thus experience significant underachievement and low performance. Understanding how and to what extent the core deficits of ADHD impact achievement is important when developing meaningful, academic interventions to address increasing successful academic achievement and performance for students with ADHD.

**Underachievement and ADHD.** The effects of ADHD symptoms on a student’s academic achievement are of great concern to parents, teachers, school personnel, other students, and to the students themselves. *Achievement* connotes the difficulty level of academic material a student has mastered. *Underachievement* is a common negative functional impairment of ADHD and is defined as underperforming relative to one’s known ability level determined by intelligence and academic achievement testing (Barkley, 2006). Academic underachievement is the major enduring outcome linked with pure ADHD (i.e., ADHD without severe disruptive behavior or mood disorder; Mannuzza, Gittleman-Klein, Bessler, Malloy, & LaPadula, 1993). Research indicates that underachievement has been directly related to ADHD-related behaviors and is not accounted for by comorbid conduct problems (Rapport, Scanlan, & Denney, 1999). In their study involving 325 diverse Hawaiian children, Rapport et al. demonstrated that school behavior (i.e., task engagement) and cognitive abilities (i.e., vigilance and memory) evolved as crucial mediators between attention deficit, intelligence, and future scholastic achievement and account for the association between ADHD symptoms and academic achievement. Because academic underachievement has been directly linked to ADHD, the prevalence of students with this disorder experiencing academic difficulties is noteworthy. Roughly 60-80% of students with
ADHD have learning problems, and 50% of these students experience underachievement (Ruschko, 1996). Approximately, 20-30% of students with ADHD are classified as having a learning disability due to identified deficits in specific academic skills (DuPaul & Stoner, 1994; Semrud-Clikeman, Biederman, Sprich-Buckminster, Lehman, Faraone, & Norman, 1992). When a sample of boys with ADHD was compared to a control group without ADHD, similar in age, gender, and IQ, a higher incidence of problematic academic performance for the participants with ADHD was found (Cantwell & Satterfield, 1978). In addition, greater than one third of the boys with ADHD in the Cantwell and Satterfield study demonstrated academic performance at least one year below their expected levels in two of the academic subject areas tested (i.e., reading, spelling, or mathematics) and were farther behind within the individual subjects compared to the control group. A study by Anderson, William, McGee, and Silva (1987) reported that 80% of 11-year olds with ADHD had learning difficulties (i.e., being at least two years behind) in reading, spelling, mathematics, or written language. Huessy and Cohen (1976) completed a follow-up study to their original study, which revealed that 50% of their sample of students with ADHD had experienced school failure by ninth grade. Although these studies adopted various definitions of ADHD and learning disability, they collectively support the premise that ADHD is strongly associated with low academic achievement and greater risk for developing serious problems at an older age.

**Low academic performance and ADHD.** ADHD can significantly impact academic performance. A student’s academic performance relates to his/her work productivity in the classroom, a functional area where students with ADHD demonstrate tremendous difficulty (Barkley, 2006). Higher than expected rates of incomplete work may contribute to a strong link found between ADHD and underachievement because up to 80% of students with ADHD exhibit
academic performance problems (Cantwell & Baker, 1991). This is further supported by research completed by DuPaul and Stoner (2003) indicating that students with ADHD struggle with scholastic performance due to noticeably low rates of work completion and academic student engagement in school. Academic engagement refers to classroom behaviors including writing, participating in tasks, reading aloud or silently, talking about academics, and asking and answering questions (Greenwood, Delquadri, & Hall, 1984). Research exploring the impact of ADHD on student engagement suggested that compared to typical peers, students with ADHD demonstrated a pattern of statistically lower rates of academic engagement and higher rates of off-task behaviors (Vile Junod, DuPaul, Jitendra, Volpe, & Cleary, 2006). That is, they demonstrated statistically significant lower rates of passive engagement time (PET) than controls. In addition, students with ADHD exhibited a pattern of lower rates of active engaged time (AET) than PET (Vile Junod et al.). The active engagement category includes classroom behaviors, such as writing, reading aloud, or talking to a teacher or peer about academic material (Shapiro, 1996). Passive engagement consists of behaviors involving listening to a lecture, looking at a worksheet, or silently reading a book (Shapiro). The pattern of incomplete work and student disengagement during academic tasks evolving in the research as reasons for low academic performance found in students with ADHD suggests that academic interventions serving to increase work completion and active and passive student engagement in school are important dimensions to consider beyond academic skill development when supporting these students in a school setting.

The application of the Vile Junod et al. (2006) study is limited in that this study involved a sample of students with ADHD who performed below grade level in math and reading, suggesting that these results should be generalized mainly to student populations with ADHD
who experience academic difficulties. Results are also limited by the small sample size (92 students with ADHD, 63 students without ADHD) and short length of classroom observations (15 minutes).

The importance of student engagement with respect to its influence on academic achievement and performance is further supported by studies showing that students who are engaged during academic instruction are exposed to more opportunities to respond to academic tasks, which increases the rate of learning academic skills (DiPerna et al., 2002). Research using direct observational procedures found that boys and girls with ADHD displayed higher rates of disruptive and off-task behaviors in classroom settings (Abikoff et al., 2002). Behaviors of students with ADHD observed in the Abikoff et al. study included higher rates of gross motor activity and fidgeting, negative verbalizations, and other off-task behaviors associated with ADHD. Previous research suggests that high levels of off-task behaviors have a strong influence on academic underachievement experienced by students with ADHD (Abikoff et al.; Platzman, Stoy, Brown, Coles, Smith, & Falek, 1992; Skansgaard & Burns, 1998). Thus, it is likely that high rates of off-task and disruptive behaviors exhibited by students with ADHD limit their academic engagement, which suggests that academic learning, work completion, and overall academic performance may be negatively impacted, as well. A number of statistical studies highlight the concern that students with ADHD are likely to struggle in academic settings more often than typical peers. The results of a longitudinal study completed by Barkley et al. (1990) revealed that when students with ADHD were compared with typical peers, three times as many students with ADHD failed a grade (29.3% vs. 10%), were suspended (46.3% vs. 15.2%), or had been expelled (10.6% vs. 1.5%). Approximately 36% of students with ADHD drop out of high school before graduation (Barkley, 1998). These studies support the premise that school failure
and academic difficulties frequently occur among students with ADHD, suggesting that prevention and intensive early intervention is warranted to help these students experience success from the onset and throughout their school histories.

**ADHD and Low Math Performance**

**Contributing factors.** Core deficits of ADHD, such as poor attention, distractibility, over activity, and limited executive functioning, likely influence a student’s math performance. Inattention has been associated with math difficulties or math learning disabilities (Marshall, Shafer, O’Donnell, Elliott, & Handwerk, 1999). Difficulties with executive functioning commonly found in students with ADHD are weaknesses in selective attention, sustained attention, and working memory (Zentall, 2007). Issues with selective attention, working at a faster rate, shorter visual scans of detailed information, and attention to irrelevant verbal or visual information decrease academic performance for students with ADHD (Zentall). These students scan detailed information more quickly, which leads to careless errors in aligning numbers, attending to calculation signs, carrying numbers in addition, and canceling numbers in subtraction (Badian, 1983). Regarding their difficulties with sustained attention, students with ADHD habituate to stimuli at a more rapid pace than students without ADHD (Sergeant et al., 2003). Students with ADHD; 1) demonstrate difficulties maintaining attention to repetitive stimuli, 2) spend less time rehearsing verbal information unless reinforced at high rates, and 3) demonstrate increased activity and errors, especially during later trials of rote or overly familiar tasks. Over learning, necessary for the execution of math problems, is often affected by these students’ difficulties in sustaining attention to repetitive tasks and stimuli and their increased over activity and impulsive responding, especially to repeated exposure to stimuli of decreasing novelty (Zentall & Zentall, 1983). Sustained attention to repetitive stimuli is necessary for
Brown's approach to math facts is automated by students. Thus, failure to practice or to benefit from repeated exposure may result in slower retrieval of math facts. Students with ADHD are at a disadvantage in that their core deficits can negatively impact cognitive processing skills, such as sustained attention, working memory, careful attention to details, and switching sets; skills necessary to become accurate, fluent, and efficient with math fact retrieval, math computation, and math applications.

Numerous studies have explored the unique influence ADHD has on working memory. Working memory issues are reflected in the difficulties children with ADHD have maintaining attention and then performing an additional task (e.g., holding information in memory in order to organize it or update this information; McInnes, Humphries, Hogg-Johnson, & Tannock, 2003). The working memory impairment in students with ADHD can be better described as a difficulty with working attention because the breakdown for these students is the capacity to manipulate information held in memory, rather than difficulties storing information (Kaplan, Crawford, Dewey, & Fisher, 2000; Sergeant et al., 2003). Difficulties with working attention are specific to auditory processing rather than visual presentation of information for students with ADHD (Chang et al., 1999). Inefficient working memory has been shown to affect computational performance, completion of math computational problems involving multiple steps, and solving math word problems for students with ADHD (Zentall, 1990; Bryant, Byrant, & Hammill, 2000; Pickering & Gathercole, 2004). Working memory and attention difficulties of the magnitude linked to students with ADHD could understandably influence their degree of uncertainty when working with math problems, slow down overall processing in attempts to be more accurate, reduce work productivity, drain their energy, and diminish positive self-efficacy in math.

As a group, students with ADHD present with specific math weaknesses. They exhibit chronic impairments in math concepts and reduced fluency in recalling math facts (Zentall,
The difficulties students with ADHD have sustaining attention to repetitive tasks may impact their efficiency in over learning or automatizing basic computational skills. The math calculation performance of students with ADHD reveals responses with more activity and errors over time and greater within-session variability (Bennett et al., 2006). Students with ADHD demonstrate greater difficulties with math facts than with applied word problems (Marshall et al., 1999). Because math development is hierarchical, the importance of accuracy and fluency of basic math facts has been emphasized in the literature for functional skill development and complex problem solving (Fuchs & Fuchs, 2005; Skinner, 1998). Thus, targeting math fact fluency and accuracy is crucial for students with ADHD, who commonly demonstrate a weakness in this important skill set needed for math proficiency.

**Motivation Deficit Linked to Underachievement in ADHD**

**Motivation defined.** A review of motivation theory and constructs reinforces the importance of targeting motivation when intervening academically with students with ADHD. In addition, a motivation construct to adopt in the development of a multi-dimensional intervention for students with ADHD and low math performance in the current study was proposed.

Motivation is the process where goal-directed behavior is initiated and sustained (Schunk et al., 2008). Student motivation directed toward academic tasks has a major influence on level of academic achievement. Academic motivation appears to vary according to subject matter, assignments, classroom climate, teacher-student relationships, and peer relationships. Situational factors, such as health and environmental stress, influence academic motivation (Smith Harvey & Chickie-Wolfe, 2007). Motivation is reflected in physical activity (i.e., effort, persistence, and other overt actions), and mental activity (i.e., cognitive actions such as planning, rehearsing, organizing, monitoring, making decisions, solving problems, and assessing progress). These
physical and mental manifestations of motivation are directed toward the attainment of goals (Schunk et al.).

**Theoretical considerations.** Motivation has been identified as one of the core deficits underlying varying behavioral and academic ramifications of ADHD. Studies that focus on the cognitive-motivation belief systems of students with ADHD indicate that intrinsic and neurochemical factors are important in understanding the unique effects of ADHD on motivation (Levy & Hobbes, 1996; Hoza & Pelham, 1995; Milich, 1994; Licht, 1993). The perception of ADHD as a reward deficiency syndrome suggests that students with this disorder have abnormally high reward thresholds. Thus, rewards need to be greater and more frequent to motivate students with ADHD (Wilkinson, Kircher, McMahon, & Sloane, 1995). Students with ADHD have more difficulty internalizing contingency systems than typical peers (Cherkes-Julkowski, Sharp, & Stolzenberg, 1997). These theories are supported by the neurochemical perspective that ADHD is a dopamine-deprived condition, which means that individuals with ADHD require more stimulating and exciting reward systems to activate the pleasure dome in their brains to allow for the experience of satisfaction and gratification. Dopamine is a chemical strongly associated with attention span, focus, follow-through, and motivation (Amen, 2001). Based on animal studies, recent research suggests that changes in dopamine signaling might account for altered sensitivity to positive reinforcement in children with ADHD. Tripp and Wickers (2007) suggest that the anticipatory firing of dopamine cells brought about by a transfer of dopamine cell responses to cues that precede reinforcers is malfunctioning in children with ADHD. They propose that children with ADHD have a diminished anticipatory dopamine cell firing, which they label the dopamine transfer deficit (DTD). The inability to develop anticipatory dopamine release results in the interruption of dopamine cell activity in response to
attending. Dopamine release occurs only in response to current and apparent instances of reinforcement. Reinforcements may be provided by the environment including events in the environment that can reinforce off-task behaviors, such as classroom noise or movement. Overall, a student with ADHD under these conditions often presents as disengaged and unmotivated. Tripp and Wickens suggest that behavioral characteristics of ADHD can be attributed to the failure to adequately predict reward leading to increased sensitivity to delay of reinforcement and less effective performance under schedules of partial reinforcement. Given the effect of decreased dopamine on focusing and attending, as well as motivation of individuals with ADHD, efficient academic interventions will need to address their atypical diminished response to mundane tasks by making academic activities interesting, engaging, and game-like or competitive (within oneself or with others) along with providing some form of immediate and frequent reinforcement.

**ADHD and an aversive motivational style.** Olivier and Steenkamp’s study (2004) suggests that students with ADHD exhibit an aversive motivational style and have motivational needs that differ from typical children. The concept of an aversive motivational style is based on the expectancy-value theory where the motivation to perform an activity depends on the approach-avoidance conflict between the hope for success and fear of failure, that is whether the person believes he or she will be successful performing the activity. Olivier and Steenkamp compared students with and without ADHD (12-15 years old in grades 7 through 9). Results revealed that the study’s participants with ADHD differed from the control group by obtaining significantly lower scores on the motivation to achieve and higher scores on negative fear of failure (Olivier & Steenkamp). Thus, in achievement-related situations, children within the ADHD group tended to demonstrate a greater need to avoid failure than a need to achieve
success. The study’s authors believe that this aversive motivational style negatively impacts achievement and persistence (Olivier & Steenkamp). Boys with ADHD in this study were observed to become frustrated, give up easily, and quit when failure was imminent. Olivier and Steenkamp theorized that students with ADHD often experience an early history of limited academic success and thus, develop low expectations and become reluctant to risk actively participating in scholastic activities necessary for developing cognitive abilities and academic skills. Olivier and Steenkamp further surmise that the students with ADHD who participated in their study maintained unrealistically low expectations of success or disengaged from achievement-related tasks as a means of avoiding negative feelings.

Children with ADHD develop a helpless response style and actively avoid exposure to stressful or negative situations (Milich, 1994). Barron, Evans, Baranik, Serpell, and Buvinger (2006) found that students with ADHD adopt a high level of goal performance-avoidance, which they associated with the underlying cause why these students experience failure in school. Students with ADHD, who become trapped in a cycle of frustration, low achievement, limited academic success, and low motivation, may learn survival skills to protect themselves from further shame and discouragement by shutting down from risking participation in academic tasks. Effective interventions need to address remediating the emotionally discouraged and seemingly unmotivated child, as well as limited academic skill development.

Various behavioral manifestations of ADHD are suspected of impacting specific motivational behaviors and attitudes and contributing to students with ADHD standing out as less motivated compared to typical peers. Children and adults with ADHD are often described as poorly motivated and exhibiting impaired persistence of effort (Barkley, 2006). The outcomes of a number of research studies support the premise that the motivation levels of students with
ADHD can be inconsistent and unpredictable. For example, students with ADHD were found to be less productive on written math tasks than a control group of typical peers (Barkley et al., 1990). ADHD is believed to result in poor regulation of arousal states (Borger, van der Meere, Ronner, Alberts, Geuze, & Bogte, 1999). In addition, students with ADHD exhibit an inability to maintain readiness for action when frustrated (Richer, 1993) or a consistent goal attainment orientation (Dunn & Shapiro, 1999). Students with ADHD often develop an external locus of control (Elliott, 1997), low perceived self-efficacy (Dunn, & Shapiro), low perceived competence in scholastic and behavioral realms (Hoza & Pelham, 1995), impaired self-regulation and goal-directed persistence (Barkley, 1997), and abnormally high reward thresholds (Brim & Whitaker, 2000). Thus, a number of factors related to motivation, academic performance, and achievement beyond the mastery of specific, academic skills present as negatively impacted by the accumulative effects of ADHD and require remediation in addition to isolated skill development.

The motivation styles of children with and without ADHD were studied by comparing parent, teacher, and self-ratings (Carlson, Boother, Shin, & Canu, 2002). Students with ADHD/C or ADHD/IA displayed motivational impairment characterized by preference for easy work, less enjoyment of learning, less persistence, and a reliance on external standards to judge their work, rather than internal standards compared to children without ADHD (Carlson et al.). There were differences revealed between these two subtypes of ADHD. Students with ADHD/C were more motivated by competitiveness and wanting to be seen as superior to others. Students with ADHD/I were less uncooperative and more passive in their learning styles (Carlson et al.). Carlson et al. suggested that students with ADHD/C and their competitive natures would respond best to game-like learning activities and public recognition of their performances, while students
with ADHD/I were expected to respond best to cooperative learning strategies and enhanced performance feedback. A limitation of the Carlson et al. study was that most of the participants with ADHD were receiving medication to treat their disorder, which could affect their motivational style. For these reasons, the results are not as applicable to non-medicated students with ADHD (Carlson et al.).

Performance of children without ADHD is superior compared to children with ADHD under conditions of limited or no reward (Barkley, 2006). Barkley suggests that individuals with ADHD have limited capacity to bridge delays in reinforcement and to allow the persistence of goal-directed acts. They have a preference for immediate over delayed reinforcement. Typical peers demonstrate a greater capacity to self-regulate intrinsic motivation by using self-talk to bridge delays between performance and the reinforcement that may be forthcoming (Barkley). Thus, future studies need to focus not only on the behavioral manifestations of ADHD, but also address low academic achievement and poor scholastic outcomes along with low motivation often associated with this disorder. In the past, most treatment outcome studies did not take place in classroom settings and focused on diminishing the incidence of ADHD-like behaviors. Given the prevalence and extent of academic and motivation problems inherent in ADHD, research endeavors must direct more attention to school-based intervention studies that target motivation.

The literature further reveals that academic enablers (i.e., motivation, study skills, interpersonal skills, and engagement) are affected by ADHD. An academic enabler is defined in the literature as promoting “attitudes and behaviors that allow a student to participate in, and ultimately benefit from academic instruction in the classroom” (DiPerna et al., 2002, p. 294). Studies indicate that motivation is identified as an academic enabler (DiPerna et al.). A study focusing on academic enablers demonstrated that prior academic achievement and interpersonal
skills directly influenced motivation; motivation directly influenced study skills and student engagement, which in turn directly facilitated academic achievement (DiPerna et al.). Thus, according to DiPerna et al., motivation indirectly influences academic achievement by directly influencing study skills and student engagement. Deficits in academic enablers, such as academic engagement and productivity (Abikoff et al., 2002; Barkley et al., 1990) and study skills (Barkley, 1998), occur in students with ADHD. Volpe et al. (2006) demonstrated that the relationship between reading or math achievement and ADHD is mediated through the effects of ADHD on prior achievement and on academic enablers. Furthermore, ADHD was shown to have an effect on motivation and study skills. Motivation was associated with prior achievement and interpersonal skills and had an indirect, but notable association with current achievement (Volpe et al.). Motivation was directly associated with engagement and study skills. These authors support the use of academic enablers (i.e., motivation, engagement, study skills, and interpersonal skills) for assessment and as skill sets to be directly taught to support underachievement in students with ADHD (Volpe et al.). There is empirical support in the research literature for integrating academic motivation constructs with current ADHD interventions by designing a multi-dimensional intervention, which focuses on academic skill and motivation impairments in students with ADHD and low academic performance.

**Academic motivation further explored.** Bandura (1986, 1988) integrated self-efficacy (i.e., one’s perceived capabilities to learn or perform actions at designated levels) and self-regulation (i.e., activation and sustained use of self-regulated learning to attain a goal) as key variables affecting motivational processes (Schunk et al., 2008). Students’ beliefs about academic abilities and performance contribute to their motivation to approach or avoid academic tasks and learning situations. When students’ self-efficacy perceptions are high, they become
more motivated to engage in tasks that foster the development of their skills and capabilities. When self-efficacy is low, students are less prone to engage in new tasks that help them learn new skills (Bandura, 1997). Students with ADHD commonly experience difficulties completing work, frequently receive negative feedback from teachers regarding their behavior, and manifest delays in acquiring academic skills. These experiences can result in establishing negative attitudes and a tendency towards work avoidance, which can weaken motivation and affect academic attainment for students with ADHD. Bandura proposed that individuals need a robust sense of personal efficacy in order to persevere and sustain effort needed to succeed against the common obstacles, setbacks, frustrations, failures, and inequities presented in life (Evans, 1989).

To help students with ADHD overcome the frustrating obstacles and negative academic outcomes they often face in learning and school settings (i.e., low work productivity and academic performance), efforts must be directed towards helping these students develop a robust sense of academic self-efficacy.

Motivation has reciprocal relationships with self-efficacy, self-regulation, learning, and performance. Motivation can strengthen self-efficacy, self-regulation, learning, and performance and these factors, in turn, can strengthen motivation (Schunk et al., 2008). Zimmerman, Bandura, and Martinez-Pons (1992) found a significant relationship between students’ efficacy for academic achievement and efficacy for self-regulated learning and academic achievement, which supports their social cognitive theory of academic self-motivation. In their academic self-motivation model, perceived self-efficacy to achieve motivates academic attainment by influencing personal goal setting. In addition, self-efficacy beliefs together with student goals influence subsequent academic attainments. In this model, self-efficacy, self-regulation, goal attainment, and academic achievement are interdependent factors, which dynamically influence
academic motivation. Additionally, Zimmerman et al. proposed that positive or negative self-efficacy beliefs influence a student’s level of goal setting and use of self-regulated learning strategies, which in turn effect academic achievement. Subsequently, a student’s academic achievement generates positive or negative self-efficacy beliefs (Zimmerman et al.). This cycle continues to regenerate positive or negative influences on student motivation and academic achievement.

Perceived self-efficacy influences the level of goal challenge people set for themselves, the amount of effort they mobilize, and their persistence in the face of difficulties (Bandura & Wood, 1989). Goals prompt self-monitoring and self-judgment of performance attainments (Bandura & Cervone, 1986). Self-regulation of motivation depends on self-efficacy beliefs and personal goals (Zimmerman et al., 1992). In the current study, self-efficacy beliefs and self-regulated learning, associated with strengthening academic motivation, were incorporated into the design of a multi-dimensional intervention in an attempt to increase academic performance and motivation in students who met research criteria for ADHD and low math performance. The constructs of self-efficacy and self-regulated learning and their influence on academic motivation are further explored.

**Self-efficacy.** Self-efficacy beliefs are critically important in light of their major contribution to strengthening self-motivation. Beliefs of personal self-efficacy form the core of human motivation, well-being, and achievement (Bandura, 2006). Bandura states, “Effective functioning requires that people develop competencies and skills. In addition, they need a strong self-belief in their own efficacy to put their skills to good use” (Evans, 1989, p. 53). Bandura (2001) maintains that motivation is sustained by outcome expectations and self-efficacy beliefs for performing effective actions. He links *self-efficacy* to motivation and defines it as a person’s
self-beliefs about their behavioral and cognitive capabilities to perform in a given domain (Bandura, 1986). Bandura’s social cognitive theory of perceived self-efficacy specifies the origin and structure of self-efficacy beliefs. This theory refers to self-efficacy perceptions as “beliefs in one’s capabilities to organize and execute the course of action required to produce given attainment” (Bandura, 1997, p. 3). Bandura proposed that individuals who perceive themselves as capable tend to attempt and successfully complete tasks or activities. Later research on self-efficacy extended the concept of efficacy beliefs to a mechanism underlying learning strategy use (Pintrich & DeGroot, 1990), goal setting (Locke & Latham, 1990), persistence (Gorrell & Capron, 1988) and academic success (Schunk, 1985). Measurements of an individual’s efficacy judgments are commonly related to subsequent school performance (Schunk, 1991). Research indicates that perceptions of academic self-efficacy are better predictors of academic achievement than traditional measures of self-concept (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996). A student’s self-efficacy can vary across academic subjects, situations, or environments; it is not a generalized belief about self-concept or self-esteem (Bandura, 1997). “Adaptive and flexible execution of abilities requires enlistment of cognitive, motivational, self-regulatory, and affect regulation skills” (Bandura, 2007, p. 646). Bandura’s concept of self-efficacy suggests that a student may perform well or poorly with the same ability depending on changes in their perceived self-efficacy (Bandura). Bandura further operationalizes perceived self-efficacy as concern with the strength of the assurance that one can execute given activities. Student beliefs and perceptions have a direct impact on motivation, self-regulation, and academic performance (Pintrich & Schunk, 2002; Bandura, 1997).

Judgments of self-efficacy determine how long a person will persist in the face of obstacles and aversive conditions (Bandura, 1982). People who experience doubt about their
abilities will diminish their effort and tend to give up. In contrast, those with greater self-efficacy will pursue challenges (Bandura). Self-efficacy beliefs impact effort and persistence and engagement in learning (Leary, 2007). From this discussion of self-efficacy, self-efficacy beliefs determine an individual’s approach or avoidance of tasks based on their expected outcomes of success or failure. The difficulties students with ADHD demonstrate with executive functions (i.e., planning, organizing, attending, self-monitoring, etc.), self doubt, and frequent failure could conceivably lead to the development of negative self-efficacy beliefs, thus weakening academic motivation and performance for these students.

Self-efficacy for learning depends on personal factors, prior experiences, and social support. During the process of learning, students become motivated by self, parent, and teacher evaluations. Self-evaluation of progress enhances self-efficacy and sustains motivation (Pintrich & Schunk, 2002). Students with positive self-efficacy (i.e., beliefs they can do a task) are more likely to work harder, persist, and achieve higher academically (Pintrich, & Schunk; Bandura, 1997). However, researchers caution that realistic praise and recognition, tasks calibrated to the student’s abilities and competencies, yet challenging enough to allow the student to experience a sense of accomplishment, are important factors to consider (Pintrich & Schunk). Self motivation is best developed and maintained through attainable sub-goals leading to future, distal goals (Bandura). These sub-goals motivate the individual and direct one’s actions. Sub-goal achievements clearly mark progress and satisfactions and contribute to the development of positive self-efficacy beliefs and intrinsic interest (Bandura,). As the conceptualization of motivation expands, there is agreement among theorists that self-efficacy is a crucial contributing factor associated with increases in student motivation.
Self-regulated learning. Another important factor affecting academic motivation is a student’s development of self-regulated learning, which is viewed as essential in learning and performance. Self-regulated learning is defined as the degree to which students are metacognitively, motivationally, and behaviorally proactive regulators of their own learning process (Zimmerman & Martinez-Pons, 1986). According to Bandura (2007), self-regulation is whether one has the efficacy to get oneself to do an activity regularly under different impeding conditions. Self-regulation is a skill that must be developed, not an act of will (Bandura). Self-regulated learners take charge of their learning and achievement by setting goals for themselves (Bandura, 1989a), adapting and applying strategies to accommodate their personal characteristics and particular learning situations to achieve their goals (Zimmerman, 1989), and by using self-regulation to maximize motivation (Bandura & Cervone, 1986). Students who are self-regulated learners exhibit positive self-efficacy about their capabilities, which influences the goals they set for themselves and their commitment to fulfill these challenges (Zimmerman). There is a significant correlation between high student achievement and the use of multiple self-regulated learning strategies (Zimmerman et al., 1992). Examples of self-regulated learning strategies include asking others for help and encouraging oneself through internalized coaching and recognizing one’s achievements (Zimmerman & Martinez-Pons). According to Leary (2007), self-regulation strategies include organization and time management, study tactics, planning and goal setting, comprehensive monitoring, and self-reflection, which influence self-awareness, strategic efforts, and capacity to improve failure. Self-regulated learning strategies target weaknesses in executive functioning, which can directly affect the learning, achievement, and performance of students with ADHD. Fostering the use of self-regulated strategies could conceivably be implemented to strengthen these students’ academic motivation and performance.
Bandura’s model of self-motivation is based on social-cognitive theory, which proposes that motivational processes influence both learning and performance (Schunk, 1985). The Social-Cognitive Model of motivation posits a reciprocal relationship between motivation and cognitive skills (i.e., processing, reasoning, memory, etc.), which together influence student achievement and learning (Pintrich & Schunk, 2002). Further, it is assumed that motivation involves cognitions, an individual’s thoughts, goals, beliefs and values (Schunk et al., 2008). The Social-Cognitive Model stresses that individuals’ actions are based on their cognitions (Pintrich & Schunk, 1996). The beliefs about being able to do a task and beliefs about the importance, value, and desire to do a task influence the amount of effort applied to accomplishing the task (Pintrich & Schunk). Cognitions are causal in that learners cognitively direct their achievement-related actions (Schunk et al.). Social learning theory espouses that individuals are motivated to perform activities that have previously been successful for them or observed as successful for others modeling the activities. As well, people perform activities they value and avoid those that are dissatisfying (Schunk, 1987).

Motivation Defined in the Current Study

The current study attempted to help students with ADHD increase their academic motivation and academic performance, based on a social cognitive model, which supports the belief that student cognitions serve to support academic motivation. Cognitions believed to affect motivation include a person’s self-efficacy beliefs of positive or negative outcomes, attributions for success and failure, internal or external locus of control, and personal goals (Smith Harvey & Chickie-Wolfe, 2007). Motivation in the current study was viewed as having a dynamically reciprocal relationship with self-efficacy, self-regulated learning, and academic performance, whereby each strengthens the other. The Academic Achievement Model proposed by
Zimmerman, et al. (1992) serves as the dynamic foundation for the interdependent relationships among self-efficacy beliefs, application of self-regulated learning strategies, goal setting and attainment, motivation, and academic achievement, as all these factors influence and positively or negatively strengthen or weaken the other. In the current study, self-efficacy beliefs and self-regulated learning, associated with strengthening academic motivation, were incorporated in the design of a multi-dimensional intervention in an attempt to increase math fact fluency and motivation in students with high levels of ADHD symptomatology and low math performance.

In the current study, factors associated with motivation, which were deficient for a given student participant, were determined and targeted to help increase the student’s motivation. Self-efficacy is one of the factors to assess when looking at where motivation breaks down for students with ADHD and low math performance. In general, self-efficacy entails one’s competency beliefs regarding expected outcomes of success or failure (Bandura, 2001). An assessment of self-efficacy examines whether the student perceives him or herself as competent regarding skills in a given academic area. Thus, self-efficacy beliefs can be positive or negative within the same student at different times depending upon the particular academic content or skill areas being examined.

Assessing a student’s use of self-regulated learning strategies can also be informative in determining where and how motivation might be breaking down, as well as how to strengthen motivation for students with ADHD. Using a structured interview procedure to measure the use of self-regulated learning strategies in non-classroom and classroom settings revealed a strong correlation with academic achievement with a group of high achieving students using substantially more self-regulated learning strategies than a low achieving group (Zimmerman &
Martinez-Pons, 1986). Zimmerman et al. (1992) found that students’ self-beliefs in their efficacy to use self-regulation strategies influenced self-motivation. An assessment of the use of self-regulated learning strategies examines whether the student is knowledgeable of learning strategies that support academic performance and learning, which strategies are used, and how often these strategies are applied. Student assessments need to specifically examine academic self-efficacy beliefs and the use of self-regulated learning strategies in order to determine which remedial approach to implement to address the unique motivational deficits of individual students. By highlighting motivational factors already intact for a student, motivational strengths can be mobilized to compensate for weaker aspects of motivation.

**Interventions for ADHD and Low Academic Performance**

**Stimulant Medication and Contingency Management**

To determine what needs to come next when designing effective academic interventions for students with ADHD, a review of what has been historically attempted to support these students in academic settings, as well as the effectiveness and limitations of these interventions was considered important. Most treatment outcome studies for ADHD have occurred outside a classroom setting and the few school-based studies conducted have primarily focused on decreasing disruptive behaviors and symptoms of ADHD. The two main interventions for ADHD reported in the literature are stimulant medication therapy (e.g., methylphenidate) and contingency management (e.g., token economy, response cost; DuPaul & Eckert, 1995). Central nervous system (CNS) stimulant medications (e.g., Ritalin, Adderall, Metadate, Concerta, Dexedrine, etc.) are the most commonly prescribed psychotropic medications to treat the symptoms of ADHD. Stimulant medications activate the level of activity, arousal, or alertness of the CNS (Barkley, 2006). The treatment goals of stimulant medication for ADHD target
increasing attention span and learning, decreasing distractibility and irritability, decreasing over activity, restlessness, and impulsivity, and increasing thoughtfulness, motivation, and overall functioning at school, work, and at home (Amen, 2001).

The effectiveness of medication intervention on academic performance is questionable. Research indicates that while there was an improvement in the core symptoms of ADHD, there were minimal direct effects on academic achievement. One study found that 47% of children with ADHD treated with methylphenidate displayed either no change or decreases in academic performance relative to placebo conditions (Rapport, Denney, DuPaul, & Gardner, 1994). Purdie, Hattie, and Carroll (2002) completed a meta-analysis of 74 studies associated with improving behavioral, cognitive, or social functioning of individuals with ADHD. Although it was expected that the effects of medication intervention decreasing pathological learning behaviors, such as inattention, impulsivity, and over activity, would improve academic performance for students with ADHD, flow-over effects to learning and achievement did not readily occur. As a rule, studies examining the effects of medication interventions were found to produce relatively minor improvements in cognitive abilities (i.e., general cognition and educational and learning outcomes in math and reading) of students with ADHD, and were not as effective as school-based interventions in helping these students improve achievement (Purdie et al.). Generally what the Purdie et al. study revealed was that improvements in behavior of students with ADHD as the result of medication intervention usually benefited teachers and parents, but did not effectively improve these students’ emotional well-being or school-based achievement. These researchers suggested that the effects of medication intervention on the self-efficacy of students with ADHD was low, and they further postulated that this was in conflict with the literature linking the importance of self-efficacy to higher achievement outcomes. They
suggested this may partially explain the limited follow-through effects from behavior to achievement. Their conclusions suggest that sole reliance on medical intervention and the relief of behavioral symptoms for students with ADHD are not sufficient to improve educational outcomes (Purdie et al.). Interventions directed towards improving the educational and learning outcomes of students with ADHD need to move beyond a one-dimensional approach, which relies exclusively on medication to reduce counter-productive behaviors. Research should move towards the design and implementation of interventions linked to developing academic skills, self-efficacy, and self-regulated learning.

Contingency management, behavioral interventions that provide or withhold rewards contingent on the occurrence of designated, desired behaviors, are designed to reduce negative behaviors (e.g., inattention, over activity, impulsivity, etc.), and increase positive behaviors (e.g., focusing, completing work, behavior regulation, etc.) associated with learning and performing successfully in school (Driscoll, 2005). Academic productivity and accuracy have been enhanced through the combined use of stimulant mediation and contingency management (Barkley, 1990). However, these interventions do not address academic difficulties that students with ADHD exhibit beyond increasing productivity during independent seatwork (DuPaul & Eckert, 1997). When interventions were reviewed in the literature, the results of studies implementing school-based behavioral strategies did not improve academic achievement (DuPaul & Eckert). Although the majority of behavioral interventions target off-task behaviors, on-task behavior does not guarantee improved academic performance (Barkley). A review of studies reporting on the efficacy of stimulant medication or contingency management strategies with students with ADHD indicate partial usefulness, but maintain insufficient effects on increasing academic achievement and scholastic performance to optimal levels (Barkley). Thus, educators must look
beyond medication therapy and contingency reinforcement to effectively remediate academic problems for students with ADHD. Further, Purdie et al. (2002) suggest that students with ADHD generally require consequences or reward contingencies more immediate, powerful, tangible, and frequent than most teachers usually provide to students in regular education classrooms. Given the constraints of a typical classroom setting and the demands of curriculum work and handling various student needs, high intensity reward management systems are taxing for teachers to implement. Further, typical classrooms are usually staffed with one regular education teacher and in rare cases, one teacher aide at best, to provide support to classrooms made up of students with and without special needs. Reliance on contingency-based interventions alone, particularly in regular education settings, presents as impractical and insufficient when attempting to improve both academic achievement in addition to behaviors affecting educational learning and performance for students with ADHD.

**Educational Interventions**

Educational interventions for students with ADHD include management of classroom climates, such as providing highly structured environments, minimal auditory and visual stimulation, preferential seating, and frequent movement breaks between lessons or assignments. School-based interventions also include interventions that involve the use of computer technology, self-instruction, peer tutoring, and cooperative learning (Purdie et al., 2002). In general, outcome studies targeting and measuring academic performance have been slow to evolve in the ADHD literature. The meta-analysis study by Purdie, et al., which reviewed 74 research studies from 1990 to 1998 regarding interventions for children with ADHD, contained only eight studies that assessed the effects of school-based interventions for ADHD. In addition to a generally, limited number of school-based studies, few of these studies involved
interventions targeting academic achievement assessed by actual classroom tasks involving math or reading. Rather, educational outcome studies focused on nonspecific cognitive outcomes, such as memory and IQ. Only eight out of 63 studies for ADHD conducted between 1971 and 1995 examined the efficacy of academic interventions (e.g., modifications to academic instruction, materials, or classroom environment), in contrast to 26 studies of contingency management and 29 investigations of cognitive-behavioral strategies (DuPaul & Eckert, 1995). Another study found that less than 100 methodologically reliable studies have investigated school-based interventions for ADHD (DuPaul & Eckert, 1997). Overall, very few studies have assessed the efficacy of academic interventions for students with ADHD (DuPaul & Eckert, 1998).

Current evidence-based approaches targeting the treatment of ADHD (i.e., stimulant medication, clinical behavior therapy, and classroom behavioral interventions) have demonstrated a positive impact on behavioral variables such as attention and disruptive behavior within classroom analogue settings; however, their efficacy in improving academic outcomes is much less clear. Long-term effects on academic achievement, as measured by standardized tests, have been limited or nonexistent (e.g., MTA Cooperative Group, 1999, 2004). Although surprisingly few treatment outcome studies for ADHD have attempted to incorporate interventions that specifically target academic outcomes, the studies that are available suggest that these interventions may be beneficial (Raggi & Chronis, 2006). Overall, the practice of designing classroom interventions targeting academic outcomes for children with ADHD is a relatively recent extension of ADHD research compared to the numerous studies in the past that have focused on minimizing the behavioral manifestations of ADHD in the classroom. Multi-dimensional studies designed to target core deficits of ADHD (i.e., attention, motivation, self-
regulation, etc.) as well as academic skill mastery are indeed a valuable part of empirically-based research and are currently needed in order to comprehensively help children with ADHD experience greater success in school.

**Academic interventions for students with ADHD.** A review of the literature revealed specific techniques and strategies, which have been used to enhance on-task behavior and/or academic production in students with ADHD. Peer tutoring (PT), computer-assisted instruction (CAI), task and instructional modifications, strategy training (ST), choice-making, and homework management comprise the main academic interventions for ADHD reported in the literature (DuPaul & Eckert, 1998; DuPaul & Weyandt, 2006; Merriman & Codding, 2008). Peer tutoring consists of pairing a student with ADHD with a peer tutor, who provides assistance, instruction, and feedback during academic activities tailored according to the individual’s academic ability and work pace (DuPaul & Stoner, 1994; Greenwald, Maheady, & Carta, 1991). A specific model of PT, Classwide Peer Tutoring (CWPT), has been used in outcome studies with students with ADHD. In the CWPT model, classmates with ADHD and without ADHD are trained in tutoring techniques and randomly paired with one another to work on academic subject material (Raggi & Chronis, 2006). Using CWPT with a seven-year old boy with ADHD improved his accuracy when completing math problems, significantly increased on-task behavior, and reduced his fidgety behavior compared to the effects of routine classroom math instruction (DuPaul & Henningson, 1993). Implementing CWPT with 18 students with ADHD and 10 peer comparison students in grades first through fifth (DuPaul, Ervin, Hook & McGoe, 1998) revealed improvements in classroom behavior and academic performance in students with ADHD. Larger increases were found in on-task behavior than performance on weekly spelling tests and math computation assessments. Limitations of these studies include the questionable
empirical validity of using a single-case design for generalization of results and the absence of academic performance measures (Greenwood, Delquadri, & Carta, 1988). In addition, there were limitations of results on academic improvement emanating from the effects of having a short treatment phase as part of the design (DuPaul et al., 1998). Studies using PT for students with ADHD show some promising results, such as increased active engagement and academic performance via practice and rehearsal of academic skills. However, in general, intervention outcome studies using PT involved brief treatment phases and lacked follow-up studies. Generally, beneficial results could not be generalized to other classroom activities (DuPaul & Eckert).

Another method used to sustain the attention and increase work productivity of students with ADHD is CAI, which involves the use of computer technology and drill and skill or game-like software to present specific instructional material in small chunks of information allowing for repeated trials and provision for immediate feedback to influence response accuracy (Ford, Poe, & Cox, 1993; Kleiman, Humphrey, & Lindsay, 1981; Mautone, DuPaul, & Jitendra, 2005; Ota & DuPaul, 2002). CAI is believed to offer a novel approach that is thought to increase active responding, learning, and motivation in children with ADHD. As well, CAI offers teachers more time and flexibility in the classroom for individualized instruction (Raggi & Chronis, 2006). Ford et al. (1993) examined the attending behavior of children with ADHD (21 elementary-age students; 18 boys, three girls) during CAI instruction in math and reading. Students used both a game and non-game format for comparison. More non-attending behaviors were observed when the CAI information was presented in a drill and practice format, while more attention was noted for the game and animation format. The limitation of this study was the exclusive focus on attending behaviors, rather than specific academic benefits. While overall studies found an
increase in the attending behaviors for students with ADHD using CAI, there were inconsistent levels of increased academic accuracy reported and motivation was not addressed, showing a need for future studies to address academic skill development along with on-task behavior and motivation to increase math performance.

Choice making is an intervention recommended for students with ADHD where students are offered a menu of academic assignments to choose from for a particular academic subject area. Dunlap et al. (1994) conducted a study examining the effects of choice making on task engagement and disruptive behaviors of three middle school students with behavioral difficulties, one of who was diagnosed with ADHD. An ABAB reversal design was used where students were asked to choose from a menu of spelling and English tasks. Results indicated that increases in task engagement along with decreases in disruptive behaviors occurred in response to choice making. A limitation of this study was the neglect to assess the effects of choice making on academic performance (Dunlap et al.).

Increasing cognitive stimulation by highlighting important cues in a spelling task with color was studied by Zentall (1989), based on the belief that students with ADHD require greater stimulation to increase student engagement. Students with ADHD demonstrated better academic performance when color was used compared to typical peers. Using color cues with unimportant aspects of the task resulted in a decrease in spelling performance with students with ADHD (Zentall). The results of this study suggest that providing academic materials in color may increase attention to details and improve academic performance for students with ADHD. Because this spelling task was highly controlled and took place outside of school, the results of the study cannot be readily generalized to a classroom setting (DuPaul & Eckert, 1998). Academic engagement was the primary focus of this outcome study, which neglected the
importance of strengthening the acquisition of academic skills and increasing motivation to improve academic performance.

ST involves instructing students in specific classroom strategies that meet the demands of a classroom setting. When specific instruction was provided in notetaking (Direct Notetaking Activity; DNA) to 14 adolescents with ADHD for a three-week period during lectures in American History, an increase in on-task behavior and improvements in completion of daily assignments for participants showing evidence of notetaking compared to participants who did not take notes were revealed (Evans et al., 1995). Quiz scores and disruptive behavior did not improve. Analyses correlating quality measures of the notes with quiz scores, assignment scores, on-task percentages, and disruptive behavior percentages revealed that when participants’ notes were high quality, on-task behavior increased, disruptive behavior was reduced, and comprehension of material improved (Evans et al.). The results of this study suggest that strategic training in notetaking can increase on-task behavior and academic performance for students with ADHD. However, this study was completed in an analog classroom setting during a summer program with a small sample size. The results cannot easily be generalized to a public school classroom, which has larger student numbers and less time for the teacher to implement the DNA strategy (Evan et al.).

Summary of Current Interventions for ADHD

Academic interventions, such as CAI, PT, ST, CWPT, stimulant medications, and contingency interventions, have helped children with ADHD increase their attention to task, but have not demonstrated clear evidence of improving academic improvement. A review of the limitations of many of the academic interventions for students with ADHD highlights the need for future studies to provide specific measures of academic skills to determine the efficacy of
enhancing academic performance. Curriculum-based measures have been suggested as a means for determining a student’s specific academic skill deficit and allowing for ongoing monitoring of increased academic proficiency (DuPaul & Eckert, 1998). Direct comparisons of different academic interventions were also suggested as a means for clearly defining which types of academic interventions optimally meet the specific needs of students with ADHD (DuPaul & Eckert). Social and treatment integrity were highlighted as important factors for determining whether recommended academic interventions are user-friendly and acceptable to the teacher and individuals implementing interventions, as well as efforts to make sure the interventions are implemented as intended (DuPaul & Eckert). Recent studies have shown that academic skill interventions have been helpful for students with ADHD regarding influencing academic growth, providing proactive and preventive means of support (e.g., instruction and task presentation, classroom climate adjustments including heightened class structure and designated quiet study areas, etc.), and leading to changes in behavioral issues and enhancement of behavioral control (DuPaul, 2007).

DuPaul and Weyandt (2006) cite a number of principles to guide the development of school-based interventions for students with ADHD. One principle recommended by DuPaul and Stoner (as cited in DuPaul & Weyandt) suggests that a school intervention include a balance of both proactive and reactive strategies. Proactive strategies involve a change in conditions before a specific behavior occurs to increase or decrease the targeted behavior. Examples of proactive strategy interventions include choice-making, CWPT, and CAI. Reactive strategies target a change in environmental conditions subsequent to the display of a specific behavior to increase or decrease the frequency in the future. Examples of reactive strategy interventions include verbal reprimands, token economy, response cost, and self-management techniques (DuPaul &
A second principle drawn from Gresham, Watson, and Skinner’s study (as cited in DuPaul & Weyandt) proposed that intervention plans should be based on assessment data rather than a trial-and-error approach, such as a functional behavioral assessment. The third principle focuses on the need to evaluate and modify treatment strategies using data-based decision-making procedures based on ongoing behavioral or academic measures (DuPaul & Weyandt). Lastly, a fourth principle recommended by DuPaul and Power (as cited in DuPaul & Weyandt) suggests involving multiple agents to implement interventions.

A review of the literature reveals that the need for studying the effectiveness of multi-dimensional interventions for students with ADHD, which target academic skills and motivation, is pressing, yet missing in current empirical research. Future academic interventions designed to support children with ADHD should be oriented towards increasing academic motivation and achievement and include measures of academic skills, social and treatment integrity, and follow-up studies to increase the effectiveness of treatment intervention on reducing the negative impact ADHD can have on academic development.

**Math Interventions for ADHD**

Mastering math facts to automaticity enables students to recall math facts quickly and with minimal effort. The development of fluency in basic math facts has been a consistent predictor of improved math performance in students with and without ADHD. By freeing up cognitive resources, such as attention and working memory, students are able to allocate their cognitive resources to solving complex math problems (Zentall, 1990). Automatic responding requires less effort and often results in higher rates of reinforcement, which may reduce math anxiety and influence students to complete assigned math work (Billington, Skinner, & Cruchon, 2004; Skinner, 2002). Thus, the probability of improving math fact fluency and its importance
for enhancing math performance in students with ADHD are likely and have been empirically supported.

A number of interventions used with students with ADHD to increase student engagement and reduce behavioral symptoms (i.e., CAI, CWPT, self-monitoring, and homework programs) have been adapted to target math skills and increase math performance. Computer-, peer-, and self-monitoring interventions are often combined with incentives and are designed to increase math fact fluency and attention in students with ADHD (Zentall, 2007). CAI has been used to specifically bolster math fact fluency in children with ADHD. Ota and DuPaul (2002) conducted a study using a MBD across participants implementing game-like software in CAI to enhance math performance in three, fourth through sixth grade students with ADHD. Ota and DuPaul administered math probes to measure math performance and used measures of on-task behaviors during independent seatwork. The results of this study showed that game-like software used in CAI significantly increased on-task student behavior with only moderate improvements in math performance (i.e., math facts completed correctly per minute) across the three students participating in the study (Ota & DuPaul). This study’s brief treatment phase may have contributed to the moderate academic improvements observed in study participants. Generalizing the effectiveness of this intervention for use in a public school setting is limited, as the intervention was delivered in a private school, special education setting with small class sizes. In addition, this study was limited to three students with comorbid ADHD and LD, which limits the generalization of results to the larger ADHD population.

Improved math fact fluency was documented in a MBD across participants involving three, second through fourth grade students with ADHD using CAI in a general education classroom when additional novelty was added to computer drill exercises (e.g., a game format
with immediate feedback provided through earned points that could be traded for a video game; Mautone et al., 2005). Although improvements in math fact fluency were attained by increasing the appeal and interest of educational materials combined with reward contingencies, as revealed in this study, there is a possibility that student participants might have externally attributed improved skills and progress in math to playing math-related computer games and to the use of the computer, rather than expanding their internal locus of control. Thus, there is a concern that a student using CAI will miss attributing increased fluency to exerting effort and developing an intrinsic sense of doing well based on personal skill mastery. Multi-dimensional interventions targeting skill mastery combined with coaching techniques focused on bridging increased student effort to academic progress and encouraging student use of learning strategies to bolster academic success are more likely to help students with ADHD develop positive self-efficacy beliefs and expect positive academic outcomes. Empowering these students through their development of positive self-efficacy and self-regulation as independent learners is expected to increase motivation that could conceivably generalize to academic performance in subject areas beyond math.

Studies implementing CWPT to improve math competency demonstrated support that peer tutoring increases active engagement and academic performance. CWPT was implemented with a 7-year-old boy with ADHD in a general-education, second grade in an attempt to increase math performance (DuPaul & Henningson, 1993). Results of this single-subject reversal (ABAB) design revealed reliable increases in on-task behavior and reliable reductions in fidgeting behavior during math class. The student’s results on curriculum-based math probes were inconsistent; however, the student made some measurable academic gains in the second CWPT phase (DuPaul & Henningson). Limitations of this study involved reduced generalizability to
larger ADHD populations because of using a single student. Further, limited data were available regarding changes in academic performance, and teacher acceptability of the intervention was not measured.

A study implementing CWPT using a within-subject, repeated-measures design with 18 students with ADHD in grades first through fifth resulted in an improvement in active engagement of students with ADHD from 22% at baseline to 82%. Additionally, there was an increase in weekly academic posttest scores from an average of 55% during baseline to 73% for CWPT conditions (DuPaul, Hook, Ervin, & Kyle, 1995). Students were provided CWPT for math, spelling, or reading according to the weak subject area identified by each student’s teacher. In this study, social integrity assessments revealed that teachers and students rated CWPT as effective, practical, and highly acceptable (DuPaul et al., 1995). A follow-up study was not included, which left undetermined whether the effects of CWPT continued past the intervention phase. The majority of studies using CWPT with students with ADHD involved interventions with short treatment phases and excluded follow-up assessments. Findings were unclear as to whether participants maintained math improvement in response to CWPT after this intervention was discontinued. Overall, CWPT has been shown to be effective as a short-term treatment combined with other treatment strategies (DuPaul & Eckert, 1998).

Improved math accuracy and productivity were demonstrated using self-monitoring in self-contained special education classrooms for three students with ADHD and LD (Shimabukuro, Prater, Jenkins, & Edelen-Smith, 1999). Academic accuracy and academic productivity were self-monitored by the students and on-task student behavior was recorded by the teacher for student performance during math ISW using textbook exercises, worksheets, and manipulative activities. A single group, MBD across three academic areas was used to examine
the effects of self-monitoring on academic performance in reading, math, and written expression for each student participant. Results of this study demonstrated that academic productivity and on-task behavior increased for all students in math, reading, and written expression with greater gains in math and reading comprehension than for written expression. As well, larger gains were noticed in productivity over accuracy (Shimabukuro et al.). Generalization across settings is an issue in this study in that the student participants were taught in a self-contained special education classroom. Self-monitoring techniques have been less effective in regular education classes (DuPaul & Eckert, 1998). Additionally, this study’s design did not measure student satisfaction in response to using this intervention.

Overall, a majority of academic math interventions reported in the literature did not achieve sufficient, consistent, or convincing results that extensively improved low math performance in students with ADHD. Academic interventions, such as CAI, PT, stimulant medications, and contingency interventions have helped students with ADHD increase on-task behavior, but have not demonstrated clear evidence of improving academic performance. Researchers suggest combining interventions to achieve more comprehensive results, such as supplementing CAI, PT, and self-monitoring interventions with contingency plans to increase results and effectiveness. Other recommendations include modifying interventions according to the student’s individualistic needs and the idiosyncratic considerations of their particular ADHD sub-type when designing the most appropriate intervention. There appears to be a consensus that math interventions for students with ADHD need to expand beyond pure math instruction or simply an emphasis on a reduction of behavioral manifestations of the disorder. Royer and Walles (2007) suggest that an area needing further study is determining how to package cognitive, educational, and motivational interventions. Given the extent of behavioral and
academic challenges students with ADHD face, studies examining motivation or math achievement suggest that these students often experience limited success and noteworthy negativity. The profile of a student with ADHD and low math performance is a real possibility and is likely to exist in every classroom. Self-evaluation of academic capabilities determines subsequent motivation and skill acquisition (Schunk, 1996). A student with ADHD and low math performance is more likely to view himself or herself as less intelligent and attribute their math failure to an unchangeable factor, such as “being stupid.” She or he may develop lower expectations for experiencing success and respond to failure with decreased effort (Licht & Dweck, 1984). Stipek and MacIver (1989) have shown that math performance can be used as a basis for self-judging intellectual ability. A student with ADHD and low math performance will most likely report limited positive, self-perceived self-efficacy because he or she will experience more frustration in response to failure than typical students and may, in turn, show less effort and persistence.

The current study was based on the premise that the following factors often linked to ADHD should be considered when designing interventions for students with ADHD: deficits in selective and sustained attention; working memory (working attention); self-regulation; and motivation (i.e., negative self-efficacy beliefs and limited use self-regulated learning strategies). Additionally, an external locus of control; arousal and reward deficiencies; limited goal setting behaviors; low frustration tolerance; avoidance of failure; and low expectation of competency in academic achievement should be taken into consideration. The current study proposed a multi-dimensional intervention that targeted both the characteristically weaker math fact fluency as well as the aversive motivational style often seen in children with ADHD. An academic intervention targeting math fact fluency supported by an effective, motivation coaching protocol
focused on enhancing academic self-efficacy and the use of self-regulated learning was proposed
to improve math fact fluency and motivation in order to increase math performance in students
who met research criteria for ADHD and low math performance.

The Multi-Dimensional Intervention

The Evidence-Based Math Intervention Component

To increase math fact fluency, the empirically-supported practice known to increase
automaticity in basic math facts, CCC (Skinner et al., 1997), served as the math intervention
component of the multi-dimensional intervention in the current study. The CCC intervention
requires students to look at an academic stimulus, such as a math fact problem with the correct
answer, cover the math problem, respond by writing the math problem with the correct answer,
and to evaluate the response by comparing it to the original math problem (Skinner et al.). As a
self-managed academic intervention, CCC was found to be effective across tasks, students, and
settings (Smith, Dittmer, & Skinner, 2002). CCC uses a drill-and-practice format, clear
instructional cues, immediate error correction, and encourages high rates of accurate academic
responding (Skinner et al.). Fluency is increased through practice and over learning (Skinner,
Ford, & Yunker, 1991). CCC learning trials are brief, thus allowing students to complete many
learning trials in a short period of time (Skinner et al., 1991). Unlike CAI, CCC is relatively
inexpensive and can be employed across curricula (Skinner, Shapiro, Turco, & Brown, 1992).
Although PT is cost-efficient, this intervention requires students to work together cooperatively
and efficiently, learning conditions not easily sustained by students (Skinner et al., 1992). Skill
mastery requires increasing accuracy, followed by fluency and maintenance building, and
generalization programming (Haring & Eaton, 1978). Studies have demonstrated CCC to
improve students’ academic skills across all these hierarchical domains (Skinner et al., 1997).
Students were successful using CCC across academic subjects, such as math (Stading, Williams, & McLaughlin, 1996), geography (Skinner, Belfiore, & Pierce, 1992), and spelling (McLaughlin, Reiter, Mabee, & Byram, 1992). A student participating in a study using CCC to learn multiplication facts was reported to independently generalize the CCC strategy to learning the bones of the body in his science class (Skinner, 1998). Another study involving three high school students attempted to replicate the use of CCC for learning scientific information by having students with learning disabilities use CCC to learn the parts of the heart (Smith et al., 2002). All three students were successful. The Smith et al. study lacked a follow-up plan and formal social validity, which left in question whether the students were able to maintain the knowledge they had learned with the support of CCC, and whether they liked the CCC procedure. In addition, the prompts remained the same throughout the study, questioning failure to assess generalization to other prompts (Smith et al.).

CCC may be particularly helpful for students with ADHD, who frequently develop an external locus of control and tend to rely on others to direct their behaviors. Self-managed interventions may increase students’ motivation to learn (Bybee & Zigler, 1992). Being a self-management intervention, CCC may increase students’ sense of internal locus of control and independence as a learner because they are likely to attribute learning to a strategy they used, rather than attributing their learning to being taught by their teacher (Skinner & Smith, 1992). CCC appears to be an efficient intervention to use to increase math fact fluency with students with ADHD because it provides over learning, expands a greater sense of internal locus of control, and requires students to develop and utilize self-management and self-monitoring skills.

CCC is supported by research to improve math accuracy and fluency for children with learning and behavioral problems across a variety of mathematic and calculation skills (Skinner,
Turco, Beatty, & Rasavage, 1989; Skinner, Bamberg, Smith & Powell, 1993; Stading et al., 1996). Using a MBD across subjects, CCC was shown to improve multiplication fact fluency and accuracy for two fourth grade students and two tenth grade students from a school for students with serious behavioral problems, who exhibited multiplication fluency below mastery level (Skinner et al., 1989). Student participants were asked to apply the CCC procedure while completing three separate training sheets (i.e., math facts listed on the left side of the paper, an index card provided to cover the problem, and space provided on the right side of the paper to write the problem down for comparison). However, the influence of CCC on increasing multiplication fact fluency and accuracy for students in this study may have been confounded by practice effects from repeated measures, resulting in inconclusive evidence of the effectiveness of CCC (Skinner et al.).

An adapted, alternating treatments design was used to compare implementing CCC using self-delivered immediate corrective feedback (SDF) versus peer-delivered immediate corrective feedback (PDF) in the multiplication performance of six, second grade students (Skinner et al., 1992). Although both the SDF and PDF increased multiplication fluency across all six participants, the results demonstrated that SDF may be more efficient and less obtrusive than PDF and resulted in larger increases in academic performance for four of the six participants (Skinner et al.). The PDF procedures took twice as long to implement. A limitation of this study was that the within-subject treatment effects were not replicated and changes where and when the CCC intervention took place for the PDF participants may have affected participant responses (Skinner et al.). The effects of CCC on the division fact performance of three male students (ages 9-12) in a self-contained classroom for students with behavioral difficulties were found to positively increase rates of correct responding to mastery level for two of the three
students (Skinner et al., 1993). A MBD across tasks was used to assess students using CCC with sub-vocal responding rather than writing the problem on the paper. The student, who did not reach this goal, did so with the use of goal setting and contingency support. All three students maintained their mastery rate of responding when assessed eight months later (Skinner et al.). A limitation of the study points to the difficulty in discerning whether each student was using CCC by sub-vocalizing the problem and comparing the answer in one’s memory with the uncovered problem on the paper.

An MBD across problem sets was used to explore whether an eight-year old girl with learning disabilities increased her recall performance of multiplication facts using CCC with parent support at home (Stading et al., 1996). The participant completed multiplication facts on written sheets composed of four targeted math facts and previously mastered facts using the CCC method. The participant showed improved performance after using CCC across all sets of multiplication facts assessed (Stading et al.). Limitations of this study include questionable generalization to other students with learning disabilities because of a sample size of one. This study took place in the participant’s home with parental intervention, which raises questions regarding generalization to a school setting. Despite these limitations, this study replicated the work of Skinner et al. (1989, 1993), who found CCC to be effective for multiplication and division problems.

The effects of CCC and explicit timing (ET) were compared on the subtraction fact fluency of 98, second and third grade male and female students, who were randomly assigned to CCC or ET conditions (Codding, Shiyko, Russo, Birch, Fanning, & Jaspen, 2007). CBA probes consisting of single-digit subtraction facts were used to assess student performance. Results revealed that students whose initial fluency levels were assessed to be in the frustration range
obtained their best performance over time using CCC compared to ET (Codding et al.). For students with initial fluency at the instructional range, ET was the most effective treatment. These results suggest that identified levels of initial fluency and accuracy have implications for intervention selection for individual students (Codding et al.). A limitation of this study was an unavoidable predicament of having to conduct CCC sessions during recess rather than class time, which may have had an effect on participant performance. In addition, it was unknown how much supplemental instruction individual teachers of participants were providing in computational skill practices, making the opportunities to practice basic mathematic skills variable across participants and classes (Codding et al.).

Studies have attempted to compare the isolated effects of CCC with the combined effects of CCC with multiple types of performance feedback (Codding, Eckert, Fanning, Shiyko, & Solomon, 2006). In one study, participants were three sixth grade students (2 female, 1 male) referred for help in math fact fluency by their teachers (Codding et al., 2006). Each student received a series of three interventions: CCC in isolation, CCC combined with performance feedback on digits correct per minute (DCPM), or CCC combined with digits incorrect per minute (DIPM). Although an alternating treatments design (ATD) did not demonstrate differentiation between treatment conditions, calculation fluency rates increased across all treatment conditions for all subjects and error rates decreased for two of the three participants (Codding et al.). This study was limited in being unable to determine whether performance feedback contributed to CCC to increase calculation fluency or whether different types of feedback affected performance (Codding et al.).

Given that there is significant empirical support substantiating CCC as an effective intervention for increasing math fact accuracy and fluency for students with and without learning
disabilities, this intervention presented as an appropriate choice to use in the current study to increase math fact fluency in students with ADHD and low math performance. By increasing the number of active and accurate academic responses, the CCC method was expected to likely help students with ADHD and low math performance increase fluency, maintenance, generalization, and mastery of unknown math facts. In turn, improved math fact fluency was expected to result in reduced student effort and increased opportunities for reinforcement (correct responses), resulting in greater engagement in assigned math assignments. A review of the literature on studies involving CCC indicated that this intervention has not been previously implemented with students with ADHD and low math performance, or combined with motivation coaching to support academic difficulties beyond math fact fluency. However, to fully address low math fact fluency and an aversive motivational style often exhibited by students with ADHD, the current study proposed a more comprehensive intervention combining CCC with motivation coaching.

**The Motivational Coaching Protocol Component**

The value of utilizing a coaching intervention paradigm with students with ADHD was explored to determine how to best integrate CCC with motivation coaching within a multi-dimensional intervention. The literature describes children with ADHD as displaying difficulties with self-regulation of motivation and impaired persistence of effort. The development of an aversive motivational style in response to frequent failure and negative reactions from teachers and parents has been cited as problematic for children with ADHD (Olivier & Steenkamp, 2004). Research was reviewed regarding the difficulties children with ADHD have in dealing with tasks that require repetitive responding and have little or no reinforcement (Barber, Milich, & Welsh, 1996). Children with ADHD have been found to be less productive and persistent completing math work (Barkley, 2006; DuPaul et al., 1990). Many of the difficulties children with ADHD
have with academic performance can be traced to poor self-management and self-regulation, which in turn result from developmental lags in executive functioning, (Barkley). Weak skills in executive functioning can impact inhibition, emotional control, organizing, planning, monitoring, and shifting (Dawson & Guare, 2004). Given that motivation presents as a significant deficit impacting the academic performances of students with ADHD, designing academic interventions to target academic skill mastery combined with motivation makes sense. Coaching is a viable tool for strengthening motivation and has been used to help adults with ADHD with their difficulties persisting and sustaining ongoing motivation to complete tasks (Barkley; Swartz, Prevatt, & Proctor, 2005). The coaching paradigm offers encouragement, structure, accountability, and helps individuals with ADHD stay on task (Barkley). ADHD coaching addresses deficits in executive functioning to offset the effects of the disorder (Quinn, Ratey, & Maitland, 2001). Coaching models have been used extensively and successfully with high school and college students with ADHD (Dawson & Guare, 2000; Merriman & Coddington, 2008; Swartz et al., 2005). Coaching has been described as a process involving goal setting, self-monitoring, performance feedback, and sometimes, contingency management (Dawson & Guare). Dawson and Guare claim that children with ADHD struggle with developing and sustaining a mental image of a goal, creating a plan to implement, dealing with the negative feelings associated with self-deprivation, motivating themselves to carry out the plan, and experimenting with different strategies for achieving their goal. These reasons support the belief that the coaching process is beneficial for students with ADHD. Coaching students with ADHD was anticipated to likely result with an increase in motivation in that demonstrating how to set goals, encouraging positive academic self-efficacy, and teaching self-regulated learning strategies was envisioned as easily fitting into the design of a coaching protocol.
Adopting a coaching model to work with younger children with ADHD has been recommended by making accommodations to the coaching models used with older students to meet the needs of the younger child (Dawson & Guare, 2004). The coaching process can be a systematic training process that initially provides the person with access to the executive skills that he or she needs in order to attain a goal (Dawson & Guare). Coaching involves helping students with ADHD deal with the aspects of their disorder that impact their academic performance (Swartz et al., 2005). Coaching is described as similar to counseling, but not the same because coaches do not explore serious emotional or behavioral problems, rather personal issues with fear of failure, frustration, and loss of confidence are treated as thwarting the individual’s goal attainment (Jaska & Ratey, 1999). From this perspective, coaching was expected to teach students with ADHD how to set goals for work completion, resulting in an increase in self-efficacy to approach and engage in tasks, as opposed to avoiding work to protect oneself from crippling frustration, fear, or failure.

Children with ADHD tend to display an external locus of control, that is, they tend to view events that happen to them as outside their personal control or due to luck or fate (Linn & Hodge, 1982). Executive skills developmentally progress from external (i.e., outside the child’s control) to internal (i.e., inside the child’s control; Dawson & Guare, 2004). Because skills in executive functioning are slow to develop in children with ADHD, adults in their lives tend to provide the external structure these students lack internally for longer periods of time past what typical peers often need. Coaching is often used to teach children with ADHD and poor executive functioning how to increase their capacity for using their executive skills through a process outlined in Table B-1 (see Appendix B for Table B-1).
A coaching intervention including self-monitoring, goal-setting, and systematic fading was used to help secondary students with ADHD improve their performance in math homework completion (Merriman & Codding, 2008). A multiple-baseline-across-subjects-design was used to explore the effectiveness of coaching to support mathematics homework for students with ADHD. Merriman and Codding developed an intervention where coaching took place daily and consisted of setting a long-term goal with a minimum of one short-term objective for homework completion and accuracy. During the coaching session, steps were designed to guide each student to set a personal goal and then discuss possible obstacles to goal attainment (Merriman & Codding). Students were taught to self-monitor homework completion, accuracy, and progress towards achieving a short-term objective and a long-term goal. The percentage of math problems attempted and completed from the previous day’s homework assignment was scored and graphed. New short-term goals were developed, as warranted. Coaching sessions were faded to every other day when students met their long- and short-term goals. Sessions were reduced to once a week when a student’s percentage accuracy stabilized for four consecutive coaching sessions and were discontinued when homework completion and accuracy were consistently at high levels for four more sessions (Merriman & Codding). Results revealed that coaching fostered improvements in homework completion for the three high school participants in the study. Two of these students maintained improved performance during fading conditions and post-treatment (Merriman & Codding). A limitation of this study involved the extensive time commitment required for professionals to implement this intervention within the time restraints realistically available in a school setting (Merriman & Codding). In addition, measurement of academic outcomes, such as CBA math probes to assess whether increased completion of homework assignments in math-affected students’ academic performance and achievement, were
not included in this study’s research design. Overall, the results of the Merriman and Codding study indicated that coaching involving goal setting and attainment coupled with review and monitoring of academic performance improved math homework performance, suggesting that a coaching paradigm could conceivably provide viable support for increasing effort, motivation, and academic attainment in math for students with ADHD.

Peer-mediated coaching was combined with CWPT to increase positive peer social behaviors of students with ADHD using a single-subject, MBD with two fourth grade students and one third grade student (Plumer & Stoner, 2005). The frequency of peer social behaviors of participants with ADHD was recorded in academic and social settings. Results revealed that student participants were actively engaged with their partners when CWPT was implemented during spelling without peer coaching of social skills. Increases in positive peer behavior were not noted in social settings (lunch and recess) during the CWPT alone intervention phase. When CWPT occurred during spelling in combination with peer tutoring for social behaviors provided throughout the school day, positive social behaviors were evident during CWPT and lunch and recess (Plumer & Stoner). Limitations of the study include the small sample size preventing the study’s results from generalizing to a larger population of elementary-age students with ADHD. Although treatment integrity measures reached satisfaction by meeting a criterion of 97% interobserver agreement, treatment acceptability measures were not implemented for teachers or student participants. Uncertainty exists as to whether adding the peer coaching element was liked by the students and teachers or found to be more helpful than implementing CWPT alone.

Overall, the Plumer and Stoner study indicated that adding a coaching protocol to an academic intervention enhanced the likelihood of increasing a set of desired behaviors. The results of their study suggests that implementing a multi-dimensional intervention, which combines an academic
intervention with motivational coaching for students with ADHD, might have more robust
effects on increasing targeted behaviors, as opposed to intervening with an academic intervention
alone.

**Evolution of the Multi-Dimensional Intervention**

In an attempt to go beyond ADHD academic interventions found in the research to date,
the current study attempted to combine implementing the CCC method to improve math fact
fluency together with motivation coaching to address low motivation and math performance
often exhibited by students with ADHD. A multi-dimensional intervention of this nature targeted
skill development through the application of CCC, as well as attempted to directly instruct goal
setting and self-monitoring of performance and develop academic self-efficacy, self-regulated
learning, and an internal locus of control for each student. The motivation coaching protocol
adopted in the study’s proposed multi-dimensional intervention was based on coaching
procedures from various models reviewed in the literature. The six-step procedure for teaching
children executive functions from Dawson and Guare (2004) was adapted in the current study to
provide a coaching protocol which allowed students to set goals, monitor their progress, and
receive decreased supervision to encourage independent learning. Each participant’s
motivational coaching protocol was based largely on developing an internal locus of control,
positive self talk, self-regulated learning strategies, and positive academic self-efficacy, as well
as visualizing oneself as a capable learner. Individual coaching protocols specifically addressed
personal academic and motivational concerns gleaned from pre-intervention assessments and
ongoing progress monitoring. The coach (i.e., the investigator) in the current study taught
participants strategies for increasing academic self-efficacy and applying self-regulated learning
practices to improve math fact fluency and motivation behaviors. Each student participant
identified a goal and developed an action plan on a weekly basis. Ongoing progress monitoring in math and motivation along with observations of classroom engagement during math ISW provided continual feedback for each participant to graph individual progress and set new goals. The multi-dimensional intervention addressed the limitations of academic interventions in the past, which solely focused on improving academic skills or minimizing ADHD behaviors, by collectively supporting skill mastery plus student motivation, self-regulated learning, and academic self-efficacy.

**Adding to the ADHD Literature**

Most studies involving children with ADHD have examined changes in behavior, or were largely conducted outside of school settings. Research has supported evidence of an aversive motivational style and limited math fact automaticity in students with ADHD. Academic interventions, such as CAI, PT, stimulant medications, and contingency interventions have helped children with ADHD increase their attention to task, but have not demonstrated clear evidence of improving academic improvement. CCC has been shown to improve student performance in math accuracy and fluency alone and with various delivery modifications, such as providing performance feedback or peer delivery of immediate feedback versus self-delivery of immediate feedback. To date, studies have not examined the effects of implementing CCC with motivational coaching focused on enhancing academic self-efficacy, use of self-regulated strategies, positive self talk, goal setting, and self-monitoring improved performance. The multi-dimensional intervention proposed in the current study attempted to extend the research on academic interventions for children with ADHD by addressing math fact fluency and motivation within a comprehensive intervention framework. The purpose of the current study is an attempt to address some of the global deficits of ADHD by improving math fact fluency and motivation.
behaviors of students with ADHD and low math performance. The proposed multi-dimensional intervention is designed to increase math fact fluency, as well as academic self-efficacy and the application of self-regulated learning strategies for the purpose of increasing student investment and success in the learning process.
CHAPTER III

Method

The purpose of the current study was to improve math fact fluency and motivation levels of students with high levels of ADHD symptomatology and low math performance. A multi-dimensional intervention was designed to increase math fact fluency and components of motivation, such as academic self-efficacy and the use of self-regulated learning strategies, as a means of expanding student investment and success in the learning process. A MBD involving yoked pairs was used to evaluate the effects of the proposed multi-dimensional intervention on the math performance, motivation levels, and on-task behaviors of students who met research criteria for ADHD and low math performance in a school setting.

Participants and Setting

A total of six male students (Ed, Rob, Jon, Harry, Dick, and Jim), ages 8 to 10 years, were recruited to be participants in the current study. Recruitment procedures are described later in this chapter in the Screening section. Three of the participants were Hispanic with one participant from a family where Spanish was the dominant language (Jon). The other two participants’ families were bilingual in Spanish and English (Harry and Ed). Two participants (Dick and Jim) were African American and one participant was Caucasian (Rob). All their families spoke English as the dominant language. Four of the students (Jon, Ed, Rob, and Harry) participated in the study in spring 2009 during Phase I of the study after completing eight months of their third-grade year (i.e., 3.8). Data collected from Ed and Rob were eliminated from the study due to an error in the research design. The remaining two students (Dick and Jim) were recruited to replace the two eliminated participants and entered the study in fall 2009 during
Phase II after completing one month in their third-grade year (i.e., 3.1). An overview of the demographic data for the current study’s participants is provided in Table 1.

Table 1

Participants’ Demographics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Ed</th>
<th>Rob</th>
<th>Jon</th>
<th>Harry</th>
<th>Dick</th>
<th>Jim</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>9-4</td>
<td>8-9</td>
<td>9-9</td>
<td>10-4</td>
<td>8-10</td>
<td>8-10</td>
</tr>
<tr>
<td>Grade</td>
<td>3.8</td>
<td>3.8</td>
<td>3.8</td>
<td>3.8</td>
<td>3.1</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Note: Age is presented in years and months. Grade placement is based on tenth of a school year.

The following data pertains to the four participants who were retained to represent the main part of the study (Jon, Harry, Dick and Jim) and excludes the participants who were eliminated from the study. Only one of these four participants was officially diagnosed with ADHD by a physician. None of the participants were taking medication to treat psychiatrically-diagnosed disorders, and none of the participants were identified by the school system with an educational disability. One participant (Jim) received one class period of small-group instruction daily in math led by a special education teacher in a resource-room setting. Two participants (Jim and Dick) attended a group tutoring program two days a week after school, which targeted language arts and math to prepare for state educational testing. Two participants repeated a grade. Jon repeated kindergarten, and Harry repeated second grade.
The investigator administered screening and pre-intervention assessments and conducted individual baseline and intervention sessions with recruited students outside the classroom setting in a private, quiet area designated by the school principal. Individual sessions were scheduled on consistent, designated days each week before or after school so as not to remove students from class time.

Parents and teachers of recruited students participated in the study by completing screening measures consisting of behavioral rating scales and academic questionnaires provided by the investigator. Two individuals recruited to be volunteer research assistants conducted weekly structured classroom observations within each student participant’s classroom during math ISW. One research assistant was a second-year doctoral student in a school psychology program and the other research assistant was a college graduate with a major in psychology, who worked on a crisis team. The research assistants also conducted treatment and social integrity checks and classroom observations for interobserver agreement checks. One of the research assistants left before the study was completed and was unable to be replaced. The research assistant who continued with the study and the investigator completed the remaining classroom observations and interobserver agreement checks. Training procedures for the research assistants are described later in this chapter in the Dependent Measure section and in Appendix I in the Intervention Manual.

Students who participated in the current study attended the same public elementary school located in a low socioeconomic, inner city neighborhood serving grades K-5. During the 2008-2009 school year, there were 505 students with a ratio of 48% male and 52% female served by 38 teachers with a student ratio of 1:13. The ethnicity of the student population was 1% American Indian, 3% Asian, 59% Hispanic, 26% Black, 10% White, and 1% Unknown. There
were 86 students in Grade 3. Seventy-three percent of the students attending this school were eligible for Free Lunch and 10% were eligible for Reduced Lunch (“Public School Review,” 2009). Massachusetts Comprehensive Assessment System (MCAS) results revealed that a majority of the students in grades three to five tested in the Needs Improvement and Warning/Failing categories in English/Language Arts and Math. The school was rated in the category of Corrective Action in English and Language Arts in the No Child Left Behind system. Fifty percent of the students were in regular education, 19.7% received special education, and 29.3% were in bilingual education (“Public School Review”).

**Measures**

The following measures were used in the study to screen participants, provide further pre-intervention information, and to collect data for the experimental conditions (see Appendix B for Table B-2, Screening, Pre-Intervention and Dependent Measures).

**Screening Measures**

*Attention Deficit Hyperactivity Disorder-Symptom Checklist-4 (ADHD-SC4; Gadow & Sprafkin, 1997).* This measurement was used to determine whether referred students screened positively for ADHD-C. The ADHD-SC4 is a 50-item behavior rating scale developed for screening DSM-IV ADHD symptoms and comorbid symptoms frequently associated with ADHD. The ADHD-SC4 is comprised of two Symptom Inventories, which screen for ADHD and ODD: the Peer Conflict Scale (PCS), which assesses interpersonal aggression; and the Symptom Side Effects Checklist, which monitors common side effects of stimulant medications. In the current study, the Symptom Side Effect Checklist was excluded from the screening protocol.
The ADHD-SC4 was chosen as a screening measure for this study because studies have shown that the parent- and teacher-completed ADHD-SC4 Checklists were reliable and valid screening measures for ADHD and ODD (Sprafkin, Gadow, & Nolan, 2001). Internal consistency for the ADHD-SC4 as a screening measurement for ADHD, ODD, and aggressive behavior with peers was supported for parent and teacher ratings on the ADHD-I items ($r = .95$ for both), ADHD: HI ($r = .95$ for both), ODD ($r = .95$ for both), and PCS ($r = .93, r = .92$; Sprafkin et al., 2001). Test-retest reliabilities for the four diagnostic categories of the teacher-completed ADHD-SC4 with a 6-week re-test interval ranged from .70-.89 (Gadow & Sprafkin, 1997). Test-retest reliabilities of the ADHD and ODD categories of the parent-completed ADHD-SC4 with a six-week interval for the Severity Count scores were as follows: ADHD Inattentive Type ($r = .76$), ADHD-HI Type ($r = .82$), and ODD ($r = .75$; Gadow & Sprafkin).

The predictive validity of the ADHD and ODD categories of the teacher- and parent-completed checklists was determined by comparing checklist scores with data-based psychiatric diagnoses. For children between the ages of six through twelve, agreement between the ADHD category and clinical diagnoses of child psychiatry outpatient services was acceptable for teacher- and parent-completed checklists, respectively (sensitivity = .68, sensitivity = .81), suggesting that the ADHD-SC4 adequately identified children with ADHD. In contrast, the capacity to identify children without ADHD was weaker (specificity = .57, specificity = .60) for children ages six through twelve years (Gadow & Sprafkin, 1997). Numerous studies have shown that the sensitivity and specificity of the ADHD-SC4 Symptom categories, increased when both the parent and teacher checklists were considered together, rather than the results of parent checklists alone (sensitivity = .93, specificity = .30; Gadow & Sprafkin, 1994, 1995; Sprafkin & Gadow, 1996). The ODD category agreed well with outpatient clinical diagnoses and
adequately identified children with ODD (sensitivity= .71, sensitivity= .69) and without ODD (specificity= .80, specificity= .60) (Gadow & Sprafkin). Again, sensitivity and specificity increased with consideration of both teacher- and parent completed checklists (sensitivity= .89, specificity= .32) for children ages 6-12 (Gadow & Sprafkin, 1997).

Validity was established for the PCS as a measure of peer aggression. Teacher ratings on the PCS were compared with direct observations of peer aggression in a school setting using the ADHD School Observational Code. Observations of negativistic behaviors significantly correlated with PCS scores. The highest correlations for the classroom setting were between the observed rates of Non-Physical Aggression and Noncompliance and PCS scores ($r = .74$ and $r = .63$, $p < .001$, respectively; Gadow & Sprafkin, 1997).

Concurrent validity for the ADHD-SC4 symptom categories (ADHD-I, ADHD-HI, ADHD-C, and ODD) for teacher- and parent-completed checklists was demonstrated through high correspondence with the Child Behavior Checklist (CBCL) and the Teacher Report Form (TRF; Gadow & Sprafkin, 1997). Correlations between the Symptom Severity scores for the ADHD and ODD categories of the teacher-completed checklist (ages 6-12) and the Attention and Aggression subscales of the Teacher Report Form (ages 6-12) were as follows: ADHD/TRF (Inattention/Attention, .82; Combined, .76) and ODD/TRF (ODD/Aggression, .88). Correlations between the Symptom Severity scores for the ADHD and ODD categories of the parent-completed checklist (ages 6-12) and the Attention and Aggression subscales of the Child Behavior Checklist were as follows: ADHD/CBCL (Inattention/Attention, .67; Combined, .67) and ODD/CBCL (ODD/Aggression, .67; Gadow & Sprafkin).

Discriminate validity of the teacher and parent checklists of the ADHD-SC4 was determined by assessing whether children referred for psychiatric evaluation received higher
scores on the teacher- and parent-completed checklists than children in the regular school population. Discriminate validity of the Symptom Severity scores for all three ADHD categories for elementary school children (ages 6-12) was determined by comparing two samples of children: (a) students receiving special education and medication for a mental health disorder or behavioral disturbance attending a regular classroom and (b) students in regular education classrooms not receiving special education or medication (Gadow & Sprafkin, 1997). Group differences, as evidenced by statistically discrepant Symptom Severity scores, showed that the Outpatient Clinical sample was significantly higher for all three ADHD categories for boys and girls from the norm sample (Gadow & Sprafkin). The ADHD-SC4 has been shown to adequately discriminate children with ADHD from nonclinical populations (sensitivity= .91, specificity= .36) when both parent and teacher ratings were considered together (Sprafkin et al., 2001). These results suggested that the ADHD-SC4 demonstrated acceptable discriminative validity for identifying clinically-referred children with ADHD. Results were less clear for discriminating clinical populations for ODD (sensitivity= .69, specificity= .65) when both parent and teacher ratings were considered together (Sprafkin et al.). Discriminate validity was not reported in the ADHD-SC4 manual for elementary-age children for either the teacher- or parent-completed checklists for the PCS. The PCS was not based on symptoms of the DSM-IV-TR, rather it was a dimensional scale with adequate reliability that measured peer conflict (Gadow & Sprafkin).

**Achievement Improvement Monitoring System Web Base: Math-Curriculum Based Measurement (AIMSweb M-CBM; Shinn, 2005).** The AIMSweb M-CBM benchmark probes appropriate for each student’s grade level were administered to determine whether referred students met the current study’s criteria for low math performance in computation. This measurement system provides 40 alternate M-CBM probes per grade for fall-, winter-, and
spring-benchmark assessment periods and is comprised of typical computation problems for Grades 1-8. For each grade, types of computational problems representing an annual grade-level curriculum were identified and weighted to create prototype grade-level M-CBM probes with identical sets of ordered problems (Shinn). Each M-CBM benchmark probe consists of computational problems displayed in rows printed on two pages. AIMSweb M-CBM Benchmark Probes (i.e., worksheets) contain 50 problems designed to assess addition, subtraction, multiplication, or division facts (i.e., 1x1 digit and 2x2 with regrouping) in single-skill (problems represented in one operation) or multiple-skill (problems presented in multiple operations) forms. M-CBM probes are administered for two-four minutes depending on the grade-level of the probe materials (Shinn). Each probe has a scoring key with the number of digits possible in the row and in a cumulative count (Shinn, 2005). Evidence-based research has demonstrated that having students provide answers to grade-level computational problems for two-four minutes was a reliable and valid assessment of general mathematics computation for typically achieving students through Grade 6 and for students with serious math problems (Marston, 1989; Thurber, Shinn, & Smolkowski, 2002). The adequacy of commercially developed, content-controlled materials are supported by previous studies indicating that generic materials can be used reliably to determine performance level and provide information for programming (Fuchs & Deno, 1991).

The few studies available investigating technical adequacy of the AIMSweb M-CBM probes have shown M-CBM interscorer agreements as .93 to .98 (Marston, 1989). The internal consistency and test-retest reliability of M-CBM probes were reported as .93 for both types of reliability (Fuchs, Fuchs, & Hamlett, 1988; Tindal, Marston, & Deno, 1983). High alternate form reliability was demonstrated among three probe forms with a median correlation of .91 (Thurber...
et al., 2002). Internal consistency of M-CBM with mixed math probes was high at .93 for 46 subjects in grades 3-9 (Fuchs et al., 1988). Convergent and divergent validity was demonstrated. M-CBM correlated highly with other measures of basic facts computation (median $r = .82$), modestly with commercial math tests (median $r = .61$), and the lowest (median $r = .42$) with tests measuring math applications (Thurber et al.).

M-CBM demonstrated high discriminate validity by differentiating among students in general education, Title I, and in programs for mild disabilities in grades 5 and 6. In addition, students in general education in grade 4 were differentiated from students with mild disabilities (Shinn & Marston, 1985). Students receiving curriculum-based assessments in reading, math, spelling, and written expression were clearly discriminated as separate groups according to their scores on curriculum-based measures (CBM) measures (Shinn & Marston). In mathematics, the students in the research sample fell into one of the following three groups: Mildly Disabled, Chapter I, and Regular Education. Discriminate validity of the M-CBM was demonstrated in that significant F ratios were discovered at grades 4, 5, and 6 when students’ results on CBMs in math computation and multiplication facts were examined. Student-Newman-Keuls (SNK) comparisons were significant for all contrasts with exception to the comparison between Mildly Disabled and Chapter 1 at grade 4 (Shinn & Marston). Student results on the M-CBM reliably demonstrated differences among the three groups with mildly disabled students scoring the lowest and regular education students scoring the highest (Shinn & Marston).

Concurrent validity was not well established between M-CBM and commercial standardized achievement tests with most correlations below .60 and a median correlation of .43 with the Problem Solving subtest and .54 with the Math Operations subtest of the Metropolitan Achievement Tests (MAT; Marston, 1989). It was suggested that M-CBM did not correlate well
with commercial math tests because the published tests have limited content validity making them poor criterion measures (Freemam, Kuhs, Porter, Floden, Schmidt, & Schille, 1983). In addition, these math tests measured silent reading skills needed to complete math word problems rather than assessing pure math computation (Skiba, Magnusson, Marston, & Erickson, 1986). Using confirmatory factor analysis and a distinct two-factor model consisting of Computation and Applications, the median factor loading of M-CBM on the Computation construct was .64 revealing moderate evidence of M-CBM as a measure of Math Computation (Thurber et al., 2002).

**Parent and Teacher Mathematic Assessment Questionnaires.** Parent and teacher interview questionnaires (see Appendix C for copies of the Parent and Teacher Math Assessment Questionnaires) were adapted from the *Teacher Interview Form for Academic Problems* (Shapiro, 1996) to request specific information about referred students’ math performance to determine if they met criteria for low math performance in order to qualify for the current study. Although the parent and teacher questionnaires varied somewhat in content, generally the questions asked whether the student exhibited specific difficulties in math, the prevalence and longevity of reported difficulties, and whether additional help or special services were received by the student. In addition, performance levels in specific areas in math, test results, and behavior during math instruction and independent seatwork were requested. Teachers were further queried about the current math curriculum and instructional procedures used in the student’s classroom. The format of the questions included ratings, open-ended questions, and *Yes/No* answers asking for further description. Validity and reliability information were not available for these questionnaires.
**Pre-Intervention Measures**

Unlike the aforementioned, screening measures used to determine student eligibility to participate in the current study, the following measures were used to obtain information regarding participants’ pre-intervention math skills, academic self-efficacy and self-efficacy for use of self-regulated learning strategies, skills, attitudes, and behaviors linked to academic success, and math operations at the instructional or frustration levels.

**Woodcock Johnson III Tests of Achievement (WJ-III ACH; Woodcock, McGrew, & Mather, 2001).** This individually administered achievement battery for ages 2-90+ years is commonly used to assess student academic achievement in reading, math, and written language and is based on age and/or grade norms. For purposes in this study, subtests used to calculate the Math Composite Score of the WJ-III ACH (Calculation and Applied Problems) in combination with the Math Fluency subtest were administered to student participants and used to examine math performance and to describe pre-intervention math levels compared to an age-normed sample. The Math Fluency subtest measures the ability to work quickly with addition, subtraction, and multiplication math facts. The Calculation subtest measures the ability to perform mathematical calculations with items ranging from writing single numbers to completing logarithmic and calculus operations. The Applied Problems subtest measures the ability to solve orally-presented, mathematical word problems.

Reliability coefficients for these math subtests were .80 or higher suggesting acceptable internal consistency (Bradley-Johnson, Kaouse, Morgan, & Nutkins, 2004). The median reliability for the Applied Problems subtest was .92 in the age five to 19 range, .89 in the seven to 10 age range for the Math Fluency subtest, and .85 in the age five to 19 range in the Calculation subtest (Mather & Woodcock, 2001). The test-retest reliability coefficients were
high (.80-.95) for the speeded subtests of the WJ-III ACH, as in the Math Fluency, when a one-day inter-administration latency was used (Bradley-Johnson et al., 2004). With a re-test interval over a one-year period, test-retest reliability for the Broad Math Composite exceeded .90 and was lower than .90 for Math Calculation (Bradley-Johnson et al.). A re-test correlation of .80 or higher was noted for the Applied Problems subtest where the exact retest interval was not reported, but was described as varying from less than one year, one to two years, or three to 10 years (Bradley-Johnson et al.).

Content validity for the subtests of the WJ-III ACH was based on expert opinion regarding the inclusion of test items, use of the Rasch model to measure particular traits, and a high correspondence with academic curricular areas mandated by federal law (Bradley-Johnson et al., 2004). The Math Fluency subtest was viewed as assessing important educational skills such as math fact fluency and accuracy. Content validity was considered less well established in the Calculation subtest, where a limited amount of test items covering the test’s age range resulted in limited information for instructional planning (Bradley-Johnson et al.). Content validity of the Applied Problems subtest was not available in the WJ-III ACH technical or examiner manuals. Criterion validity was supported such that subtests and clusters were said to correspond to major curricular requirements cited in federal law (McGrew & Woodcock, 2001). Construct validity for W-J III ACH was acceptable indicating that the achievement subtests were interrelated (Bradley-Johnson et al.).

Regarding concurrent validity, achievement clusters had moderate to high correlations with Kaufman Test of Educational Achievement (KTEA) and Wechsler Individual Achievement Test (WIAT) subtests and composites. Data were not reported regarding the relationship of WJ-III Achievement subtests to the KTEA and WIAT measures (Bradley-Johnson et al., 2004).
Academic Competence Evaluation Scales (ACES; DiPerna & Elliott, 2000). The ACES is a rating scale system commonly used to measure student skills, attitudes, and behaviors that contribute to academic success in the classroom. The ACES--Teacher form and the ACES--Student form were designed to provide valuable input for planning and evaluating school-based interventions for students experiencing academic difficulty. The ACES is comprised of two broad scales: Academic Skills (i.e., basic skills in subjects usually taught within school curriculums) and Academic Enablers (i.e., skills that support students benefiting from classroom instruction).

Internal consistency coefficients were very high on the teacher and student forms across all grade levels on the ACES Academic Skills and Academic Enablers scales: the mean coefficient alpha was .99 for the ACES--Teacher form with subscales ranging from .94-.99. The mean coefficient alpha on the ACES--Student form was .94 for the Academic scales and .99 for the Academic Enabler scales with the mean coefficients for the subscales ranging from .83 to .96 (DiPerna & Elliott, 2000). The coefficient alpha for the Mathematics subscale for the third-fifth grade cluster was .98. The coefficient alpha for the Motivation and Study Skills subscales for the third-fifth grade cluster were .97 and .96, respectively on the ACES--Teacher form. Test-retest stability coefficients were .93 for the Mathematics subscale on the teacher form and .77 on the student form, .96 and .84 for the Motivation subscale, and .96 and .68 for Study Skills subscale (DiPerna & Elliott). The teachers in the standardization sample rated the same students two to three weeks after the initial rating for test-retest reliability for the ACES--Teacher form. Students rated themselves four to five weeks after their initial rating for the ACES—Student form.

Content validity was supported by factor analysis conducted with the standardization sample indicating there were two broad scales with multiple subscales. The ACES--Student
factor structure was highly congruent with that of the ACES--Teacher, which provided convergent evidence for the academic skills and academic enabler constructs rated by the teachers (DiPerna & Elliott, 2000). Ratings of students who varied in developmental level and gender supported evidence for constructs measured by the ACES.

Concurrent validity was supported by the high correlations between the ACES--Teacher and the Iowa Test of Basic Skills (correlations ranging from .58-.87 with the majority of skills .80 and above; DiPerna & Elliott, 2000). Overall, scores from the ACES--Teacher and ACES--Student correlated well with external criteria used to assess students’ academic functioning (DiPerna & Elliott).

Multidimensional Scales of Perceived Self-Efficacy (MSPSE; Bandura, 1989b). The MSPSE is a 57-item, self-report measure with nine subscales. The MSPSE is comprised of the following subscales: Self-Efficacy for Academic Achievement; Self-Efficacy for Self-Regulated Learning; Self-Efficacy in Enlisting Social Resources; Self-Efficacy for Leisure Time Skills and Extracurricular Activities; Self-Regulatory Efficacy; Self-Efficacy to Meet Others’ Expectations; Social Self-Efficacy; Self Assertive Efficacy; and Self-Efficacy for Enlisting Parental and Community Support (Miller, Coombs, & Fuqua, 1999). Each subscale contains items rated on a seven-point Likert-type scale (not well at all for a rating of 1, not too well for 3, pretty well for 5, and very well for 7). The MSPSE is based on Bandura’s social cognitive theory of perceived self-efficacy (Bandura, 1986), which specified the origin and structure of self-efficacy beliefs. This theory referred to self-efficacy perceptions as “beliefs in one’s capabilities to organize and execute the course of action required to produce given attainment” (Bandura, 1997, p. 3). Bandura proposed that individuals who perceived themselves as capable tended to attempt and successfully complete tasks or activities. Later research studies on self-efficacy extended the
concept of efficacy beliefs to a mechanism underlying learning strategy use (Pintrich & DeGroot, 1990), goal setting (Locke & Latham, 1990), persistence (Gorrell & Capron, 1988) and academic success (Schunk, 1985). Measurement of efficacy judgments was commonly related to subsequent school performance (Schunk, 1991). Research indicated that perceptions of academic self-efficacy were better predictors of academic achievement than traditional measures of self-concept (Bandura et al., 1996). There are a number of studies, which have administered separate subscales of the MSPSE (see Williams, 1996; Zimmerman et al., 1992).

The internal consistency and reliability for the overall MSPSE was high with a reported alpha coefficient of .92 with a sample of male and female high school students (Miller et al., 1999). A principal factor analysis revealed nine common factors were extracted to ascertain the structure of the MSPSE. These factors related well to the original subscale structure where seven of the nine correlations were at least .82 and five of these correlations were at least .90 (Miller et al.), evidence of strong construct validity for the MSPSE. The basic factor structure of the MSPSE reasonably represented Bandura’s model (Bandura et al., 1996), the model on which MSPSE was based (Miller et al.). Efficacy perceptions varied across academic domains of functioning and differentiated among different aspects of academic functioning. A theoretical fit was not found with the construct of the MSPSE (Miller et al.).

The AAE subscale, used in the current study to obtain information about each participant’s perceived level of academic self-efficacy, is composed of nine items that measure students’ perceived capabilities to achieve in nine academic domains: mathematics, algebra, science, biology, reading and writing language skills, computer use, foreign language proficiency, social studies, and English grammar. Items primarily dealing with academic subjects commonly taught at the elementary-school level were used in the current study. An alpha
coefficient of .74 was reported for the AAE subscale suggesting acceptable internal consistency and respectable reliability with a high-school age sample of mixed gender (Miller et al., 1999). Test-retest reliability was not addressed in the literature. The AAE displayed reasonable content validity (i.e., the items were generally conceptually consistent with the subscale label; Miller et al.). The AAE demonstrated an adequate degree of construct validity, as evidenced in a moderate relationship ($r = .65$) between the subscale and the second-order, empirically-based Academic Efficiency (AE) factor (Miller et al.). Information on divergent validity was not available.

The SRL subscale, used in the current study to obtain information on participants’ use of self-regulated learning strategies, is composed of 11 items that measure students’ perceived capabilities to display self-regulated learning: completes homework by deadlines; studies instead of participating in other interesting activities; concentrates on school subjects; takes class notes during instruction; uses the library or internet to get information for class assignments; plans and organizes schoolwork; remembers information presented in class and textbooks; arranges a study place without distractions; motivates self to do schoolwork; and participates in class discussions. An alpha coefficient of .87 was found for the SRL subscale substantiating high internal consistency and reliability with a sample of female and male high school students (Miller et al., 1999). Test-retest reliability was not available. The SRL displayed reasonable content validity (i.e., the items were generally conceptually consistent with the subscale label; Miller et al.). The SLR demonstrated a high degree of construct validity, as reflected in the strong relationship ($r = .96$) between this subscale and the first-order, empirically-based Basic Study Skills (BSS) factor (Miller et al). Divergent validity was not addressed in the literature.

**Curriculum-Based Assessment Math Computation Probe Generator (Intervention Central, 2009).** Single-skill math computation probes obtained from the Curriculum-Based
Assessment Math Computation Probe Generator provided at the Interventionalcentral.com website were administered to participants to identify a math operation at the instructional or frustration level for each participant in order to further identify which math facts to target under intervention conditions. A problem type can be selected for each single-skill computation worksheet. Selections in the Advanced Settings section can change the size of digits in a math problem or alter the numbers of columns and rows for a worksheet. Intervention Central provides teachers, school, and districts with free articles and tools to successfully implement educational programs and interventions. This site was created by Jim Wright, a Response-To-Intervention (RTI) consultant and trainer from central New York, who works in the public schools as a school psychologist and administrator.

**Dependent Measures**

**Progress monitoring.** Participant outcomes in math fact fluency, self-ratings in motivation, and percentages of positive student engagement were dependent variables, which were monitored by assessing participant progress during baseline and intervention conditions. Progress monitoring is considered a valuable tool for evaluating academic interventions (Shapiro, 2004a).

**AIMSweb Math Fact Probes (Shinn, 2005).** In the current study, participants’ progress in math fluency was monitored by administering the AIMSweb Math Fact Probes to determine the effectiveness of intervention conditions and for student monitoring as part of the motivation coaching protocol for the study’s multi-dimensional intervention. These math fact probes are designed to identify which types of math problems students can do correctly and to monitor progress to assess the effects of a given math intervention (Shinn). CBM procedures are responsive to student improvements in academic achievement and are known for their...
effectiveness in exploring the operative relationship between performance and instruction intervention provided over time (Shinn, 1989). The AIMSweb Math Fact Probes were chosen for this study because they provide numerous similar-type items across the same grade level and are sensitive to student improvement. Each math fact probe is designed with six rows containing seven math fact problems displayed on a front-to-back worksheet. All probes are based on number families 0-12 and are presented as single-skill fact probes (Shinn). There are seven types of AIMSweb fact probes: Addition Fact Families 0-12 (0=0 to 12=12); Subtraction Fact Families 0-12 (0-0 to 24-12); Addition and Subtraction Fact Families 0-12; Multiplication Fact Families 0-12 (0x0 to 12x12); Division Fact Families 0-12 (0/0 to 144/12); Multiplication and Division Fact Families 0-12; and Addition, Subtraction, Multiplication and Division Fact Families 0-12 (Shinn, 2005). Math Fact Probes are scored by counting the number of Correct Digits (CD) in the answer. For each probe, there is a scoring key with the number of digits possible in the row and in a cumulative count. (see Screening Assessments for psychometric properties of AIMSweb Math-CBM Benchmark and Math Fact Probes).

Motivation Probe. A motivation probe was designed for the current study to monitor participants’ perceptions of their display of behaviors associated with motivation to help determine the effectiveness of the study’s intervention conditions with respect to improving participant motivation (see Appendix E for a copy of the Motivation Probe). The Motivation Probe is a self-report measurement comprised of 12 items using a seven-point Likert scale to assess self-perceived, demonstrations of personal characteristics and activities linked to motivation. Assessment items are rated not well at all for a rating of 1, not too well for 3, pretty well for 5, and very well for 7 as adopted from Bandura’s (1989b) MSPSE. Scores on items are summed to generate a motivation total score. The Motivation Probe was developed using
selected items with high factor loadings from the standardized Motivation subscale of the ACES Academic Enablers scales (DiPerna & Elliott, 2000). The ACES Motivation subscale items incorporated in the Motivation Probe and their respective factorial loadings were as follows: 

- taking responsibility for one’s learning (.68);
- goal setting (.74);
- frequency of doing good work (.72); and
- persevering when work is hard (.68).

The study’s Motivation Probe also contained pertinent items from the Self-Efficacy Questionnaire for Children (SEQ-C; Muris, 2002) and the SRL subscale from the MSPSE (Bandura, 1989b), as well as other items drawn from research literature in motivation. In general, questions from the Motivation Probe addressed self-efficacy for schoolwork, motivation behaviors (i.e., self-encouragement, best effort, goal setting, and work completion), and the implementation of self-regulated learning strategies involving organization of schoolwork and arranging a constructive study place. Distinct items were chosen to prevent overlapping of items and redundancy of information.

**Behavioral Observation of Students in Schools (BOSS; Shapiro, 2004a).** This structured interview system was used to obtain weekly estimates of participants’ on-task (active and passive student engagement) and off-task behavior during math ISW as the class worked on assigned math fact worksheets provided by the investigator to each participant’s teacher. The BOSS is an observational system designed for grades Pre-K through 12 to efficiently monitor student behavior through the calculation of frequencies and percentages.

Research was not available to support convergent validity of the BOSS. Data demonstrated that PET and a composite consisting of the three off-task scores of the BOSS discriminated between students with ADHD experiencing academic problems from peers with typical development observed during math or reading instruction (DuPaul et al., 2004). Effect sizes reported for these variables ranged between -.53 and 1.25 (Volpe, DiPerna, Hintze, &
Shapiro, 2005). Treatment sensitivity of the BOSS was supported by research that examined the
efficacy of CAI for three children with ADHD (Ota & DuPaul, 2002). The BOSS categories of
AET with effect sizes between -2.91 and -13.01 and a composite of three off-task scores (effect
sizes between 1.8 and 3.06) were discovered to be sensitive to adaptations in instructional
modality (i.e., regular math instruction vs. computer assisted learning; Volpe et al.).
Interobserver agreement for the BOSS was well supported by a study involving repeated
measurement of three participants where total agreement ranged between 90 and 100% (Ota &
DuPaul). Interobserver agreement was further supported in a comparison study completed by
DuPaul et al. with kappas ranging from .93 to .98. in a sample of children with and without
ADHD (N=136).

*Academic Competence Evaluation Scales (ACES; DiPerna & Elliott, 2000).*

The Motivation and Study Skills enabler subscales from the *ACES–Teacher* form were
administered to participants pre- and post-intervention in the current study to examine whether
participants showed improvement in positive behaviors associated with academic motivation at
the completion of the study (DiPerna & Elliott; see Pre-Intervention Measures for psychometric
properties of the ACES). The Motivation and Study Skills subscales were chosen because items
from these subscales were closely related to components of academic motivation as defined in
the motivation literature, which earmarked positive, academic self-efficacy beliefs and the use of
self-regulated learning strategies as important components of academic motivation and
achievement (Zimmerman et al., 1992).

**Social Acceptability Measures**

*Children’s Intervention Rating Profile (CIRP; Witt & Elliott, 1985).* Treatment
acceptability of the multi-dimensional intervention for participants was assessed by
administering an adapted version of the Children’s Intervention Rating Profile (CIRP; Witt & Elliott; see Appendix G for a copy of the adapted CIRP). The original CIRP contained seven items and used a six-point Likert scale ranging from I agree to I do not agree for children to rate acceptability of an intervention they had received. Internal consistency of this scale ranged between .75 and .89 across a variety of studies. The CIRP was found to discriminate between interventions as seen in several studies utilizing fifth and sixth grade children as participants (Finn & Sladeczek, 2001). Elliott, Witt and Galvin (1983) demonstrated that the CIRP was comprised of one primary factor, which accounted for 79% of the variance. The remaining variance was associated with Item two of the CIRP, which loads on its own factor, teacher harshness (Witt & Elliott, 1985). Scores for each item on this scale are summed to derive a total treatment acceptability score. Items two, three and four require reverse scoring. Possible scores can range from seven to 35, with 35 indicating the highest level of acceptability.

**Intervention Rating Profile for Teachers (IRP-15, Witt, Elliott, & Martens, 1984).**

An adapted version of the IRP-15 (see Appendix H for a copy of the adapted IRP-15) was used to assess teacher acceptability of the study’s multi-dimensional intervention. The original IRP-15 was adapted from the Intervention Rating Profile for Teachers (IRP) and contains 15 statements that allow teachers to rate various aspects of intervention acceptability (e.g., sample item: I would suggest the use of this intervention to other teachers). Research demonstrated the IRP to be a reliable (i.e., Cronbach's alpha = .91) multifactor measure of acceptability (Witt et al., 1984). The IRP-15 is designed to measure general acceptability provided in a unitary measure of acceptability, which is the teacher’s total score on the IRP-15 (Witt et al.). A principal components factor analysis of the IRP-15 revealed one primary factor with item loadings ratings from .82 to .95. Reliability of the IRP-15 using Cronbach's alpha was .98 (Witt et al).
**Intervention Materials**

**Participant intervention package.** Intervention materials for participants were contained in an intervention package, which included separate CCC and motivation coaching packets stored in individual binders for each participant. CCC packets contained a Math Fact Record Sheet for recording each participant’s list of known and unknown math facts, CCC worksheets, CCC math fact probes, and AIMSweb math fact probes (see Appendix I, Intervention Manual, Procedures for CCC alone for copies of the Math Fact Record Sheet, CCC worksheet, and CCC math fact probe). Motivation coaching packets contained the *General Strategies for Strategy Action Plan* reference sheet, which lists strategies to increase academic self-efficacy and self-regulated learning and SAP forms used for developing participants’ strategy plans, contracting participant commitment to the plan, and for recording participant progress on goal attainment and implementation of selected learning strategies (see Appendix I, Intervention Manual, Procedures for CCC+MC for the General Strategies for Strategy Action Plan and a copy of the SAP form). Additional materials in the coaching packet included the *Goal/Strategies Index Card*, which listed participants’ math fact fluency goals and selected learning strategies and was kept in participants’ desks to prompt implementation of the strategies and for recording strategy use (see Appendix I, Intervention Manual, Procedures for CCC+MC for a copy of the Goal/Strategies Index Card and Appendix J for a hypothetical example of a coaching session demonstrating implementation of a SAP and Goal/Strategies Index Card). Progress monitoring graphs were provided to allow participants to record their scores on math fact probes, the Motivation Probe, and percentages of student engagement (see Appendix I, Intervention Manual, Procedures for CCC+MC for copies of progress monitoring graphs).
Other intervention materials. Researcher materials used for the study’s interventions consisted of a tape recorder and an audiotape with the verbal prompt, *Next*, repeated every 1.5 seconds to assess participants’ known and unknown math facts in their targeted math operation. A stop watch was available to time participants’ performance on math fact probes. A pre-recorded BOSS audio-tape with timed intervals and *Walkmans* were used by the researchers to record active and passive student engagement and off-task behaviors on BOSS Coding Sheets during classroom observations.

Procedures

Consent

Permission to conduct the current study was obtained in writing from the school district’s research office and from the principal of the elementary school selected for the study (see Appendix K for the school district and school permission forms). An Institutional Review Board (IRB) proposal was submitted to the Northeastern University’s (NEU) Division of Research Integrity to seek permission to conduct the current study with elementary school-age students. The study was initiated once the submitted IRB was accepted by NEU’s Division of Research Integrity (see Appendix K for a copy of the NEU IRB approval) and permission was granted by the assistant superintendent through the school district’s research office (see Appendix K for a copy of the school district approval letter). The investigator contacted the school principal, who referred the investigator to four, third-grade teachers, to seek recruits for the current study. Letters explaining the purpose and nature of the study were sent to the third-grade teachers requesting referrals for students exhibiting symptoms of ADHD and low math performance (see Appendix K for a copy of the teacher referral letter). Parents of referred students were contacted, received an explanation of the study, and were asked to provide written
consent to proceed with the screening process and to allow their child to participate if accepted into the study (see Appendix K for a copy of the parent permission letter). Accepted student participants were asked to sign a child assent form confirming their agreement to participate and informing them of their choice to stop participating at any time during the course of the study (see Appendix K for a copy of the child assent form).

**Screening**

**Screening criteria for participants.** Four, third-grade teachers were asked to refer male students who demonstrated features of ADHD-C and low math performance in their classrooms. To participate in the study, students were expected to meet the following criteria: (1) a T score ≥60 on the ADHD-C category of the ADHD SC4 teacher protocol using normative data based on the child’s age and gender with this qualifying score not mandatory for the parent protocol (ADHD-SC4; Gadow & Sprafkin, 1997); (2) student scores below the 30th percentile on grade-appropriate, AIMSweb M-CBM, math computation benchmark probes (Shinn, 2005); (3) placement in a regular or special education third grade; and (4) no plans to move from the school of attendance in the 2008-2009 and 2008-2010 academic years. Students participated in the study irrespective of whether they received medication for ADHD. The ADHD-SC4 required parents and teachers to rate the severity of DSM-IV symptoms of ADHD and ODD. The Symptom Severity score indicated the degree to which a referred student exhibited clinical symptoms. Each item was scored using a four-point Likert scale as follows: never = 0, sometimes = 1, often = 2, and very often = 3. The score for each symptom was totaled to generate a score for each disorder category (ADHD-I, ADHD-HI, ADHD-C, or ODD; Gadow & Sprafkin, 1997). Symptom Severity scores were considered when screening eligible participants for the current study. T scores ≥60 on the teacher checklist were used to determine whether prospective participants
screened positively for ADHD-C in the current study. A qualifying score on the parent checklist was not mandatory criteria for acceptance into the study. T scores ranging from 60-69 fell in the Moderate Severity range of the ADHD-SC4 classification system and T scores ≥ 60 on the ODD category and the PCS were used to screen students with high levels of oppositional and interpersonal aggression, respectively (Gadow & Sprafkin, 1997). For the AIMS-web, M-CBM Grades 3 probes, participants were given two minutes to complete as many problems as they can. M-CBM benchmark probes were scored by determining the total number of Digits Correct (DC). In the current study, the number of DCs for student referrals on the AIMSweb M-CBM benchmark probes was compared to the performance of grade-level peers using aggregate norms from the AIMSweb Growth Table for Mathematics Computation (AIMSweb, 2009). The Parent and Teacher Mathematic Assessment Questionnaires were used to interview the candidate’s parent(s) and teacher in a written format to obtain information about the student’s basic skills in mathematics.

Students meeting any of the following criteria were originally expected to be excluded from the study: (1) T scores ≥ 60 for the ODD category or on the PCS of the ADHD-SC4 on the teacher protocol with this criteria not mandatory on the parent protocol, (2) evidence of deficits in intellectual functioning, (3) significant visual or hearing impairments (4) a history of brain damage, or (5) a developmental disability.

**Participant screening assessment.** Screening measures assessed behavior and academic skills of students referred by their perspective teachers to determine eligibility for participation in the study. The investigator provided copies of the ADHD-SC-4 to the parent/guardians and teachers of referred students to assess their levels of inattention and hyperactivity/impulsivity. In addition, math questionnaires were provided to students’ parents and teachers to obtain
background information on the candidate’s math performance (see Appendix C for Parent and Teacher Math Questionnaires). The investigator administered a grade-appropriate, AIMSweb M-CBM benchmark probe to referred students to determine their eligibility for meeting the study’s low math performance criteria. The screening process was continued until four candidates meeting screening criteria were identified. Parents were informed whether their children met criteria to serve as participants in the current study, at which time written parent consent and student assent to participate as a subject were obtained (see Appendix K for copies of the parent consent letter and the child assent form). All of the referred students in the current study were accepted into the study. If there had been students who did not meet participant criteria, their parents would have been contacted, provided reasons why their child did not qualify as a candidate for this study, and thanked for their participation in the recruitment process. If there had been students who met criteria for ADHD but did not meet the study’s criteria for low math performance, their parents would have been provided input regarding their child’s risk status for ADHD. The results of the ADHD-SC4 would have been explained, and these parents would have been referred to their family practitioner for further evaluation.

**Screening assessment results.** Table 2 summarizes participants’ results on the ADHD-SC4 and AIMSweb M-CBM screening assessments. All participants’ parents and teachers completed the ADHD-SC4 with the exception of one teacher who neglected to fill out ratings for the ODD and PCS sections of the ADHD-SC4 for two participants. Most of the students, who were retained as participants for the study, met the full aforementioned criteria. The potential participant pool was significantly limited by the low numbers of teacher referrals for potential candidates and returned parent consents. Exceptions were made to accept two participants who did not meet full criteria and to eliminate the score criteria for ADHD-Combined Type on the
### Table 2

*Participants’ Results on the ADHD-SC4 and AIMSweb M-CBM Screening Measures*

<table>
<thead>
<tr>
<th>Assessments</th>
<th>Jon</th>
<th>Harry</th>
<th>Dick</th>
<th>Jim</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ADHD-SC4</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher Ratings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADHD/Inattentive</td>
<td>54</td>
<td>58</td>
<td>56</td>
<td>62</td>
</tr>
<tr>
<td>ADHD/Hyperactivity-Impulsive</td>
<td>72</td>
<td>66</td>
<td>62</td>
<td>54</td>
</tr>
<tr>
<td>ADHD/Combined</td>
<td>64</td>
<td>66</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Parent Ratings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADHD/Inattentive</td>
<td>&lt;50</td>
<td>78</td>
<td>54</td>
<td>74</td>
</tr>
<tr>
<td>ADHD/Hyperactivity-Impulsive</td>
<td>&lt;50</td>
<td>74</td>
<td>58</td>
<td>62</td>
</tr>
<tr>
<td>ADHD/Combined</td>
<td>&lt;50</td>
<td>76</td>
<td>56</td>
<td>68</td>
</tr>
<tr>
<td><strong>ADHD-SC4 ODD</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher</td>
<td>62</td>
<td>&gt;78</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Parent</td>
<td>&lt;50</td>
<td>&gt;78</td>
<td>56</td>
<td>60</td>
</tr>
<tr>
<td><strong>ADHD-SC4 PCS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher</td>
<td>58</td>
<td>78</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>---------</td>
<td>----</td>
<td>----</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Parent</td>
<td>&lt;50</td>
<td>66</td>
<td>58</td>
<td>50</td>
</tr>
</tbody>
</table>

**AIMSweb M-CBM Benchmark**

| <25th percentile | <25th percentile | 26th percentile | <10th percentile |

*Note: AIMSweb M-CBM Benchmark scores are percentiles.*

According to the results of the ADHD-SC4, all four participants obtained a T-score at least one standard deviation above the mean (60 or higher) suggesting they were rated within the Moderate range of symptom severity for ADHD-C and met study criteria. Results on parent ratings from the ADHD-SC4 were mixed. Two students (Harry and Jim) were rated as falling within the High range of symptom severity for ADHD-C (T-scores 76 and 69, respectively) while the two remaining participants, Jon and Dick, were rated in the Low range (T-scores <50 and 56, respectively). Thus, only two participants were rated as exhibiting ADHD-like behaviors across two environments. Regarding exclusionary criteria associated with the ODD and PCS scores from the ADHD-SC4, teacher scores were only available for two students as one teacher neglected to provide these ratings for the remaining two participants. One participant (Jon) was rated in the Moderate range for ODD symptom severity (T-score=62) by his teacher and the remaining participant (Dick) was rated by his teacher in the High range (T-score>78), resulting with both these participants as not meeting the study’s exclusionary cut-off criteria (T-score ≥ 60).
Three of the participants were rated by their parents as below the severity cut-off for ODD (Jon, <50; Jim, 56; and Dick, 56), while the same participant (Harry) who was rated with high severity for ODD symptoms by his teacher, was also rated in the High range by his mother (T-score >78). Three of the participants were rated by their parents as below the severity cut-off for PCS (Jon, T-score <50; Dick, T-score=56, and Jim, T-score=50) while Harry was rated in the Moderate severity range (T-score=66), suggesting difficulties with peer conflict (PCS) and non-compliance (ODD) as perceived by his mother and teacher.

All four participants met cut-off criteria in math computation as reflected in their low performance on the mix-skilled, AIMSweb M-CBM Benchmark probe, where they performed below the 30th percentile for their grade according to AIMweb math computation aggregate norms (see Table 2).

All four participants’ families remained living in the school’s catchment area. None of the participants demonstrated evidence of low cognitive ability, significant visual or hearing impairments, a history of brain damage, or a developmental disability. Overall, two of the participants met full criteria for the study (Dick and Jim), while the remaining two participants had higher scores than admissible on the ODD category and/or PCS scales of the ADHD-SC4 but met all other criteria (Jon and Harry).

**Parent and teacher math assessment questionnaires.** Parent math questionnaires were returned for all four participants. Teacher questionnaires were returned for three of the four participants. A review of the teacher and parent math questionnaires revealed that all participants were rated with some difficulties in math along with parent and teacher concerns regarding poor attention/concentration and difficulties completing assigned work on time. Two of the participants were rated at the mastery level for addition and subtraction math facts (Jon and
Harry) by their teachers. Dick was rated at the instructional level for addition facts and at the frustration level for subtraction facts. Information on Jim’s skill level in math facts was not available. Jon was rated at the mastery level in addition and subtraction with regrouping. Harry was rated at the mastery level in addition with regrouping and at the instructional level for subtraction with regrouping. Information regarding participants’ skill levels in math computation was not reported for Jim and Dick by their teacher. Results from the teacher questionnaire were not used to determine participants’ targeted math operations in the current study. Research has shown that teachers were inaccurate in coding mastery, instructional, or frustrational mathematic levels in most math operations (Eckert, Dunn, Codding, Begeny, & Kleinmann, 2006).

Assessment criteria and procedures used to determine participants’ performance levels (mastery, instructional, and frustrational) are described further in this chapter under Determining participants’ targeted math operation.

**Pre-Intervention Assessment Battery**

Once participants were identified, each participant received a pre-intervention assessment battery administered by the investigator. Pre-intervention assessment results were used to further describe participants’ math performance and motivation. The Math Composite subtests (Calculations and Applied Problems) and Math Fluency subtest of the WJ-III ACH were administered to establish achievement levels in math prior to implementation of baseline and intervention conditions and to obtain a description of participants’ math skills. Selected Academic Skills subscales (Mathematics on the ACES--Teacher form and Mathematic Skills on the ACES--Student form) and Academic Enablers subscales (Motivation and Study Skills on the ACES--Teacher and ACES--Student forms) were administered to participants to assess student and teacher perceptions of math competencies, student motivation, and study skills as part of the
pre-intervention battery. The ACES--Teacher form asked teachers to provide two ratings for each item on the scale. The first rating used a five-point Likert scale for teachers to rate proficiency or frequency of academic skills or behaviors described in the item. Proficiency ratings were used for the Academic Skills scale items and are as follows: far below=1, below=2, grade level=3, above=4, and far above=5. Teachers used a five-point Likert scale to rate frequency of the occurrence of skills and behaviors on the Academic Enablers scale. Frequency ratings were as follows: never=1, seldom=2, sometimes=3, often=4, and almost always=5. Additionally, teachers were asked to provide importance ratings using a three-point scale (not important=1, important=2, and critical=3) for each item on the Academic Skills and Academic Enablers scales to provide information on which skills and behaviors were most crucial to target for intervention for a particular student.

The ACES--Student form uses Frequency ratings for both the Academic Skills and Academic Enablers scales. Importance ratings are not included. The same five-point Likert scale for Frequency ratings on the ACES--Teacher form are used on the ACES--Student form (1=never to 5=almost always; DiPerna & Elliott, 2000). Participants’ raw scores with 90% confidence intervals resulting from teacher ratings on the subscales of the Academic Skills scale and Academic Enablers scale were used to determine each participant’s overall level of competence for academic skills and enabling behaviors (DiPerna & Elliott, 2000). Participants’ functioning was classified according to competency ranges based on raw-score confidence intervals: Developing, Competent, or Advanced. Developing denoted that a person’s performance is below grade-level expectations/frequency and would benefit from intervention (e.g., a raw score of 22.75 with Confidence Intervals: 19.25-25.25 fell in the Developing range). Competent indicates grade-level or slightly above grade-level expectations/frequency in the skill domain. Advanced
indicates performance well-above grade-expectancy/frequency and represented a strength (DiPerna & Elliott). To determine how a participant’s ratings compared to ratings for same-grade students, raw scores were converted into deciles (i.e., percentile ranks divided into ten categories, i.e., a student in the 2nd decile scored as well as or better than 10-20% of students in the appropriate grade cluster from the standardized sample; DiPerna & Elliott). Deciles range from one to 10 with higher scores indicating higher functioning. Raw scores obtained from participant ratings on the student-completed Academic Skills scale and Academic Enablers scales were used to explore the student’s perception of his competence for academic skills and enabling behaviors.

Teacher and student responses on the ACES also provided input for the development of each participant’s individualized motivation coaching protocol. The ACES--Teacher form was re-administered post-intervention to examine participants’ growth in motivation and math according to their teachers’ perceptions of changes in motivation behaviors and math performance in class that could be broadly associated with effects from the study’s interventions. A discussion of the post-intervention results on the ACES--Teacher form is provided in the Result and Discussion sections of this study.

For purposes of the current study, the Self-Efficacy for Academic Achievement (AEE) and the Self-Efficacy for Self-Regulated Learning (SRL) subscales of the MSPSE (Bandura, 1989a; see Appendix D for copies of the AEE and SRL) were used to assess pre-intervention levels of participants’ self-efficacy beliefs regarding their academic performance and use of self-regulated learning strategies. Additionally, participants’ responses on the MSPSE provided input for individual motivation coaching protocols. Items and areas rated as weaknesses by the participants on the motivation and self-efficacy measures influenced the development of participants’ individualized coaching protocols.
Single-skill math computation probes designed using the Curriculum-Based Assessment Math Computation Probe Generator provided at the Interventionalcentral.com website were used to designate a math operation at the instructional or frustration level for each participant in order to identify which math facts to target during intervention conditions. Single-skill math computation probes used in the current study contained 20 computation problems created for each math operation (i.e., addition without regrouping, addition with regrouping, subtraction without regrouping, subtraction with regrouping, multiplication, and division).

**Pre-Intervention Assessment Results**

**Participant results on the WJ-III ACH math subtests.** Table 3 summarizes participants’ results on math subtests from the WJ-III ACH. The group as a whole performed within the Average range for their age in overall math achievement as reflected in the group’s mean composite score in Broad Math ($M=96.5, SD=7.63$, range, 88-106). The Broad Math composite is based on scores from the Calculation and Applied Problems subtests of the W-J III ACH. The mean group performance on the Calculation subtest fell within the Average range ($M=93.50, SD=5.06$, range, 87-98). The mean group performance on the Applied Problems subtest also fell within the Average range ($M=98.75, SD=9.81$, range, 87-111). Participants were administered a supplemental subtest in math fluency from the W-J III, which revealed an overall group mean (Fluency: $M=97.25, SD=12.57$) within the Average range but with noticeable variability in participant performance ranging from below average to high average (SS range: 82 to 112).

Participants ranged from demonstrating a consistent performance profile across math calculation, word problems, and math fact fluency to displaying discrepant strengths and weaknesses. For example, Harry performed within the Average range in math calculation (SS:
Table 3

*Participants’ Pre-Intervention Results on Math Achievement Subtests from the WJ-III ACH*

<table>
<thead>
<tr>
<th>Assessments</th>
<th>Jon</th>
<th>Harry</th>
<th>Dick</th>
<th>Jim</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodcock-Johnson III</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calculation</td>
<td>97</td>
<td>92</td>
<td>98</td>
<td>87</td>
</tr>
<tr>
<td>Applied Problems</td>
<td>111</td>
<td>98</td>
<td>99</td>
<td>87</td>
</tr>
<tr>
<td>Fluency</td>
<td>112</td>
<td>82</td>
<td>101</td>
<td>94</td>
</tr>
<tr>
<td>Broad Math</td>
<td>106</td>
<td>94</td>
<td>99</td>
<td>88</td>
</tr>
</tbody>
</table>

*Note: Scores are standard scores.*

92, 30th percentile, Confidence Interval: 88-97) and solving word problems (SS: 98, 45th percentile, CI: 95-102) accompanied with a noticeably weaker, below-average performance in math fact fluency (SS: 82, 12th percentile, CI: 79-86). Jon’s results revealed high-average performance in solving math problems (Applied Problems, SS: 111, 76th percentile, CI: 106-115) and in math fact fluency (Fluency, SS: 112, 79th percentile, CI: 109-115). In contrast, his performance on the Calculation subtest was slightly lower and within the Average range (SS: 97, 41st percentile, CI: 92-101). Dick and Jim’s math skills were relatively similar across math demands. Dick performed consistently within the Average range across all math areas (Calculation, SS: 98, 46th percentile, CI: 94-101; Applied Problems, SS: 99, 47th percentile, CI: 95-103; and Fluency, SS: 101, 52nd percentile, CI: 98-103). Jim performed below average to low
average across math demands (Calculation, SS: 87, 20\textsuperscript{th} percentile, \textit{CI}: 82-92; Applied Problems, SS: 87, 19\textsuperscript{th} percentile, \textit{CI}: 83-91; and Fluency, SS: 94, 34\textsuperscript{th} percentile, \textit{CI}: 90-97). Three out of the four participants tested within age expectations in math fact fluency on standardized testing. Harry is the only participant who performed low in math fact fluency on the WJ-III ACH.

**Participant results on the ACES subscales.** When participants’ teachers were asked to rate items on selected subscales from the \textit{ACES--Teacher} form, the group, mean raw-score performance on the Math subscale entailed confidence intervals which extended from mainly falling in the Developing range crossing slightly into the Competent range (Mean Raw Score: 23.75, \textit{SD}=2.21, \textit{CI}: 20.75-26.75). The group mean performance on the Motivation subscale also fell mainly in the Developing range barely crossing into the Competent range (Mean Raw Score: 29.25, \textit{SD}=1.25, \textit{CI}: 26.25-32.25). Group performance on the Study Skills subscale (Mean Raw Score: 22.75, \textit{SD}=3.20, \textit{CI}: 19.25-25.25) fell in the Developing range. Table 4 summarizes participants’ individual decile scores and competency ranges for the \textit{ACES--Teacher} and \textit{ACES--Student} forms. All four participants were rated in the Developing range on subscales examining student performance in math and study skills on the ACES—Teacher form. Three participants obtained scores at the 2\textsuperscript{nd} decile and one at the 1\textsuperscript{st} decile in study skills. Two participants obtained scores at the 1\textsuperscript{st} decile in math, one at the 2\textsuperscript{nd} decile, and one at the 3\textsuperscript{rd} decile. Three out four participants’ raw scores on the Motivation subscale fell in the Developing range with three participants’ obtaining scores at the 2\textsuperscript{nd} decile and one at the 1\textsuperscript{st} decile.

When participants were asked to rate items on selected subscales from the \textit{ACES--Student} form, the mean group performance on the Math subscale fell solidly in the Competent range (Mean Raw Score: 27.25, \textit{SD}=4.34, \textit{CI}: 24.25-30.25). The mean group performance on the Motivation subscale (Mean Raw Score: 27.25, \textit{SD}=4.34, \textit{CI}: 24.25-30.25) fell in the Competent
Table 4

*Participants’ Pre-intervention Results on Selected ACES Subscales*

<table>
<thead>
<tr>
<th>Assessments</th>
<th>Jon</th>
<th>Harry</th>
<th>Dick</th>
<th>Jim</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teacher Form/Subscale</strong></td>
<td>Range/Decile</td>
<td>Range/Decile</td>
<td>Range/Decile</td>
<td>Range/Decile</td>
</tr>
<tr>
<td>Motivation</td>
<td>Developing/2</td>
<td>Developing/1</td>
<td>Competent/2</td>
<td>Developing/2</td>
</tr>
<tr>
<td>Study Skills</td>
<td>Developing/2</td>
<td>Developing/2</td>
<td>Developing/2</td>
<td>Developing/1</td>
</tr>
<tr>
<td>Math</td>
<td>Developing/1</td>
<td>Developing/3</td>
<td>Developing/1</td>
<td>Developing/2</td>
</tr>
<tr>
<td><strong>Self-Report Form/Subscale</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motivation</td>
<td>Competent/7</td>
<td>Developing/2</td>
<td>Competent/5</td>
<td>Competent/3</td>
</tr>
<tr>
<td>Study Skills</td>
<td>Competent/7</td>
<td>Developing/5</td>
<td>Competent/6</td>
<td>Competent/4</td>
</tr>
<tr>
<td>Math</td>
<td>Competent/8</td>
<td>Developing/5</td>
<td>Competent/5-6</td>
<td>Competent/8</td>
</tr>
</tbody>
</table>

*Note:* Competence levels are based on confidence intervals determined from participants’ raw scores. A decile is a percentile rank that has been divided into ten categories (e.g., a student in the 2nd decile scored as well or better than 10% to 20% of students in the appropriate grade cluster from the standardized sample.

Three out of four participants rated themselves in the Competent range on subscales examining student performance in math, motivation, and study skills with one participant rating himself in the Developing range in all areas. Decile scores ranged from five to eight for math, two to seven for motivation, and four to seven in study skills.
Participant results on the MSPSE. The Self-Efficacy for AEE and the Self-Efficacy for SRL subscales from the MSPSE were used to assess participants’ perceived levels of student self-efficacy in academic achievement and the use of self-regulated learning strategies. Participants’ total raw scores on the AEE and SRL are summarized in Table 5. Raw scores on the AEE and SRL can range from 0 to 63. The average group performance calculated from participants’ raw scores on the AEE ($M=49.25$, $SD=11.50$, range, 36-63) and SRL ($M=50.50$, $SD=10.11$, range, 39-63) indicated that participants’ self-efficacy scores for academic learning (i.e., math, reading, science, etc.) and for use of self-regulated learning strategies were relatively similar. Converting mean raw scores on the AEE and SRL scales into percentages revealed that participants as a group rated their self-efficacy both in academic learning and use of self-regulated learning strategies at a moderately high level as reflected in group mean percentages of 77% for AEE and 79% for SRL.

Table 5

*Participants’ Pre-Intervention Results on Selected Scales of the MSPSE*

<table>
<thead>
<tr>
<th>MSPSE Scales</th>
<th>Jon</th>
<th>Harry</th>
<th>Dick</th>
<th>Jim</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEE</td>
<td>63</td>
<td>45</td>
<td>36</td>
<td>53</td>
</tr>
<tr>
<td>SRL</td>
<td>63</td>
<td>39</td>
<td>47</td>
<td>53</td>
</tr>
</tbody>
</table>

*Note:* Scores are total raw scores. Maximum raw score=63.

Independent and Dependent Variables

Student participants were assessed under varied experimental conditions starting with
baseline conditions where intervention was withheld while math fact and motivation probes and classroom observations assessing student engagement were implemented to determine participant performance on dependent measures before intervention. Progress in math fact fluency was assessed through the administration of grade-appropriate math fact probes provided through AIMSweb. During every participant session across experimental conditions, a math fact probe consisting of 42 randomly assigned, fact problems was administered to participants to be completed within a two-minute limit. Changes in motivation were explored through repeated administration of a self-rating, motivation probe developed for this study. Weekly total scores were graphed for each participant to track personal progress in motivation levels as part of the motivation coaching protocol for the multi-dimensional intervention.

Frequency of student engagement in the classroom was obtained through repeated momentary-time sample observations of on-task behavior during math ISW using the Behavioral Observation of Students in School (BOSS). Percentages of a student’s time during observations were identified as academically on- or off-task. The BOSS provided a momentary-time-sample observation sheet (see Appendix F for the Boss coding sheet) to record active engagement time-AET (i.e., writing, reading aloud, raising a hand, talking to the teacher or peer about assigned material, or researching information) and passive engagement time-PET (i.e., listening to a lecture, looking at a worksheet, silently reading, looking at the blackboard, or listening to a peer respond to a question) at the beginning of 15-second time intervals. Off-task behaviors were recorded using a partial interval method during the remainder of each interval. Off-task behaviors include off-task motor (OFT-M, e.g., leaving seat to get a drink of water), off-task verbal (OFT-V, e.g., talking with another student about nonacademic issues), and off-task passive (OFT-P, e.g., staring out the window). The BOSS coding sheet was used in the current
study to record participants’ incidents of active and passive engagement during math ISW during classroom observations. Student engagement scores were derived from the percentage of total time each participant remained either actively or passively on-task during the classroom observation. Total engagement scores (active plus passive percentage scores) were reported and graphed to monitor each participant’s on-task behavior during math ISW over the course of the study. Off-task behaviors were recorded but did not serve as a dependent variable in this study, and as such, were not graphed as part of participants’ progress monitoring in student engagement.

A coding audiotape, lasting 15 minutes in duration and containing intervals of 15 seconds, was used to allow observers to code on- and off-task behaviors. The observer was cued to observe the targeted student at the onset of four separate intervals, at which time the observer coded the student’s observed behavior as falling into one of the five categories (i.e., AET, PET, OFT-M, OFT-V, or OFT-P) on the BOSS coding sheet. Every fifth interval, observations were conducted on a randomly selected peer rather than the targeted student to obtain peer and target student comparisons for each of the behavioral categories. Participants’ total time engaged or disengaged during the observation was represented by percentages of time observed in each of the five behavioral categories. Teacher-directed Instruction (TDI) was coded every fifth interval, which estimated the percentage of time the teacher was involved in direct instruction, as distinguished from sitting at his/her desk or correcting papers (Shapiro, 2004b). The research assistants and investigator were trained to administer the BOSS during five hours of training, or until they demonstrated competency by successfully observing and coding on-task and off-task behavior of a taped classroom vignette with 90% accuracy.
Two separate intervention phases served as independent variables to help determine whether adding motivation coaching to an academic intervention (CCC+MC) had a larger effect on increasing participants’ performance on the dependent variables (i.e., math fact fluency, motivation, and positive student engagement during math ISW) compared to the academic intervention without motivation coaching (CCC alone).

**Research Design**

Single-subject methodology was used to evaluate the effects of the proposed multi-dimensional intervention. A MBA across four participants was used to measure and compare participants’ performance in math fact fluency, self-rated motivation, and student engagement during baseline conditions and the two separate intervention conditions (CCC alone and CCC+MC).

Originally, the study’s two treatment interventions (CCC alone and CCC+MC) were implemented in two different sequences to distinguish the effects of these two interventions on participant performance. Thus, an attempt was made to address the carry-over effects of CCC alone on CCC+MC (Kazdin, 1982). Four participants were divided into yoked pairs with each pair slated to receive one of two alternative sequences of the intervention conditions (i.e., Baseline, CCC alone, followed by CCC+MC or Baseline, CCC+MC, followed by CCC alone). The study’s four original participants began under baseline conditions with the administration of math fact fluency probes and the Motivation Probe along with classroom observations during math ISW. Initial results from the yoked pair who had received the reverse-order sequence design (CCC+MC, then CCC alone) revealed that the positive effects from motivation coaching continued during the CCC alone phase, rather than the expected decrease in performance on dependent measures. Inconclusive data resulted from the reverse-order sequence design and were
dropped from the study. Two replacement participants were recruited and were administered the CCC alone, then CCC+MC sequence and each of their results were yoked with one of the remaining participants to complete concurrent MBDs.

In the current study, baseline conditions were implemented and remained in effect until stable responding or decreasing trends in the performance on dependent measures occurred before introducing the CCC alone condition to participants. Similar practices were implemented for the CCC alone condition before introducing the CCC+MC condition to participants. Experimental control is accomplished through the staggered introduction of the independent variable at different points in time, as in the use of a multiple-baseline design (Horner et al., 2005). The following staggered introduction of the independent variables in the current study was implemented for participants in both yoked pairs. Once a stable or downward trend for baseline was established for the first participant of each yoked pair, the CCC alone condition was introduced to him while baseline conditions remained in effect for the second participant. When a stable intervention response was noticed for the CCC alone condition for the first participant, the CCC alone condition was introduced to the second participant and the CCC+MC condition was initiated for the first participant. The second participant started CCC+MC after a stabilized trend was established for the first participant. Further experimental control was promoted by randomly selecting math fact items for the study’s separate intervention conditions.

Experimental effects characterized by positive changes in math fact fluency and motivation during CCC alone were predicted. Stronger experimental effects in math fact fluency, motivation levels, and student engagement during math ISW were predicted with the implementation of CCC+MC following the termination of CCC alone.
Experimental Conditions

**Baseline condition.** Participants were administered AIMSweb math fact probes and the Motivation Probe without intervention. Two participants were additionally observed in the classroom to assess on-task behaviors during math ISW. Assessments continued for each participant until the participant demonstrated stabilized baseline behavior or a downward trend on dependent measures. At the end of each baseline session, participants were thanked for being cooperative and completing the work asked of him.

**Intervention condition I: CCC alone.** After baseline, participants received the CCC alone condition, which was implemented by the investigator during 15-minute, individual sessions three times a week. During CCC alone, participants were directed to practice unknown, single-digit operational facts using CCC (Skinner et al., 1997; see CCC procedure in this document, p. 106) with no added interventions. Usual and customary recognition and praise from the investigator were provided when participants exhibited effort and accuracy in performance.

**Determining participants’ targeted math operation.** In order to determine unknown operational facts for participants to practice during intervention sessions implementing CCC, it was first necessary to identify a math operation to target. Single-skill math computation probes from Informationcentral.com were administered in the four operations (i.e., addition, subtraction, multiplication, and division) at various degrees of difficulty (i.e., addition without regrouping, addition with regrouping, subtraction without regrouping, subtraction with regrouping, etc.) to each participant. As recommended by Shapiro (2004a), addition and subtraction probes were given two minutes and multiplication and division probes were given five minutes. Criteria specified by Deno and Mirkin (1977) were used to determine when participants were considered performing at the mastery level for third grade in a mathematical operation (i.e., ≥20 DCPM and
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≤ 2 DIPM), the instructional level (i.e., 10-19 DCPM and 3-7 DIPM) or the frustration level (i.e., 0-9 DCPM and > 8 DIPM). A math operation identified to be at the instructional level was recommended for determining targeted math facts for student instruction (Shapiro). Table 6 summarizes participants’ targeted math operation and level of competency. None of the participants tested at an instructional level for a math operation. Codding et al. (2007) provided evidence suggesting that students benefited more after receiving the CCC intervention when the math operation targeted was initially assessed in the frustration level of fluency rather than the instructional level. Thus, in the current study, math operations testing at the frustration level were targeted and used to identify unknown math facts for participants to use when implementing the CCC intervention. When more than one math operation with an accompanying degree of difficulty fell in the frustration range for a participant, the target operation was chosen according to an expected, hierarchical range of acquired math skills (i.e., addition should be

Table 6

<table>
<thead>
<tr>
<th>Participant</th>
<th>Targeted math operation</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jon</td>
<td>Subtraction with regrouping</td>
<td>Frustration</td>
</tr>
<tr>
<td>Harry</td>
<td>Subtraction without regrouping</td>
<td>Frustration</td>
</tr>
<tr>
<td>Dick</td>
<td>Addition with regrouping</td>
<td>Frustration</td>
</tr>
<tr>
<td>Jim</td>
<td>Subtraction without regrouping</td>
<td>Frustration</td>
</tr>
</tbody>
</table>
mastered before subtraction, subtraction with regrouping before multiplication, etc.; Shapiro, 2004a).

Determining participants’ unknown and known math facts. A test-teach-test format was used in the current study to determine which math facts were known or unknown for each participant (test), to teach unknown math facts using the CCC method (teach), and then to assess which math facts had been mastered (test; Poncy, Skinner, & O’Mara, 2006). Unknown facts were determined on an ongoing basis during treatment sessions for CCC alone and CCC+MC. The tap-a-problem procedure, which involves the use of a metronome and was promoted by Poncy et al. was adapted for the current study. Rather than using a metronome as proposed by Poncy et al., an audiotape was used in the current study, which provided the voice prompt Next to cue participants to attempt a math fact problem every 1.5 seconds until the last problem in the last row was attempted on the math fact probe. Participants were administered a probe containing 20 math facts randomly picked from the 100 single math facts of their respective, targeted math operation. When the prompt Next was heard, participants knew to move onto the next problem and to leave the answer blank if they could not provide an answer within the time limit. Math facts where participants were unable to provide an accurate answer within the 1.5-second time limit were designated as unknown and not considered fluent. Known facts were identified by the participant providing the correct answer within 1.5 seconds on the math fact probe. In addition to identifying unknown math facts, the tap-a-problem procedure discouraged the use of counting strategies (i.e., using fingers, counting up or down, or mental calculating), thus encouraging the development of automatic responding (Poncy et al.). Each participant’s known and unknown math facts were listed on the Math Fact Record Sheet in the appropriate columns labeled Known
**Facts or Unknown Facts** (see Appendix I, Intervention Manual for procedures for CCC alone, Math Fact Record Sheet).

**CCC procedure.** Using the procedures outlined by Skinner et al. (1997), each participant received a packet with a CCC worksheet designed with five problems presented with correct answers on the left side of the paper. Space was provided next to each problem for the participant to write the problem with an answer while covering over the original problem, and then proceeding with a comparison between the written response and original prompt (see Appendix I, Intervention Manual, CCC Procedures for CCC worksheet). The CCC procedure included five steps: a) the participant was asked to look at a math fact with the answer on the left side of the paper, b) cover the problem with an index card, c) write the problem and answer on the same sheet of paper next to the covered problem, d) uncover the problem with the answer, and e) compare answers (Codding et al., 2006; Skinner et al.). If the response was incorrect, the participant repeated the CCC procedure until he responded correctly before moving onto the next math problem (Skinner et al.).

In the current study, CCC worksheets were created for each participant listing their targeted, single-digit operational facts. Five math facts were chosen from a participant’s set of unknown math facts and inserted into the study’s CCC worksheet to be practiced and learned using the CCC method during a treatment session. Students were asked to use the CCC method to practice designated unknown facts for five minutes (Codding et al. 2006). In the current study, an additional component was added to the traditional CCC procedure, which provided some performance feedback. Following the CCC practice period, the participants were administered an individually-designed, math fact probe consisting of 20 single-digit math facts, which included the five chosen, unknown math facts interspersed with known facts (see Appendix I,
CCC procedures, CCC Math Fact Probe-\textit{Popper Test}). This CCC math fact probe was administered using standard procedures (Shinn, 1989) with the tap-a-problem audiotape to determine if the unknown facts practiced using CCC had become known. In the current study, when an unknown math fact practiced during CCC became known it was labeled a \textit{popper} indicating that fact was now automatic and \textit{popped out} rather than requiring the use of finger counting or mental strategies. Thus, this CCC math fact probe became known as the \textit{Popper Test}.

The results from the popper test were recorded on the participant’s Math Fact Record Sheet (see Appendix I for a copy of the Math Fact Record Sheet). Participants watched as the investigator transferred unknown math facts that became known from the \textit{Unknown} column on the Math Fact Record Sheet to the \textit{Known} column with the date the fact became known. Math facts practiced using CCC, which remained unknown on the popper test, were repeated in the subsequent CCC session and inserted into the CCC Worksheet along with additional facts from the participant’s set of unknown math facts. Subsequent to the popper test, a single-skill math fact probe from AIMSweb was administered to the participant within a two-minute time frame. Scores were determined by summing DCPM to allow the participant to see how he performed. The investigator recorded these scores to monitor how the participant performed in math fact fluency. Participants did not graph their results nor self-monitor their performance in math fact fluency during this condition.

\textbf{Intervention condition 2: The multi-dimensional intervention.} The study’s multi-dimensional intervention (CCC+MC) was implemented with participants subsequent to the CCC alone condition by the investigator three times a week during 30-minute, individual sessions. The procedures for CCC were continued with the addition of initiating each participant’s individualized motivation coaching protocol (CCC+MC). Motivation coaching focused on
participants: (a) learning and implementing self-regulated learning strategies; (b) setting and attaining goals; (c) self-monitoring by graphing their progress on M-CBM fact probes, the Motivation Probe, and percentages of total student engagement from the BOSS observations; (d) developing positive self-talk; (e) linking personal progress with effort and use of self-regulated learning strategies; and (f) recognizing increases in positive self-efficacy beliefs (see Appendix I for Intervention Manual, Motivation Coaching Protocol). Goal setting in the current study was based on participants’ performance on the AIMSweb CBM math fact fluency probes. Research validates the use of CBM as an effective intervention for increasing student achievement (Shinn, 2008). CBM involves progress monitoring and is an evidence-based measure inherently sensitive to assess improvement in achievement in four to 10 weeks allowing educators to identify whether an intervention is working for a particular student (Shinn). To ensure meaningful intervention for each participant, motivation-coaching protocols were modified according to participants’ personal responses on pre-intervention motivation measures and feedback from ongoing administration of the Motivation Probe.

**SAP.** As part of the motivation coaching protocol, participants were asked to develop a SAP (see Appendix I for a copy of the SAP form) once a week during the multi-dimensional intervention phase. The SAP consisted of setting an attainable goal for DCPM on math fact fluency probes, selecting one or two self-regulated learning strategies to implement as part of a developed plan to enhance performance on the math fact probes, and rating participant follow-through on the implementation of the selected learning strategies. The Goal Strategy Index Card (see Appendix I for a copy of a Goal Strategy Index Card) was to be kept in the participant’s classroom desk for him to record when he implemented one of the selected, learning strategies in the classroom. The participant was expected to bring the Goal Strategy Index Card to each
treatment session for progress monitoring (see Appendix J for a hypothetical example of a motivational coaching session). The Goal Strategy Index Cards were not utilized as intended as none of the participants brought them to class, kept track of strategy implementation, nor remembered to bring them back to show the investigator during treatment sessions. Thus, the Goal Strategy Index Cards were discontinued, which prevented participants from rating and monitoring implementation of their selected learning strategies. As a replacement, the investigator kept a record of whether the participants accomplished their designated DCPM goals in math fact fluency, what type of self-regulated learning strategies were selected by each participant, and how often the investigator observed or had physical evidence (e.g., extra CCC work completed at home and returned to the investigator) that indicated a self-regulated learning strategy was implemented by the participant inside or outside of treatment sessions.

Progress monitoring of participants’ individual scores on the math fact probes and the Motivation Probe and in student engagement provided data to assess the effectiveness of adding motivation coaching to an academic intervention in comparison to baseline and CCC alone conditions. AIMSweb math fact probes in the participant’s targeted math operation were administered by the investigator during each intervention session for both intervention conditions. The Motivation Probe and classroom observations were implemented once a week. For the classroom observation, two of the four participants were systematically observed during math ISW when their teachers were asked to administer an assigned math fact worksheet. Results from math fact and motivation probes administered during intervention sessions and systematic observations (see Appendix I for copies of participant progress monitoring graphs) were graphed by participants during the multi-dimensional intervention to provide self-monitoring as part of the motivation coaching protocol.
Parent Feedback at the Conclusion of the Study

The investigator met with participants’ parent(s) when intervention conditions terminated to provide feedback on the performance and progress of their children over the course of the study. Parents were offered the option of having their child’s study results communicated to their perspective teachers by signing a permission section located on the original, parent permission form allowing students to participate in the study (see Appendix K, Parent Permission). The parents of all four participants granted permission and participants’ results were communicated to participants’ teachers.

Data Analysis

Data from the study’s dependent measures were visually analyzed to decide whether there was a significant change in the data between baseline, the CCC alone, and CCC+MC experimental conditions. Visual inspection is regarded as an effective method to determine whether an intervention has produced a reliable change because of marked and stringent criteria, thus allowing only clear and robust interventions to be interpreted as producing a causal relationship between independent and dependent variables (Kazdin, 1982). The magnitude of change across experimental conditions and the rate of these changes were analyzed. Magnitude of change was assessed by looking at median rate of performance and level change for each participant during baseline, CCC alone and CCC+MC conditions. Rate of change was examined by trend and latency analyses of the change (Kazdin).

The level, trend, and variability of performance occurring during baseline and the two separate intervention phases of the current study were interpreted (Horner, Carr, Halle, McGee, Odom, & Wolery, 2005). The level was interpreted by comparing the median performances of each participant occurring during baseline and the two separate intervention conditions (Horner
et al.). The trend was analyzed by inspecting the rate of increase or decrease of the best-fit straight line for each of the dependent variables (i.e., math fact scores, motivation probe scores, and student engagement percentages) across experimental conditions for each participant (i.e., slope; Horner et al.). Variability was evaluated by interpreting the degree to which a participant’s performance fluctuated around a slope during an intervention condition (Horner et al.). Visual analysis also involved the immediacy of effects following the onset or withdrawal of an intervention condition, the magnitude of changes in the dependent variables, and the consistency of data patterns across subjects (Horner et al.).

The magnitude of the trend was estimated as high, medium, or low denoting a rapidly increasing or decreasing pattern or a gradually increasing or decreasing pattern in the data (Kennedy, 2005). While examining patterns of relative difference when the CCC alone condition was implemented first followed by the CCC+MC condition across participants, an increased difference in level and trend from CCC alone to CCC+MC was expected. When the order of the intervention conditions was alternated with CCC+MC (Condition 2) introduced after Baseline and before the onset of CCC alone (Condition 1), a flattening and a decrease in trend were expected. This did not happen as anticipated, rather participants involved in the reverse-order sequence continued to improve, thus demonstrating a carry-over effect from CCC+MC to CCC alone. Clear distinctions between the effects of CCC alone versus CCC+MC were not demonstrated under the reverse-order sequence condition, which resulted in the elimination of data from the participants who had received the reverse-order sequence of intervention conditions.

To supplement visual inspection, the percentage of overlapping data (PND) was used to measure the reliability of the amount of change in behavior as evidenced in the dependent
variables between experimental phases. The PND was adopted because it directly relates to
graph visual analysis, provides an objective measure of intervention strength, and can be
easily and efficiently calculated (Parker and Hagan-Burke, 2007). PNDs for data results
between baseline and CCC alone and then between CCC alone and CCC+MC were
calculated for each participant by identifying the highest datapoint in the baseline data (Phase
A) and calculating the percentage of datapoints in CCC alone (Phase B) that exceeded it
(Scruggs, Mastropieri, & Casto, 1987). Likewise, the highest datapoint in the CCC alone data
(Phase B) was identified and the percentage of datapoints in CCC+MC (Phase C) that
exceeded it was calculated. PND scores (0%-100%) were interpreted using conventions
proposed by Scruggs, Mastropieri, Cook, and Escobar (1986) according to the following
guidelines: PND > 90% was considered highly effective; PND >70% was effective;
50<PND<70% was questionable effectiveness; and PND < 50% was considered unreliable or
ineffective treatment results.

**Interobserver Agreement**

The investigator and a research assistant completed the classroom observations to check
for interobserver agreement (IOA) when assessing on-task engagement during math ISW. Active
and passive engagement behaviors were coded using the BOSS. Observation data for two of the
participants (Jon and Harry) were used in the current study, which included a total of 18
observations, nine for each participant. Two reliability checks were conducted for Jon’s
classroom observations, which resulted in the percentage of observations for IOA to be 11.1%.
One IOA was conducted during the CCC alone condition and one during the CCC+MC
condition. Coefficient kappa was calculated to determine whether the level of IOA was beyond
chance level. Kappa is expressed as:
where Po equals the agreement on occurrences and non-occurrences divided by the total number of agreements and disagreements, and Pc equals the proportion of expected agreements on the basis of chance (determined by multiplying the number of occurrences for Observer 1 times the number of occurrences for Observer 2 plus the number of non-occurrences for Observer 1 times the number of non-occurrences for Observer 2 and dividing this sum by the total number of intervals squared). Kappa values range from +1.00 to -1.00 with observer agreement beyond chance levels indicated by high positive kappas and high negative kappas indicating observer agreement much lower than expected by chance. Kappa is a conservative measure with values ≤ 0 considered poor, .01 to .20, slight, .21 to .40, moderate, .41 to .60, substantial, and .80 to 1.0, as almost perfect (Landis & Koch, 1977). Suen and Ary (1989) defined kappa as the least controversial of the available IOA indices, as most applicable to different types of observation data, and as the IOA index of choice. In the current study, kappa calculated for the IOA observation during CCC alone indicated that agreement between the two observers was assessed as moderate (k=.34). Kappa was moderate (k=.28) for the IOA observation during CCC+MC indicating similar IOA agreements for both intervention conditions. Total agreement was calculated by dividing the sum of the agreed-upon instances of occurrence and nonoccurrence for the behavior in question by the total number of intervals. Total agreement is typically represented by the mean level of agreement and range of the reliability checks. IOA is regarded as acceptable when kappa coefficients meet or surpass 80% (Kazdin, 1982). In the current study, total agreement was slightly lower that what is typically considered acceptable reliability (M= 75%, SD=.12; range: 69% to 81%).
Treatment Acceptability

Treatment acceptability for CCC+MC was measured by administering separate, adapted social validity questionnaires to the student participants (CIRP; Witt & Elliott, 1985) and to their teachers (IRP-15; Witt, Elliott, & Martens, 1984) at the end of multi-dimensional intervention phase. Acceptability ratings by teachers and participants indicated that the intervention was acceptable to both. A graduate student in school psychology and a City Year staff member from the participants’ elementary school served as research assistants. Each research assistant individually administered the adapted CIRP to two participants. The research assistants verbally described the multi-dimensional intervention to each participant, administered a sample item using non-study information to acquaint the participant with the rating procedure, and then implemented the rating scale. Because the readability of the adapted CIRP was at a fifth-grade level, the items of this scale were read aloud to all participants, and participants were asked to indicate their response for each item. Items addressed fairness, expected effectiveness, and potential adverse effects associated with the intervention. Each item was rated using a five-point Likert scale ranging from I agree to I do not agree. Numerical values were not available for points on the original and the study’s adapted versions of the CIRPS’s Likert scale. For evaluation purposes in the current study, a numerical score was assigned to each point on the adapted CIRP scale ranging from 0 =I don’t agree to 5 =I agree with higher agreement scores indicating higher acceptability. CIRP Items three and four were in reverse order and assigned numerical quantities accordingly (i.e., 0 =I agree to 5 =I don’t agree) with higher disagreement indicating higher acceptability. Thus, higher values represented higher acceptability for all scale items. Composite scores on the adapted CIRP can range from seven to 42 with higher scores
indicating greater levels of acceptability. A composite score $\geq 24.5$ meets criterion for acceptability (Witt & Elliott).

**Participant treatment acceptability.** The participants’ mean composite score on the adapted CIRP (see Appendix G for a copy of the adapted CIRP) indicated that the multi-dimensional intervention was considered acceptable ($M=32.75$, $SD=6.23$) by surpassing the expected acceptability criterion of $>24.5$ (Witt & Elliott, 1985). Individual participant composite scores ranged from 29 to 42. The participants’ mean score as a group on individual items was generally favorable ($M=3.9$, $SD=.83$) with ratings of items ranging from 3.1 to 5.0. Jon’s mean-item rating on the adapted CIRP was 5 ($SD=.00$). Jim’s was 4 ($SD=1.9$). Dick’s and Harry’s were 3.4 ($SD=2.37$) and 3.1 ($SD=1.21$), respectively. Ratings for three out of the four students indicated that they found the intervention fair ($M=4.25$, $SD=1.5$ range, 2 to 5). All four participants endorsed motivation coaching as a comfortable method for receiving help ($M=5$, $SD=.00$). Only one participant was certain that the multi-dimensional intervention would not cause problems with his friends. The other three participants ranged from agreeing to slightly agreeing that the intervention could be problematic with their friends ($M=2.5$, $SD=2.08$, range, 0-5). Three of the participants believed there were other interventions that could better help with math and motivation problems, while one participant disagreed ($M=2.0$, $SD=2.4$, range, 0-5). All of the participants endorsed the intervention as being good to use with other children ($M=4.5$, $SD=.57$, range, 5-4). All but one of the participants agreed that they liked using the intervention to increase their math facts and motivation ($M=4.25$, $SD=1.5$, range, 5-2). All of the participants endorsed the intervention as helping them do better in school ($M=4.75$, $SD=.50$, range, 5-4).

**Teacher acceptability.** At the conclusion of the last intervention phase, the investigator asked each teacher to read over a summary of the multi-dimensional intervention and then to fill
out the Adapted IRP-15 to assess acceptability of this intervention (See Appendix H for Intervention Summary and a copy of the Adapted IRP-15). Teachers were instructed to respond to the statements by indicating their level of agreement or disagreement using a six-point Likert-type scale with ratings ranging in the following order: 1=\textit{strongly disagree}, 2=\textit{disagree}, 3=\textit{slightly disagree}, 4=\textit{slightly agree}, 5=\textit{agree}, and 6=\textit{strongly agree}. Composite scores on the IRP-15 can range from 15-90 with higher scores indicating greater levels of acceptability. Mean ratings $>52.50$ meet criterion for acceptability (Von Brock & Elliott, 1978). The teachers’ mean composite score on the Adapted IRP-15 ($M=86.25, SD=10.56$, range, 77 to 100) surpassed the acceptability criterion of $\geq 50.25$ (Von Brock & Elliott, 1987) indicating that the multi-dimensional intervention was highly accepted by teachers of participants. Teacher ratings of individual items from the adapted IRP-15 ranged from four to six (slightly agree to strongly agree) across participants with the mean score of individual items generally demonstrating favorable teacher endorsement of all the scale items from the adapted IRP-15 ($M=5.4, SD=.43$, range, 5.1 to 6.0). Teachers rated all four participants as benefiting from the multi-dimensional intervention ($M=5.75, SD=.50$) and endorsed the intervention as a good method for increasing math facts and motivation ($M=5.75, SD=.50$).

**Treatment Integrity**

A total of 11\% of the treatment sessions received integrity checks, which were fewer sessions than originally planned. There were changes in the study involving the elimination of integrity data from two original participants and inconsistent availability of research assistants to conduct integrity checks. Research assistants were trained in the CCC alone and CCC+MC interventions and asked to observe the investigator as she implemented intervention conditions with participants. Research assistants were given procedural checklists identical to the
intervention protocols from the study’s Intervention Manual, which contained scripted
instructions and designated steps on how to implement each intervention condition (Codding et
al., 2006; see Appendix L for the CCC Researcher Integrity Checklist and Appendix M for the
CCC+MC Researcher Integrity Checklist). Research assistants checked off intervention steps on
the procedural checklists completed by the investigator for either of the intervention conditions
observed. Treatment integrity checks were only available for Jon and Harry’s treatment sessions.
Treatment checks were available for 3.6% of CCC+MC sessions (one integrity observation) and
for 7% of CCC alone sessions (three integrity observations). Treatment integrity was determined
by totaling the number of steps on the procedural checklist and then multiplying by 100.
Treatment integrity for CCC alone averaged 91.6% (range, 83% to 100%) and was 48% for the
one CCC+MC treatment observation. Treatment integrity averaged 81.5% (range, 80% to 83%)
for Jon and Harry when both CCC alone and CCC+MC checks were combined.
CHAPTER IV

Results

Effects of the CCC Alone and Multi-Dimensional Interventions on Math Fact Fluency

Results in math fact fluency for two participants who received the CCC+MC, then CCC alone sequence during Phase I (i.e., two participants (Rob and Ed) received CCC alone, then CCC+MC and two participants (Jon and Harry) received CCC alone, then CCC+MC) were eliminated from the study because of carry-over effects from CCC+MC to CCC alone making it unclear whether adding motivation coaching to CCC alone had a positive effect (See Appendix N for Figures 1a and 1b, which summarize the eliminated results in math fact fluency for Rob and Ed). For participants retained in the study, Figures 2 and 3 summarize participants’ (Jon, Dick, Harry, and Jim) performance in math fact fluency during Phase II (i.e., two participants were added to replace the eliminated students and all four participants who received CCC alone, then CCC+MC were retained in the study) as measured by the number of DCPM on each assessment across three conditions: baseline, CCC alone, and the study’s multi-dimensional intervention (CCC+MC). Comparisons of the magnitude of change during CCC alone compared to CCC+MC revealed increases in math fact fluency for all four participants with the addition of motivation coaching to the academic intervention relative to the academic intervention alone with only one participant (Jon) demonstrating a reliable effect. Three of the four participants (Jon, Dick, and Harry) demonstrated improvements in math fact fluency, such that there were positive shifts in their median rate of DCPM performance during CCC alone compared to their baseline performance and then again during CCC+MC conditions compared to CCC alone. Jon’s median DCPM increased from 19.5 during baseline to 28 during CCC alone (PND=88%) and increased again to 40.5 during CCC+MC (PND=100%) indicating highly effective results with
the implementation of CCC alone after no intervention and again with CCC+MC following CCC alone. Dick’s median DCPM increased from 20 to 37 (PND=82%) from baseline to CCC alone and then from 37 to 45 (PND=33.3%) from CCC alone to CCC+MC. Thus, Dick’s data demonstrated a strong effect related to his increase in DCPM for CCC alone compared to DCPM with no intervention and an unreliable effect for the increase during CCC+MC compared to CCC. Harry’s median DCPM was 13 at baseline, 17.5 during CCC alone, and 23 during CCC+MC indicating a highly reliable effect (100%) for the increase between baseline and CCC alone and an increase below chance level (PND=44%) for the increase in DCPM during CCC+MC compared to CCC alone. The fourth participant (Jim) did not show a noticeable increase in DCPM during CCC alone compared to his baseline performance but demonstrated a noticeable, but unreliable increase in DCPM when motivation coaching was added to CCC. His median DCPM only increased from 9 to 10 (PND=9%) from baseline to CCC but then increased to 15.5 during CCC+MC (PND=56%).

Visual inspection revealed that there were immediate, positive changes in level with the introduction of CCC alone and then again when coaching was added during CCC+MC for Jon and Dick (see Figure 2). This provided support for the positive effects of CCC+MC compared to CCC alone. In contrast, Harry and Jim’s level changes were inconclusive (see Figure 3). Harry showed an immediate, positive level change when CCC alone was initiated followed by an immediate, negative level change with the onset of CCC+MC. Jim’s levels remained similar at the onset of CCC alone compared to the end of baseline and from the onset of CCC+MC compared to end of CCC alone.

Increased rates of change found in math fact fluency performance during CCC+MC relative to CCC alone further supported the positive effects of adding motivation coaching to
Figure 2. Jon’s and Dick’s digits correct per minute for math facts.

Figure 3. Harry’s and Jim’s digit correct per minute for math facts.
CCC. All four participants showed an increase in rate of improved math fact fluency performance between CCC alone and CCC+MC as evidenced by a negative trend in the wrong direction for DCPM at the end of the CCC alone condition followed by an immediate or gradual change to a positive trend in DCPM performance when motivation coaching was added to CCC.

Visual inspection of Jon’s data indicated an increase in math fact fluency performance associated with the addition of motivation coaching to CCC (see Figure 2, the top graph). That is, there was an immediate increase in the level of Jon’s DCPM from the end of CCC alone to the onset of CCC+MC. Additionally, Jon’s median performance across the first four treatment sessions in the CCC+MC condition (34.6 DCPM) was noticeably higher than his median performance during the last four sessions of CCC alone (27 DCPM). Jon’s results demonstrated a positive, upward trend during CCC+MC in contrast to CCC alone, where his performance was more variable and ended in a downward trend. In summary, comparisons of changes in the median rate of DCPM performance and visual inspection of level changes and trend differences between the CCC alone and CCC+MC intervention phases for Jon’s results supplemented by a strong effect size collectively supported the finding that adding motivation coaching to an academic intervention may have had a greater effect on improving math fact fluency than the academic intervention alone. The academic intervention alone also presented as effective in improving math fact fluency relative to no intervention.

Results for Dick were less conclusive than Jon’s data regarding establishing a reliable increase in math fact fluency during CCC+MC compared to CCC alone. An immediate change in level from the end of CCC alone and the onset of CCC+MC was noted in Dick’s math fact fluency performance (see Figure 2, bottom graph). However, his initial performance, as demonstrated in the median performance of the first four sessions of CCC+MC (38.75 DCPM),
was similar or slightly lower to his median performance for the last four sessions of CCC alone (39.75 DCPM). Subsequently, Dick’s performance in math fact fluency demonstrated support for the positive effects of CCC+MC compared to CCC alone as evidenced by a gradual, positive change in trend and an immediate increase in level in his median performance to 52 DCPM for the last four sessions of CCC+MC, which was noticeably higher than his median performance for the last four sessions of CCC alone (39.75 DCPM). Dick’s median performance for the first four sessions of CCC alone compared to the last four sessions in CCC alone revealed an increase of 6.75 DCPM. In contrast, his median performance for the first four sessions of CCC+MC relative to his median performance for the last four sessions of CCC+MC increased 13.8 DCPM. Specifically, Dick’s results showed a positive, upward trend during CCC+MC, while the trend during CCC alone was less steep, more variable, and headed downward in the wrong direction at the end of the CCC alone condition. Although comparisons of changes in median rate of performance in math fact fluency and visual inspection revealed positive changes in levels and trends between the CCC alone and CCC+MC intervention phases for Dick, the overall effect of adding motivation coaching to the academic intervention relative to the academic intervention alone was found to be unreliable. In contrast, the academic intervention alone compared to no intervention demonstrated an increase in math fact fluency well beyond chance.

Harry’s results demonstrated some support for CCC+MC over CCC alone but his overall results were inconsistent and less conclusive than Jon’s data. Visual inspection revealed that there was an immediate, negative change in level from the end of CCC alone to the beginning of CCC+MC indicating a decrease in math fact fluency performance with the onset of CCC+MC (see Figure 3, top graph). Further, Harry’s median performance in math fact fluency across the last four sessions during the CCC alone condition was 19 DCPM, and his median performance
during the initial four sessions of CCC+MC was comparable at 19.25 DCPM, indicating minimal improvement. In contrast, Harry’s data also showed some support of CCC+MC over CCC alone. In addition to his median performance in math fact fluency increasing between CCC alone and CCC+MC, his median performance for the last four sessions of CCC+MC (24.5 DCPM) improved from his median performance for the last four sessions of CCC alone and the first four sessions of CCC+MC, 19 DCPM and 19.25 DCPM, respectively. In addition, Harry’s results showed a gradual, positive upward trend during CCC+MC that was steeper and surpassed the upward trend noted during CCC alone. As found with Dick’s results, Harry’s data indicating positive changes in math fact fluency when motivation coaching was added to the academic intervention compared to the academic intervention alone were unreliable. In contrast, the increase in math fact fluency demonstrated during the academic intervention alone relative to no intervention was well above chance level.

Unlike the other three participants, Jim only displayed sustained improvements in math fact fluency during CCC+MC. His performance in math fact fluency during baseline and CCC were comparable showing considerable variability and minimal growth (see Figure 3, bottom graph). Although the level change from the end of CCC alone and the onset of CCC+MC reflected a brief, immediate change downward, his data during CCC+MC demonstrated a rapid, upward trend followed by variability that generally indicated improved performance compared to CCC alone. Visual inspection of Jim’s data demonstrated strong support for the effectiveness of CCC+MC over CCC alone. Jim’s median performance in math fact fluency during the first four sessions of CCC+MC (Median DCPM=14.75) was higher than in the last four sessions of CCC alone (Median DCPM =11). In addition, his performance in math fact fluency during CCC alone showed a downward trend at the end of this condition and demonstrated a rapidly accelerating
upward trend after one session during CCC+MC. Although visual inspection of Jim’s data suggested increases in math fact fluency when motivation coaching was added to the academic intervention relative to the academic intervention alone, the effect was questionable. Unlike the other three participants, Jim’s performance in math fact fluency did not respond favorably to the academic intervention in comparison to no intervention.

**Effects of the Multi-Dimensional Intervention on Motivation**

**Participant self-rated motivation.** Changes in participant motivation levels were measured by administering the Motivation Probe, a non-standardized self-rating scale developed for the current study where total scores could range from 0 to 84. Figures 4 and 5 summarize participants’ scores in self ratings from the Motivation Probe administered during baseline sessions and once a week during CCC alone and CCC+MC. The four participants’ scores on the Motivation Probe across experimental conditions were highly variable, thus providing inconclusive results and limited support for the addition of motivation coaching to the academic intervention as having a reliable effect on increasing scores in participants’ self-rated motivation compared to the academic intervention alone. Rather, results indicated that the academic intervention alone may have had a more consistent positive effect on self-rated motivation.

Jon consistently maintained high self-ratings in motivation across the baseline, CCC alone, and CCC+MC conditions resulting in minimal changes in level and trend (see Figure 4, top graph). His median total score on the Motivation Probe was 82 at baseline and increased to and remained at 84 for CCC alone and CCC+MC. The PND was 66.6% for his increase in self-rated motivation between baseline and CCC alone indicating a questionable effect and 0% between CCC and CCC+MC indicating an unreliable effect, Thus, there was lack of
**Figure 4.** Jon’s and Dick’s Motivation Probe Total Scores.

**Figure 5.** Harry’s and Jim’s Motivation Probe Total Scores.
statistical support for the positive effects of CCC+MC relative to CCC alone on self-rated motivation, as well for CCC alone relative to no intervention.

Dick’s self-ratings in motivation increased to a median score of 84 during CCC alone in comparison to his baseline score of 58 with a PND of 100%, which strongly supported CCC alone as having a positive effect on increasing self-rated motivation in his case. In contrast, his median score decreased to 78 during CCC+MC with a PND of 0%, which indicated that CCC+MC was less effective in improving participants’ self-rated motivation relative to CCC alone. Visual inspection revealed an immediate, positive change in level from the end of baseline to the onset of the CCC alone condition (see Figure 4, bottom graph) and no change in level from the end of CCC alone to the beginning of CCC+MC. The trend in Dick’s data was flat during CCC alone and changed to a downward, negative trend during CCC+MC. Thus, adding motivation coaching to CCC did not improve self-rated motivation compared to CCC alone, rather Dick’s motivation ratings went down during CCC+MC and demonstrated a deteriorating effect.

Jim and Harry demonstrated slight changes in their median total scores on the Motivation Probe from CCC alone to CCC+MC, 70 to 74 and 64 to 66, respectively, both with PNDs (33.3%) indicating unreliable effects. Median total scores in self-rated motivation from baseline to CCC alone increased from 58 to 64 for Harry (PND=66.6%) indicating a questionable effect and from 64 to 70 for Jim (PND=33.3%) suggesting an unreliable effect. They both showed immediate, positive changes in level with the onset of CCC alone after the baseline condition (see Figure 5). In contrast, there was an immediate, negative change in level from the end of CCC alone to the onset of CCC+MC for Harry. Jim’s level stayed relatively the same from CCC alone to CCC+MC. For both of these participants, self-ratings of motivation were relatively flat
during CCC alone and shifted to positive, upward trends during CCC+MC, which demonstrated some support for self-rated motivation increasing during CCC+MC compared to CCC alone. Overall, the motivation data suggested that the academic intervention (CCC alone) may have had a positive effect on self-rated motivation in that all four participants demonstrated increases in their median total scores on the Motivation Probe during CCC alone in comparison to baseline results (i.e., one participant with a strong effect, two participants with questionable effects, and one participant with an unreliable effect), while data during CCC+MC relative to CCC alone were more variable, less reliable, and inconclusive (i.e., three participants demonstrating unreliable effects and one showing a deteriorating effect).

**Effects of the Multi-Dimensional Intervention on Student Engagement**

**Total positive student engagement during math ISW.** Student engagement data were only reported for participants Jon and Harry. The total percentage scores in student engagement (active plus passive engagement) summarized in Figure 6 for Jon and Harry were highly variable across baseline, CCC alone, and CCC+MC conditions. Their results were inconclusive as to whether the CCC+MC intervention had an impact on improving student engagement during math ISW in the classroom compared to CCC alone. Jon’s median percentage score in student engagement improved from baseline (Median=71%, range, 60%-94%) to CCC alone (Median=81%, range, 79%-83%). However, Jon’s engagement data showed a positive, upward trend during baseline, and the PND for his increase in student engagement between baseline and CCC alone was 0% suggesting an unreliable effect. A high degree of variability in baseline data may reduce the PND value of a treatment phase that follows. Extreme outlier values in baseline data may overlap a large percentage of the treatment phase data points, even if overall the
treatment phase appears highly successful (Faith, Allison, & Gorman, 1996), which appears to be the case for Jon’s baseline data. There was a negative change in level from the end of the baseline condition to the onset of CCC alone and a flattened trend during CCC alone. This demonstrated inconsistencies and variability in the data, which questioned the reliability of CCC alone showing conclusive positive effects on student engagement compared to the baseline condition.

Jon’s median percentage score in student engagement during CCC+MC (Median=89%, range, 75%-98%) surpassed his median engagement score during CCC alone (Median=81%, range, 79%-83%). Although there was an immediate decrease of 6% of total student engagement from the end of CCC alone to the onset of CCC+MC for Jon’s engagement data, there was a rapid upward trend during CCC+MC compared to CCC alone. The PND was 66.6%, which suggested a questionable effect of CCC+MC having a larger influence on increasing Jon’s total engaged time during math ISW compared to CCC alone. Conditions during Jon’s classroom
observations were consistent whereby his teacher implemented a math fact worksheet provided by the investigator, instructed the students to correct the worksheet as a class, and then transitioned to teacher-led instruction towards the end of the observation period for every classroom observation.

Harry’s median percentage scores for total student engagement across baseline, CCC alone and CCC+MC were highly variable (Median=58%, range, 44%-63%; Median=75%, range, 38%-85%; and Median=56%, range, 54%-92%, respectively). His median percentage score for total student engagement (Median=56%) decreased during CCC+MC compared to CCC alone (Median=75%) with a PND of 33.3%, suggesting that CCC+MC did not have a greater influence on increasing Harry’s total engaged time during math ISW compared to CCC alone. Visual inspection showed variable student engagement during CCC+MC as reflected in an immediate decrease of 29% of total engagement time from the end of CCC alone to the onset of CCC+MC followed by a steep increase of 36% of engagement time and ending with a steep decline of 38% engaged time during CCC+MC. Although Harry’s median engagement score increased from baseline (Median=58%, range, 46%-63%) to CCC alone (Median=75%, range, 38-85), a PND of 66.6% suggested that the effect of the academic intervention alone on increasing student engagement compared to baseline was questionable. Visual inspection revealed an immediate increase of 29% of total engaged time from the end of baseline to the onset of CCC alone followed by a steep decline of 37% engagement time and ending with a steep increase of 47% engaged time during CCC alone.

**Active student engagement versus passive engagement during math ISW.** Figure 7 summarizes Jon and Harry’s separate percentages of active versus passive student engagement across experimental conditions. Although both participants showed greater improvement in
active engagement during CCC+MC relative to CCC alone, these effects were found to be unreliable. Jon’s median percentage score in active engagement increased from 56% (range, 40%-65%) during CCC alone to 62% (range, 56%-79%) during CCC+MC. The PND was 33% indicating an unreliable effect regarding CCC+MC having a greater impact on active engagement compared to CCC alone. His median active engagement score increased from 36% (range, 31-52) during baseline to 56% (range, 40%-65%) during CCC alone with a PND of 66.6% indicating that the academic intervention alone had a questionable effect on increasing active student engagement compared to no intervention.

Visual inspection of Jon’s active engagement showed an immediate positive change in level from baseline to CCC alone with an increase of 20% in active engagement between these two experimental conditions, and a subsequent increase of 22% in active engagement between CCC alone and CCC+MC. For all three experimental conditions, Jon demonstrated a positive upward trend and then a negative downward trend. Jon’s median percentage scores in active

![Figure 7. Jon and Harry’s Active vs Passive Engagement During Math Period as Measured by the BOSS.](image-url)
engagement across baseline, CCC, and CCC+MC were consistently higher than his median percentage scores in passive engagement.

Jon’s median percentage score in passive engagement increased from 22% (range, 14% to 40%) during CCC alone to 33% (range, 19% to 37%) during CCC+MC with a PND of 0% suggesting an unreliable effect for CCC+MC increasing passive engagement compared to CCC alone. Jon’s median percentage score in passive engagement increased from 19% (range, 9% to 29%) during baseline to 22% (range, 14% to 40%) during CCC alone. The PND was 33.3% indicating that the academic intervention alone may have also had an unreliable effect on increasing passive student engagement compared to no intervention. Visual inspection of Jon’s total percentage of passive engagement revealed a negative, downward trend during baseline and variable, downward than upward trends during CCC alone and CCC+MC. Jon’s passive engagement showed an immediate positive change in level from baseline to CCC alone with an increase of 13% in passive engagement between these two experimental conditions, and a subsequent immediate decrease of 3% between CCC alone and CCC+MC.

Figure 7 also summarizes Harry’s percentage scores of active versus passive engagement during math ISW. Similar to Jon, Harry’s median percentage scores in active engagement were higher than his passive engagement scores across all experimental conditions. As seen with Jon’s data, the visual distinction between Harry’s active engagement scores being higher than his passive engagement scores was most apparent during the CCC+MC condition in comparison to baseline and the CCC alone conditions. Harry’s median percentage score in active student engagement increased from 35% (range, 29% to 58%) during CCC alone to 42% (range, 40% to 77%) during CCC+MC with a PND of 33% indicating that adding motivation coaching to an academic intervention may have had an unreliable effect on increasing active student
engagement. His median percentage score in active engagement increased from 29% (range, 19% to 42%) during baseline to 35% (range, 29% to 58%) during CCC alone with a PND of 33.3% suggesting that the academic intervention alone may have had an unreliable effect on increasing active student engagement, as well. Harry demonstrated a slight, positive change in level from the end of baseline to the onset of CCC alone where his active engagement increased 6%. There was an immediate, negative change in level at the end of CCC alone and at the onset of CCC+MC with his active engagement decreasing 18%. Harry displayed a variable, upward then downward trend in active engagement during baseline and a gradual, positive upward trend during CCC alone followed by a variable trend during CCC+MC.

Harry’s median percentage score in passive engagement decreased from 27% (range, 8%-39%) during CCC alone to 15% (range, 13%-17%) during CCC+MC with a PND of 0%. This suggests that adding motivation coaching to the academic intervention had a deteriorating effect on passive student engagement. In contrast, his median percentage score in passive engagement increased from 21% (range, 17%-39%) during baseline to 27% (range, 8%-39%) with a PND of 0% indicating CCC alone as having an unreliable effect on increasing passive engagement compared to no intervention. Visual inspection revealed that there was an immediate, negative change in level at the end of CCC alone and at the onset of CCC+MC with Harry’s passive engagement decreasing 10%. In contrast, there was an immediate positive change in level between the end of baseline and the onset of CCC alone where passive engagement increased 22%. There was a downward trend during baseline, a downward trend followed by an upward trend during CCC alone, and a downward trend during CCC+MC in passive engagement. One would expect to see a decrease in passive engagement during CCC+MC relative to Harry’s increase in active engagement during this intervention as
evidenced by his separate data sets for active and passive student engagement. Although Jon and Harry’s results were considered statistically unreliable, visual inspection suggested that adding motivation coaching to an academic intervention may have been effective in improving active engagement and that passive engagement may have decreased relative to an increase in active engagement.

**Participant Motivation Pre- and Post Intervention**

**Teacher ratings.** Participants’ pre- and post- intervention results on the motivation and study skills enabler subscales from the *ACES—Teacher* form were examined to investigate participant improvement in motivation behaviors at the end of the study. Table B-2 (see Appendix B for Table B-2) summarizes changes in participants’ teacher ratings pre- and post-intervention on the Motivation subscale from baseline to the study’s completion. Teacher ratings improved for all four participants on the Motivation subscale suggesting an increase in motivation behaviors recognized by participants’ teachers in the classroom. Jon’s teacher ratings on the Motivation subscale improved from scoring in the Developing range (2\(^{nd}\) decile; 90\(^{th}\) confidence interval=20-26) at baseline to the Advanced range (9-10\(^{th}\) decile; 90\(^{th}\) confidence interval=52-58) post-intervention, an increase of seven decile levels. Teacher ratings for student motivation for the remaining three participants (Dick, Harry, and Jim) improved two decile levels from pre- to post-intervention. Harry’s teacher ratings on the Motivation subscale improved from scoring in the Developing range (1\(^{st}\) decile; 90\(^{th}\) confidence interval=18-24) to falling in the Developing and Competent ranges (3\(^{rd}\) decile; 90\(^{th}\) confidence interval=25-31). Jim’s teacher ratings improved from scoring in the Developing and Competent ranges (2\(^{nd}\) decile; 90\(^{th}\) confidence interval=22-28) to exclusively falling in the Competent range (4\(^{th}\) decile; 90\(^{th}\) confidence interval=27-33). Lastly, Dick’s teacher ratings on the Motivation subscale
improved from scoring in the Developing and Competent ranges (2nd decile; 90th confidence interval=23-29) to scoring exclusively in the Competent range (4th decile; 90th confidence interval=29-35).

Table B-2 also summarized changes in participants’ teacher ratings pre- and post-intervention on the ACES Study Skills subscale from baseline to the end of the study. Jon’s teacher ratings in study skills increased from scoring in the Developing and Competent ranges (2nd decile; 90th confidence interval=28-34) to the Advanced range (10th decile; 90th confidence interval=52-58), an increase of eight decile levels. Jim’s teacher ratings on the Study Skill subscale advanced from the Developing range (1st decile; 90th confidence interval=25-31) to the Developing and Competent ranges (2nd decile; 90th confidence interval=26-32). Dick and Harry’s teacher ratings in study skills expanded from scoring in the Developing range and the beginning of the Competent range (2nd decile; 90th confidence interval=26-32) to the Developing range and more extensively into the Competent range (Dick: 2nd decile; 90th confidence interval=30-36; Harry: 2nd decile; confidence interval=28-34).

**Specific improvements in motivation.** Table B-3 (see Appendix B for Table B-3) summarizes participants’ improvement on teacher-rated items from the ACES Motivation subscale to examine whether participants commonly demonstrated progress in specific motivation behaviors. Participants as a group demonstrated a mean-item improvement on 6.5 items of the 11-item, motivation subscale over the course of the study when pre- and post- ACES results were compared. Jon improved his performance on all 11 Motivation subscale items. Dick and Harry increased their performance on six items and Jim on three motivation items. Five of the 11 items from the motivation subscale met criteria for at least three out of four participants showing improvement. All four participants demonstrated improvement in the item: *Taking*
responsibility for my learning. Motivation items where three out of four participants demonstrated improvement were: *Is motivated to learn, Prefers challenging tasks, Produces high quality work*, and *Is goal-oriented*.

**Specific improvement in study skills.** Table B-4 (see Appendix for Table B-4) summarizes participants’ improvement on teacher-rated items from the ACES Study Skills subscale and overall participant improvement on individual subscale items to examine whether participants commonly demonstrated progress in specific study skill behaviors (study skills are similar to self-regulated learning strategies, which are associated with enhancing motivation). Participants as a group demonstrated a mean-item improvement on 4.5 items of the 11-item, study skills subscale over the course of the study. Jon improved his performance across all 11 study skill items. Dick and Harry each increased their performance on two items and Jim on three. Two of the 11 items from the study skill subscale met the criteria for at least three out of four participants showing improvement: *Prepares for tests* and *Reviews materials*.

**Participant performance on SAPs.** Reviewing participants’ SAPs to examine whether self-designated goals in math fact fluency were achieved, which self-regulated learning strategies were targeted by participants, and the extent to which participants were successful implementing their SAPs helped to investigate the types of motivation behaviors participants exhibited during CCC+MC and which motivation behaviors could be associated with improved teacher-rated items on the ACES subscales. Requirements for SAPs, such as setting and monitoring goals in math fact fluency and selecting and implementing self-regulated learning strategies during CCC+MC by participants (e.g., *Study math facts before quiz, Complete extra practice with math facts, Ask for help, Use positive self-talk, Participate in class, and Check work*) overlapped with some of the improved items on the ACES—Teacher form, such as *Assumes responsibility for*
own learning, Is goal-oriented, Is motivated to learn, Prepares for tests, and Reviews materials.

Table B-5 (see Appendix B for Table B-5) summarizes the content of participants’ SAPs regarding their success with goal attainment in math fact fluency, types of self-regulated learning strategies chosen, and frequencies of demonstrating strategy usage during and outside of treatment sessions. The mean participant score for successful goal attainment in math fact fluency on participants’ SAPs during CCC+MC indicated that as a group the participants attained a high percentage of their self-designated goals for DCPM ($M=83\%$) with individual mean percentages of successful goal attainment ranging from 66% to 100%. A total of eight different strategies were selected and implemented across the four participants. Because the study’s Goal Strategy Index Card was unsuccessful and eliminated as a procedure, the investigator recorded when participants demonstrated their targeted, self-regulated learning strategies during treatment sessions over the course of all of the treatment sessions during the CCC+MC condition. As a group, the participants were observed by the investigator as implementing strategies at a mean rate of 15.5 times over the course of all treatment sessions during CCC+MC ranging from nine to 21 times for individual implementation of learning strategies.
CHAPTER V

Discussion

The current study examined the effectiveness of a multi-dimensional intervention combining an evidence-based math intervention with motivation coaching to address low math fact fluency and motivation in students with high levels of ADHD symptomatology. The study addressed a number of questions related to academic, attitudinal, and behavioral outcomes.

Hypothesis 1: Effects on Math Fact Fluency.

It was hypothesized that adding motivation coaching to an evidenced-based, academic intervention would lead to greater growth in math performance for students with high levels of ADHD symptomatology compared to intervening with the academic intervention in isolation. Results from the current study supported this hypothesis as all four participants demonstrated improvements in math fact fluency during the multi-dimensional intervention compared to the academic intervention alone. Indeed, one participant (Jim) did not demonstrate improvements in math fact fluency until motivation coaching was added to the academic intervention.

These findings are consistent with extant research, which demonstrated the positive effects of coaching students with ADHD. The current study is consistent with studies which have demonstrated that coaching fosters improvement in targeted academic behaviors for students with ADHD (Merriman & Codding, 2008). When students with ADHD were asked to monitor academic accuracy and productivity in math, their productivity increased (Shimabukuro, et al. 1999), similar to the findings in the current study where motivation coaching involving self-monitoring improved performance in math fact fluency for students with high levels of ADHD. Dawson and Guare’s (2004) coaching model for students with ADHD served as a framework for the motivation coaching protocol adopted in the current study. The results of the current study, in
turn, supported their claims that students with attentional problems can achieve academic goals by participating in a program which uses coaching to help with management skills, organization of assignments into meaningful tasks and development of study skills.

Implications. The current study was the first to examine math performance and the effects of targeting an academic skill combined with motivation coaching. The finding that an academic intervention with motivation coaching had a larger effect on math fact fluency relative to the academic intervention alone expands the intervention literature for students with ADHD. In particular, the study’s multi-dimensional intervention improved academic performance in students with high levels of ADHD within a natural school setting without added assistance from medication or the use of contingencies and/or stimulating environments. The majority of academic intervention studies involving students with ADHD have focused on reducing inattention and disruptive behavior and increasing on-task behavior, were largely conducted outside of the natural school setting, and relied on medication, contingencies, game-like software, and/or peer tutoring (Dunlap, et. al, 1994; DuPaul & Eckert, 1998; DuPaul & Henningson, 1993; DuPaul & Weyandt, 2006; Mautone, et. al, 2005; Ota & DuPaul, 2002; Raggo & Chronis, 2006; Zentall, 2007). For most of these studies, increases were noted in academic engagement sometimes accompanied by reports of improvement in academic performance, which was not examined or monitored by formal, academic assessment (Greenwood, et al., 1988; DuPaul et al., 1998; Ford et. al, 1993). The current study expands the literature regarding academic interventions for students with ADHD by directly assessing and monitoring participants’ progress in academic performance, motivation, and student engagement within the same study.
The study’s positive findings demonstrating the beneficial effects of providing academic intervention with motivation coaching compared to the academic intervention alone presents as promising for treating the aversive motivation style attributed to students with ADHD (Olivier & Steenkamp, 2004). The current findings suggest that students with high levels of ADHD symptomatology can benefit from coaching, which directly targets self-regulated learning strategies and provides opportunities to increase positive academic self-efficacy beliefs to strengthen academic motivation.

This study’s multi-dimensional intervention reflects some of the principles underlying school-based interventions recommended for students with ADHD by DuPaul and Weyandt (2006). These principles include: (a) developing interventions based on assessment data rather than trial-and-error; (b) evaluating and modifying treatment strategies using a data-based decision-making model; (c) balancing the inclusion of proactive and reactive strategies; and (d) involving multiple agents to implement interventions.

The current study used assessment data to develop interventions. Specifically, evaluation procedures were utilized to assess participants’ instructional or frustration level in a math operation, known and unknown math facts, and performance in math fact fluency and motivation. Participants’ individualized, motivation coaching protocols involved SAPs, which were based on initial pre-assessments of students’ academic self-efficacy beliefs and use of self-regulated learning strategies (MSPSE; Bandura, 1989b), as well as items rated low by participants on the study’s motivation probe and by participants and teachers on the ACES Motivation and Study Skills subscales. Further, ongoing progress monitoring of participants’ results on dependent measures (e.g., AIMSweb math fact probes, the study’s self-rating motivation probe, and systematic classroom observations, if applicable) were used to evaluate
and modify participants’ targeted self-regulated learning strategies and math fact fluency goals for their SAPs during the multi-dimensional intervention.

The principle underlying school-based interventions calling for evaluating and modifying treatment strategies using a data-based decision-making model (DuPaul & Weyandt, 2006) is reflected in the multi-dimensional intervention’s procedures, which required ongoing assessment of an academic skill being targeted during individual treatment sessions. Participants were regularly administered math fact probes used to monitor their progress in math fact fluency, which provided feedback as to whether self-selected, treatment strategies were constructive. Additionally, the study’s coaching protocol required participants to set goals for reaching a designated number of digits correct on math fact probes based on successfully surpassing previous scores and attaining pre-set goals. When participants were successful reaching DCPM goals, they examined the usefulness of self-selected learning strategies on their SAPs and made decisions to either continue with a strategy or determine a more useful replacement strategy.

The motivation coaching protocol represented in the multi-dimensional intervention, utilized both proactive and reactive strategies. Proactive strategies are those which change conditions before the occurrence of a target behavior. In the multi-dimensional intervention, each participant’s individualized SAP developed during motivation coaching included selected learning strategies designed to modify antecedent events (e.g., task avoidance, negative self-efficacy beliefs, and/or limited academic self-regulation) in order to promote changes in learning and achievement conditions and encourage student actions expected to enhance participant performance (i.e., math fact fluency, self-rated motivation, and positive classroom engagement). Reactive strategies are described as interventions that involve a change in environmental conditions following the display of a target behavior (e.g., self-management procedures are
considered reactive strategies and supported by research for addressing ADHD-related behavior; DuPaul & Weyandt, 2006) to increase or decrease its frequency. As part of the coaching protocol in the multi-dimensional intervention, participants employed self-management techniques by graphing their progress in math fact fluency, self-rated motivation, and student engagement to receive immediate feedback on their performance. In the current study, performance feedback results usually provided evidence of success, and participants’ efforts were linked to their improvement in math fact fluency, motivation, and/or student engagement (if applicable).

The multi-dimensional intervention did not meet the recommendation to involve multiple intervention mediators (i.e., teacher, parents, etc.) with the implementation of school-based interventions, as mainly the treatment provider (investigator) and participants were included in the current study. Teachers were asked to administer math fact probes during classroom observations and participants’ assessment results and progress were occasionally communicated to parents and teachers upon parent request. Although teachers and parents were involved in the current study, their roles could be expanded, as will be further explored later under discussion limitations of the study.

The results in the current study support the premise that motivation mediates the relationship between ADHD and academic achievement (e.g., Volpe et al., 2006). Students with high levels of ADHD symptomatology demonstrated greater improvement in math fact fluency, and in one case, only showed improvement when motivation coaching was added to an academic intervention. In addition, the finding that motivation coaching enhanced the effectiveness of CCC supports the academic self-motivation theory referred to by Zimmerman et al. (1992), which proposes that academic self-efficacy and self-regulated learning strategies are strongly linked to motivation and academic achievement. These investigators found a significant
relationship between students’ efficacy for academic achievement, efficacy for self-regulated learning, and academic achievement. In their model, self-efficacy beliefs associated with achievement influence academic attainment by influencing personal goal setting. Positive or negative self-efficacy beliefs influence a student’s level of goal setting and use of self-regulated learning strategies, which in turn affect academic achievement (Zimmerman et al.). In the current study, participants set goals in math fact fluency and usually met these goals, as evidenced in their performance on M-CBM probes. During the multi-dimensional intervention, participants’ success was linked to their efforts in using selected, self-regulated learning strategies from their SAPs.

The positive influence found in the current study of coaching motivation by targeting student’s academic self-efficacy and use of self-regulated learning strategies as a means of increasing academic performance additionally supports Bandura’s (1986, 1988) theoretical position that integrating self-efficacy and self-regulation are key variables affecting motivational processes. Likewise, the current study’s results support Pintrich and Schunk’s (2002) theory that motivation and cognitive factors interact and have a joint impact on student achievement and learning, as reflected in the social cognitive model of motivation. Overall, the findings of the current study suggest that targeting motivation components, such as increasing positive academic self-efficacy beliefs and the use of self-regulated learning strategies, are important considerations for academic instruction and remedial work for students with ADHD.

**Hypothesis 2: Effects on Academic Motivation.**

The literature suggests that students with ADHD commonly exhibit a core deficit in motivation characterized by low, perceived academic self-efficacy and a tendency towards avoidance of achievement-related activities to address fear of failure and reduce negative
feelings, namely an *aversive motivation style* (Olivier & Steenkamp, 2004). It was hypothesized in the current study that adding individualized, motivation coaching to an evidence-based academic intervention would enhance academic motivation for students with high levels of ADHD symptomatology and low math performance.

**Participants’ self-rated motivation and implications.** Growth in motivation was measured by comparing each participant’s scores on the Motivation Probe across baseline, CCC alone, and the multi-dimensional intervention. A comparison of participants’ scores on the Motivation Probe during the multi-dimensional intervention relative to CCC alone were highly variable (i.e., two participants demonstrated slight increases in positive, self-rated motivation, one stayed the same, and one participant’s ratings deteriorated) and did not support the multi-dimensional intervention as having a reliable effect on increasing positive, self-rated motivation compared to the academic intervention alone. Rather, the motivation data suggested that the academic intervention alone may have had a more consistent positive effect on self-rated motivation in that all four participants demonstrated increases in their median total scores on the Motivation Probe during CCC alone in comparison to baseline results (i.e., one participant with a strong effect, two participants with questionable effects, and one participant with an unreliable effect). This may be the result of additional performance feedback provided by the Popper Test implemented in the current study subsequent to CCC during the CCC alone intervention, which gave participants feedback on whether unknown math facts practiced during the CCC procedure became known and automatic.

The inconclusive findings in the current study regarding questionable effects of the multi-dimensional on self-rated motivation do not support past research that demonstrated the positive impact of coaching students with ADHD (Dawson & Guare, 2000; Plumer & Stone, 2005;
Swartz et al., 2005; Merriman & Codding, 2008). In regards to the variability across participants in their ratings on the Motivation Probe, this self-rating scale was not standardized, nor an accurate measurement of improved participant motivation. Indeed, the Motivation Probe may have been inflated over the course of the study due to the Hawthorne effect where participants may have answered in a manner to present themselves favorably and knew they were participating in a study (Ray, 2006).

**Teacher rated motivation pre- and post-intervention and implications.** Pre-intervention scores on the *ACES--Teacher* form placed all participants in the Developing range in math and study skills with the majority also rated in the Developing range in motivation. These scores suggest that for the majority of student participants, teachers perceived math, motivation, and study skills as areas needing support. Pre-intervention scores on the *ACES--Student* form indicated that the majority of participants rated themselves as competent in math, motivation, and study skills. These scores suggest that before receiving treatment participants perceived themselves as more competent in math, motivation, and study skills than they had been rated by their teachers.

Participant improvement in motivation was examined by comparing pre- and post-intervention teacher ratings on the ACES motivation and study skill subscales and participants’ self-ratings of motivation on the Motivation Probe. During post-intervention assessment, all four participants demonstrated improvements on the ACES Motivation and Study Skills subscales compared to their pre-intervention scores. Specifically, participants as a group improved on over half of the items comprising the teacher-rated Motivation subscale. Because the ACES subscales were not administered after each intervention, it is uncertain whether participants’ teacher-rated improvement in motivation was related to the effects of CCC alone, the multi-dimensional
intervention, or both. Thus, these results are only exploratory. However, ratings for all participants improved from baseline to post-intervention suggesting that further investigation into whether students with ADHD can benefit motivation coaching is worth exploring.

**Improvement in specific indicators of motivation.** A further look at motivation items on the ACES Motivation subscale where the majority of participants showed improved teacher ratings post-intervention suggest that the multi-dimensional intervention may have contributed to participants assuming more responsibility for their learning, showing increased motivation to learn, becoming more open to challenging tasks, producing higher quality work, and becoming more goal-oriented. These findings are consistent with the motivation literature, which has suggested that self-regulated learning involves students taking charge of their learning and achievement by setting goals for themselves (Bandura, 1989a; Schunk, 1991), adapting and applying strategies to achieve their goals (Zimmerman, 1989), and using self-regulation to maximize motivation (Bandura & Cervone, 1986). Subscale items endorsed as improved by teacher ratings were targeted by the motivation coaching protocol implemented during the multi-dimensional intervention in that participants set goals, implemented a plan to use self-regulated learning strategies, and graphed personal progress in math fact fluency, motivation, and student engagement. The implication for practice is that students with high levels of ADHD symptomatology may have benefited from direct coaching of specific aspects of motivation, as suggested by improved teacher ratings on particular items from the ACES motivation subscale.

**Teacher ratings of study skills.** Although some degree of improvement in study skills was evident for all four participants according to pre- and post-intervention ratings, improvements in study skills appeared smaller than those noted for motivation. The majority of participants demonstrated improvement in preparing for tests and reviewing materials. These two
study skills were inherently practiced in the study’s CCC procedures and were selected by all participants as self-regulated learning strategies to implement for their SAPs. Participants’ improvement in specific indicators of motivation and study skills reported in the current study support the Swartz et al. study (2005), where a college student with ADHD benefited from coaching specific skills as evidenced by improvement in study time and goal achievement of a specific course grade. In general, the current study’s findings imply that participants demonstrated improvement in specific indicators of motivation and study skills, which had been practiced during CCC alone and/or during the multi-dimensional intervention. These findings provide further support that students with high levels of ADHD symptomatology might benefit from direct coaching and ongoing practice of study skills and self-regulated learning strategies related to academic motivation, as supported by improved teacher ratings on the ACES subscales. Consideration should be given to the possibility that classroom instruction, teacher influence, or math-fact practice in the classroom outside of the study may have contributed to teacher-rated improvements for participants in motivation and study skills.

**Participants’ response to the SAP and implications.** An examination of participants’ SAPs that is whether DCPM goals in math fact fluency were met and which self-regulated learning strategies were selected and implemented, helped to further explore motivation behaviors exhibited by participants during the implementation of the multi-dimensional intervention. Data collected from participants’ SAPs revealed that they were usually successful in attaining pre-set goals in math fact fluency, selected a variety of self-regulated learning strategies, and were observed implementing selected learning strategies during the multi-dimensional intervention treatment sessions. Successful goal attainment and self-regulated learning strategies selected for SAPs, such as *study math facts before quiz, complete extra*
practice with math facts, ask for help, use positive self-talk, participate in class, and check over work overlap with some of the improved items on the ACES--Teacher form, such as assumes responsibility for own learning, is goal-oriented, is motivated to learn, prepares for tests, and reviews materials. Implications from these findings suggest that students with high levels of ADHD symptomatology may have been taught and successfully coached to use specific, self-regulated learning strategies, which likely occurred in the classroom as well as during treatment sessions, and may have had an influential effect on improved, teacher ratings in motivation and study skills.

**Hypothesis 3: Effects on Student Engagement**

It was hypothesized that students with high levels of ADHD symptomatology and low math performance would benefit from improvements demonstrated in math fact fluency and motivation during individual treatment sessions when motivation coaching was added to an academic intervention compared to the academic intervention alone by displaying increased student engagement during math ISW in the classroom setting. Student engagement data were available for two participants. Unfortunately, these data were inconclusive. Although one participant (Jon) increased his on-task behavior (total active and passive engaged time) in class during the multi-dimensional intervention compared to the academic intervention alone, his improvement was not above chance level. This participant may have made a greater effort to remain on-task when the investigator observed him in the classroom knowing that he would be graphing his student engagement data during treatment sessions. The other participant (Harry) demonstrated variability and inconclusive results in total student engagement during the multi-dimensional intervention compared to CCC alone.
There were inconsistencies and variability in Jon’s engagement data, which questioned the reliability of the academic intervention alone demonstrating conclusive positive effects on student engagement compared to no intervention. In contrast, Harry’s data showed an increase in total student engagement during the academic intervention alone compared to no intervention but with a questionable effect.

High variability in the total engagement data may have been influenced by a noticeable discrepancy in classroom observation conditions for these two participants. The participant who demonstrated some improvement in student engagement during the multi-dimensional intervention compared to the academic intervention alone was observed under consistent classroom conditions where students in class worked on math fact fluency worksheets provided by the investigator as planned for the study. The participant’s whose student engagement deteriorated during the multi-dimensional intervention was observed under inconsistent classroom conditions including teacher-led instruction and/or the class completing the study’s math fact sheets or different math assignments provided by the teacher. Because some of the participant observation data were excluded from the study and there were limited data sets for the participants who were observed, there was an insufficient amount of information available to measure the effects of the multi-dimensional intervention on student engagement relative to the academic intervention alone.

Percentages of active versus passive student engagement were examined separately in addition to total engagement scores. Although the effects were statistically unreliable, both participants demonstrated higher median percentages of active engagement versus passive engagement during the academic alone condition compared to baseline, and then again during the multi-dimensional intervention compared to the academic intervention alone. For one
participant (Harry), active engagement increased during the multi-dimensional intervention relative to the academic intervention alone, while at the same time passive engagement decreased. These findings differ from the Vile Junod et al., study (2006) where students with ADHD exhibited lower rates of active engaged time than passive engaged time.

**Implications.** The study’s inconclusive results related to on-task behavior in the classroom, do not support the majority of research for students with ADHD where a reliable increase in on-task behavior associated with supports such as stimulating environments and materials, peer tutoring, and self-monitoring for accuracy were observed (DuPaul & Henningson, 1993; Evans et al., 1995; DuPaul et al., 1998; Shimabukuro et al., 1999;). Overall, the inconsistent results between the two participants in the current study could be due to the variability in classroom conditions during observation, the relationship between the participants and the observer, and other confounding variables that could affect student engagement outside of the intervention being implemented at the time. The question remains unclear whether a multi-dimensional intervention targeting academic skill mastery and motivation would generalize across settings and increase student engagement in the classroom for students with ADHD and low academic performance. Despite questionable findings, data demonstrating an increase in total student engagement for one participant and an increase in active engagement for both participants during the multi-dimensional intervention compared to the academic intervention alone suggest that it is worthwhile to further investigate the potential benefits of adding motivation coaching to an academic intervention and its impact on increasing student engagement in the classroom. In future investigations, consistent classroom conditions during systematic observations and anonymity of the observer may provide greater experimental control
for examining the effects of the multi-dimensional intervention on classroom student engagement for students with ADHD and low math performance.

**Treatment Acceptability**

Results from teacher acceptability ratings indicated that the multi-dimensional intervention was endorsed by teachers of participants as a worthwhile intervention for improving math fact fluency and motivation and as benefiting all participants in the study. Participant treatment acceptability ratings revealed that all of the participants endorsed the intervention as helping them do better in school, as being a comfortable method to receive help, and as a good intervention to use with other children. The majority of participants liked using the intervention, but agreed that there might be better methods for helping them with difficulties with math and motivation. Some of the participants were concerned that the intervention would cause problems with their friends. Overall, the general consensus among the teachers and students who participated in the study was that the multi-dimensional intervention was beneficial in helping participants improve their skills in math fact fluency and enhance their motivation. Favorable ratings from participants and teachers imply that students with high levels of ADHD symptomatology would benefit from academic interventions, which focus on skill mastery along with the development of positive self-efficacy beliefs and the use of self-regulated learning strategies to enhance academic motivation and performance.

**Limitations**

There are a number of limitations to be considered when interpreting the findings of the current study. Multiple treatment interference can occur when more than one treatment is administered to the same participant with the effects from one treatment likely influencing the effects of another treatment (Campbell & Stanley, 1963). In the current study, multiple
treatments (i.e., CCC alone and CCC + MC) were delivered in the same sequence for all participants making it difficult to distinguish the effects of the multi-dimensional intervention from the effects of the academic intervention alone on improved math fact fluency and improved teacher ratings in motivation and study skills. The effects of different interventions may be due to the sequence in which they were administered making it ambiguous to draw conclusions about the effect from each intervention (Kazdin, 1982). The current study’s design originally attempted to control for carry over effects by alternating the order of conditions across participants (i.e., CCC alone, then CCC+MC or CCC+MC, then CCC alone), however it quickly became clear that once participants received motivation coaching they continued to utilize self-regulated learning. This precluded the ability to distinguish effects of the two intervention conditions, and so it was considered necessary to have the multi-dimensional intervention follow the CCC alone condition. Thus, data from the two participants who received CCC+MC, then CCC alone were eliminated from the study and two additional participants were recruited. Three of the four participants demonstrated (Jon, Dick, and Harry) highly effective increases in math fact fluency after receiving the academic intervention alone before motivation coaching was added suggesting carry over effect from CCC alone to the multi-dimensional intervention. These findings are similar to the research literature supporting the efficacy of CCC to increase students’ academic performance in math fact fluency and other academic tasks (McLaughlin et al., 1991; Skinner, 1998; Skinner et al., 1992; Skinner et al., 1997; Smith et al., 2002; and Stading et al., 1996). In contrast, three out of four participants (Dick, Harry, and Jim) demonstrated unreliable increases in math fact fluency considered below chance level during the multi-dimensional intervention with only one participant (Jon) showing a reliable increase in performance.
Combining CCC with the implementation of the *Popper Test* during the CCC alone intervention in the current study to determine whether unknown facts practiced using CCC became known provided a motivation component separate from the CCC intervention originally proposed by Skinner (1998). Thus, participants’ results obtained during the CCC alone intervention were not in response to a pure CCC intervention. CCC alone and CCC+MC are better analyzed as providing two, qualitatively different levels of motivation intervention with the CCC alone containing a low-tier motivation component and CCC+MC including an expanded, higher-tier motivation component. A comparison of participants’ results in response to *pure* CCC relative to CCC combined with motivation coaching was not obtained in the current study. Taking into consideration that only one participant’s findings reliably supported CCC+MC over CCC alone regarding increases found in math fact fluency, the supposition that the effects of CCC continued during the multi-dimensional intervention, and the realization that CCC alone contained a low-level motivation component, the effects of adding motivation coaching to the academic intervention relative to CCC alone become less clear.

All of the students selected for the study may not have met full criteria for ADHD-Combined Type as stipulated in the DSM-IVTR. Only one participant was medically diagnosed with ADHD-Combined Type previous to participating in the study. While all participants were rated by their teachers with high levels of ADHD symptomatology, only two of them were additionally rated high by their parents. Because not all participants were rated as exhibiting ADHD symptoms across two environments (home and school), the results of the current study should technically be attributed to students with high levels of ADHD symptomatology rather than generalized to the ADHD student population. In addition, the limitation of mainly relying on teacher input regarding students’ behavior in school rather than including both parent and
teacher behavioral ratings makes it more difficult to obtain a pure sample of students with ADHD as there may be environmental, psychosocial, and medical reasons not related to having ADHD, which could be contributing to students’ exhibiting poor attention, impulsivity, and overactivity.

The ACES--Teacher form used to assess changes in participants’ motivation and study skills was administered pre- and post-intervention making it difficult to distinguish if teacher ratings in motivation improved in response to the implementation of the multi-dimensional intervention, CCC alone, or the combined effects of both interventions. Researchers replicating the study in the future should consider administering the Motivation and Study Skills subscales from the ACES--Teacher form subsequent to the CCC alone intervention and re-administering them after the multi-dimensional intervention to improve experimental control.

The IOA data was more limited in the current study than planned resulting in an insufficient number of IOA events to adequately measure interobserver agreement. IOA data collected from participants who were eliminated from the study were not used and classroom observations were not obtained for the two replacement participants. The remaining IOA data were restricted to two IOA observations following one participant over the course of the study. This substantially limited the amount of data obtained to measure student engagement during math ISW and the validity of the completed observations. In addition, the investigator completed classroom observations when research assistants were unavailable, which may have compromised the legitimacy of the data from these observations and IOA results. Student engagement may have improved in the current study for reasons unrelated to intervention conditions. Future replications of this study should recruit a sufficient number of research assistants (e.g., four or more) and emphasize the importance of committing to the full length of
the study so as not to jeopardize the integrity of the investigation. Offering financial compensation in addition to research experience might help insure more reliable commitments from future recruits.

The treatment integrity data was more limited in the current study than planned. Only four of the seven treatment integrity observations were used due to the elimination of participants from the study. Thus, there were insufficient data to indicate whether the study’s multiple treatments were implemented as intended, which ultimately interfered with securing sufficient treatment validity. Securing a sufficient number of committed research staff and having the investigator complete an intervention checklist while implementing the study’s interventions would avoid inadequate treatment integrity in future investigations.

Using Deno and Mirkin (1977)’s criteria as recommended by Shapiro (2004a) for determining students’ math skills at the mastery, instructional, and frustrational levels in the current study was ineffective for identifying math computation skills at the instructional level for participants. None of the participants in the current study were assessed as functioning at the instructional level in math computation skills using this approach. Newer criteria researched and recommended by Burns, Van, and Jiban (2006) suggest that students in the second and third grades perform at an instructional level when attaining 14-31 digits correct per minute. These authors further concluded that the criterion recommended by Deno and Mirkin (1977), 10-19 digits correct per minute (dc/min) represents an instructional level for students in the first through third grades, was estimated, lacked information about how the criterion were developed, not based on empirical data, and questioned as a valid approach. A second and more pertinent approach to consider for analyzing academic performance to determine instructional intervention for students is Instructional Hierarchy (IH; Haring, Lovitt, Eaton, & Hanson, 1978). Rather than
expecting students’ levels of performance to change, assessing whether different levels of efficiency are attained, such as accuracy, fluency, generalization, and adaptation, help to determine how to design instruction to meet the student’s level of proficiency in a given academic subject (Daly, Hintze, & Hamler, 2000).

Unknown supplemental influence from the school’s math curriculum, teacher instruction, and extra math help outside of the study’s treatment sessions, may have contributed to participants’ increases in math-fact performance during the study. The school’s math curriculum focused on math problem solving and provided less instruction and practice with computation and math facts. However, one of the participants received special education support in math outside of the classroom and two participants received math tutoring two days a week after school to prepare for state assessments. One of the teachers reported administering the math fact worksheets provided by the investigator to her class outside of the study’s scheduled classroom observations. Thus, supplemental math fact practice outside of the study’s treatment sessions may have confounded the current findings regarding the positive effects of the study’s multi-dimensional intervention on increasing participants’ math fact fluency. In addition, unknown adult encouragement and praise or academic motivational programs (e.g., classroom behavior plans encouraging increased academic participation) occurring outside of treatment sessions may have contributed to participants’ improvement in teacher ratings on the motivation and study subscales and in participants’ self-ratings in motivation beyond the single effects of the multi-dimensional intervention.

Expanding implementation of the study across back-to-back school years may have contributed to the variability noted in participants’ performance on dependent measures. Two students participated in the study towards the end of their third-grade year (April-June 2009) and
two students participated at the beginning of third grade (September-December 2009). The effects of the multi-dimensional intervention compared to the academic intervention alone on participants’ performance in math fact fluency, motivation, and student engagement may have been affected by variability in participant maturation due to differences in chronological age and grade placement. Regarding students participating in the fall 2009, one teacher commented that her ratings may not have been accurate as she reported not knowing the participants well enough when completing pre-intervention assessments in October after having these students in class for only two months. The disparity of teachers knowing student participants better during the spring versus the fall segment of the study may also have implications for the variability of pre- and post-teacher ratings on the ACES Motivation and Study Skills subscales. An additional factor to consider regarding the possible disparity in participant maturation was that two participants, Jim and Harry, had repeated a grade and were close to being chronologically a year older than the other participants.

The length of the study did not allow sufficient time to implement fading of the multi-dimensional intervention to slowly reduce the amount of support received by participants and to guide them towards independently implementing self-regulated learning strategies. Future studies should include fading procedures for participants to allow for greater self-sufficiency with the implementation of learning strategies.

Improvements in methodology for future studies should include measuring whether implementation of the multi-dimensional intervention generalizes to completion of math tasks in the classroom, increased student engagement, and/or increased positive self-efficacy beliefs and use of self-regulated learning strategies across subjects (e.g., reading, spelling, writing, science, and social studies) and settings (classroom and homework). It was unknown whether participants
maintained increased performances in math fact fluency and active classroom engagement past the study, thus, follow-up procedures are recommended to determine whether these positive effects continued after the multi-dimensional intervention was terminated.

It is unknown what effect the multi-dimensional intervention had on participants’ performance on math tasks and curriculum expectations in the classroom. Particularly for class curriculums adopting CBM and progress monitoring in math computation and applied problems, it would be beneficial to assess whether the multi-dimensional intervention has an effect on participants’ performances on CBM progress monitoring probes and benchmark assessments.

The PND was used to assess the reliability of visual analysis in the current study by determining overlap between experimental phases across baseline and the CCC alone and multi-dimensional intervention phases. The PND statistic may not have been sensitive enough to assess potential positive effects of the multi-dimensional intervention on measures of math fact fluency, motivation, and student engagement. The PND assumes data are normally distributed (Parker & Hagan-Burke, 2007), which was not always the case for the current study’s short data sets. In addition, outlier data can impact the utility of the PND.

The Student Goal Index Card, which was used to help students track their use of self-regulated learning strategies, did not appear age-appropriate for third-grade students, was difficult to manage for students with ADHD, and hard to implement in a classroom setting. None of the participants used it in the classroom to record when they used a learning strategy from their SAPs, nor remembered to bring it to treatment sessions as requested. Should the Goal Index Card be used in future studies, the investigator may want to consider options such as implementing a reward system for students using the cards in class and bringing them to treatment sessions or asking the student’s teacher to record when the student displayed
designated learning strategies in class. Participants could then graph the data collected from either of these methods to monitor their progress with independently implementing self-regulated learning strategies. This could provide a venue to allow participants to set goals for learning strategy implementation, as well as highlight goal attainment in this area. Having participants self-monitor their use of learning strategies could provide opportunities for them to develop positive self-efficacy beliefs related to using learning strategies, which could assist with enhancing academic motivation.

Because the study’s motivation probe is a non-standardized measurement and participants’ scores were based on subjective, self-reporting, the psychometric properties of this measure are unknown. Participant reactivity to the Motivation Probe threatened the validity of the current study in that participants were aware that they were being assessed and would be graphing their scores to monitor their progress. In some cases, participants seemed focused on attaining high scores rather than representing accurate self-assessments on motivation items.

Finally, when considering the study’s results and implications for practice, the personal dynamics, attention, and the benefits of consistently working in a one-on-one situation with the investigator should be regarded as likely contributing on some level to participant improvement in math fact fluency outside the single influence of the multi-dimensional intervention. Because the multi-dimensional intervention provided more adult attention relative to CCC alone, this may confound the finding suggesting that motivation coaching targeting academic self efficacy and use of self-regulated learning strategies improved participants’ performance in math fact fluency.

**Future Directions**

There is not a single theory of teaching or learning, to date, that addresses all of the challenges faced by students; indeed single theories may never adequately address the
complexities of learning (Harris, 1982; Pressley, Graham, & Harris, 2006). The current study attempted to meet the complex learning needs of students with ADHD and low math performance by examining the effectiveness of a multi-dimensional intervention designed to address some of the challenges these students face with learning. There are several important considerations to address in future investigations of adding motivation coaching (i.e., targeting academic self-efficacy and self-regulated learning) to an academic intervention targeting skill mastery. The current study did not address whether participants’ increased math fact fluency (i.e., automaticity in recalling math facts) improved their performance in the computation operation (i.e., addition or subtraction with or without re-grouping) where they originally tested at an instruction or frustration level. The positive effects and generalization of the multi-dimensional intervention could be further explored by additionally assessing math computation while targeting math fact fluency. This could be accomplished by administering single-skill, CBM math computation probes in addition to math fact probes during the two intervention phases. Participants could apply their improved skills in math fact fluency to math computation and graph their progress, thus providing opportunities for them to receive instruction and practice in computation deficiencies. In addition to increasing motivation resulting from greater success in math fact fluency, participants could work towards further increasing motivation through the development of positive self-efficacy beliefs regarding increased success with math computation and through generalization of self-regulated learning strategies adopted for math fact fluency to math computation. Monitoring participant progress in math computation during CCC alone and the multi-dimensional intervention would offer an additional comparison measure to assess the effectiveness of the multi-dimensional intervention relative to academic interventions without
motivation coaching, as well as examine its effectiveness regarding generalization to math competencies beyond math fact fluency.

Future studies should consider a variety of personnel options for implementing the multi-dimensional intervention. Considerations should be given to available school staff beyond school psychologists and special educators, whose availability is usually restricted by extended caseloads. Tutors, teacher aides, student teachers, and school volunteers could be trained in the multi-dimensional intervention, and then faded when students demonstrated sufficient improvement and readiness to receive reduced support. Future research designs should consider establishing criteria and determining instruments to assess when students are ready for fading and/or termination of the multi-dimensional intervention.

Greater effectiveness of the study’s multi-dimensional intervention is anticipated by increasing the number of intervention mediators, as recommended by DuPaul and Power (2000), through increasing communication between the motivation coach (investigator) and participants’ teachers and parents regarding participant progress during treatment. Setting up a system where participants bring ongoing progress reports to their parents and teachers would elicit additional positive support and coaching from influential people in their lives. This would provide increased opportunities for participants to develop positive, academic self-efficacy beliefs, as well as receive increased recognition and reinforcement for their efforts. In turn, this expanded network of positive feedback would likely lead to increases in participants’ academic motivation. Research has demonstrated the effective use of daily report cards (DRC) in many “multi-component interventions” with students with ADHD, which provided frequent home-school communication and resulted in improved academic and behavioral performance for this student.
population (Barkley et al. 2000; Murray, Rabiner, Schulte, & Newitt, 2008; Owens, Richerson, Beilstein, Crane, Murphy, & Vancouver, 2005; Wells et al. 2000).

**Generalizing across academic subjects.** Given that all of the study’s participants improved in math fact fluency when receiving the multi-dimensional intervention, future studies may want to investigate whether the multi-dimensional intervention could be applied to other subject areas beyond math and be combined with academic interventions in addition to CCC. The literature has demonstrated the success of using CCC across subjects (e.g., spelling, geography, and science; McLaughlin et al., 1991; Skinner et al., 1992; Stading et al., 1996; Skinner, 1998; and Smith et al., 2002). Thus, the multi-dimensional intervention could be used to increase fluencies in reading and spelling vocabularies to improve students’ academic performance and motivation in reading and writing, as well as to learn terms and factual data in science and social studies. Self-regulated strategy development (SRSD) in writing proposed by Harris, Santangelo, and Graham (2008) is an example of an effective intervention where students were directly taught self-regulated strategies combined with specific writing skills, similar to the multi-dimensional intervention proposed in the current study involving math skills.

**Extending to other student populations.** The current study was restricted to working with male students in the third grade with ADHD symptoms and low math performance. It is unknown whether female students with ADHD and low math performance and/or children in higher or lower grades would experience similar benefits from the multi-dimensional intervention. Replicating this study with female students and/or older or younger student populations would help determine the extent to which the current study’s results for the multi-dimensional intervention could be generalized to other populations.
The study’s findings suggested that multi-dimensional intervention was supportive in helping students with high levels of ADHD symptomatology, low math performance, and those who may typically display an aversive academic motivation style, improve their performance in math fact fluency and active student engagement. It is suggested that targeting academic skill mastery together with motivation would be effective for typical students and students with educational disabilities, such as learning disabilities, serious emotional disturbance, neurological impairment, communication disorders, autism spectrum disorder, etc. As adaptations were suggested when implementing the multi-dimensional intervention across academic subjects, adaptations could be extended to meet the needs of various student populations.

**Generalizing to classroom instruction.** Researchers should consider examining how the multi-dimensional intervention could be incorporated into the classroom curriculum where teacher-led instruction combined targeting mastery of academic skills with motivation coaching for the class as a whole. A group design study where all members of the entire class receive practice in skill mastery combined with motivation coaching would provide information on the efficacy of using the multi-dimensional intervention in a classroom setting. The group design could be arranged to have classroom teachers directly teach students self-regulated learning strategies, encourage positive self-talk, link academic success to student effort, provide opportunities for students to experience personal success to enhance positive self-efficacy beliefs in the subject matter being taught, and require students to self-monitor academic performance in the targeted subject matter. SRSD is an example of a multi-dimensional intervention provided to the class as a whole, which successfully helped students with and without learning difficulties attain significant and meaningful improvements in writing knowledge, skills, motivation, and self-regulation based on learning strategies that promoted independence with managing the
writing process (Graham & Harris 2003; Harris & Graham 1999). Thus, it is feasible that all students would benefit from formal education in developing self-regulated learning strategies, self-encouragement, and motivation. A multi-dimensional approach to learning targeting academic skills and motivation (i.e., academic self-efficacy and self-regulated learning) could be applicable in settings ranging from individual tutoring to full classroom implementation across academic subjects and student populations.

**Extending to student skill areas outside of academic performance.** Future studies could examine how the motivation coaching component of the multi-dimensional intervention could be used to treat emotional, behavioral, and/or social deficits displayed by students. For example, the study’s motivation coaching protocol could be used as an intervention for social skills training to help students with limited interpersonal skills improve social interaction within a school setting. Students’ social skills could be assessed and specific social skills known to be lacking could be targeted using the SAP model. The motivation coaching model could also be adapted for use to target desired behavioral changes for students with social adjustment and behavioral difficulties (e.g., social anxiety, oppositional behaviors, low frustration tolerance, and bullying behaviors).

**Follow-up studies.** Since the current study is the first of its kind to investigate the efficacy of targeting academic skill mastery together with motivation coaching for students with high levels of ADHD symptomatology, this study needs to be repeated incorporating the suggestions listed within this section to further determine the reliability and sustainability of the multi-dimensional intervention’s positive effects on math fact fluency and further explore its impact on academic motivation and student engagement. Combining CCC with the implementation of the *Popper Test* during the CCC alone intervention in the current study to
determine whether unknown facts practiced using CCC became known provided an added motivation component separate from the CCC intervention originally proposed by Skinner (1998). Thus, participants’ results obtained during the CCC alone intervention in the current study were not in response to a pure CCC intervention. Future studies could examine the separate effects of the original CCC procedure proposed by Skinner to increase math fact fluency compared to the current study’s extended CCC model involving an additional motivation component. The extended CCC model could prove to be more helpful than the standard CCC procedure for improving students’ math fact fluency. A comparison of participants’ results in response to pure CCC relative to CCC combined with motivation coaching is another suggested study that might better highlight the efficacy of including motivation coaching with mastery interventions. Evidence-based practices are severely needed to support students who are experiencing academic, behavioral, and social difficulties in our schools. Thus, extending the scope of the current investigation is important to determine whether the implementation of the study’s multi-dimensional intervention is feasible, practical, and effective for school settings.
Appendix A: Attention-Deficit/Hyperactivity Disorder Symptoms

(DSM-IV-TR; American Psychiatric Association, 2002)

Inattention Symptoms

Often fails to give close attention to details or makes careless mistakes
Often has difficulty sustaining attention during tasks or play activities
Often does not seem to listen when spoken to directly
Often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (not due to oppositional behavior or failure to understand instruction)
Often has difficulties organizing tasks and activities
Often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort
Often loses things necessary for tasks or activities
Is often easily distracted by extraneous stimuli
Is often forgetful in daily activities

Hyperactivity Symptoms

Often fidgets with hands or feet or squirms in seat
Often leaves seat in classroom or in other situations in which remaining seated is expected
Often runs about or climbs excessively in situations in which it is inappropriate (in adolescents or adults, may be limited to subjective feelings of restlessness)
Often has difficulty playing or engaging in leisure activities quietly
Is often “on the go” or often act as if “driven by a motor”
Often talks excessively

**Impulsivity Symptoms**

- Often blurts out answers before questions have been completed
- Often has difficulty awaiting turn
- Often interrupts or intrudes on others (e.g., interrupts conversations or games).
Appendix B: Tables B-1 to B-7

Table B-1

*Teaching Children Executive Functions*

Step 1: Describe the problem behaviors/situation, i.e., gives up with challenging items.

Step 2: Set a goal, i.e., persevere longer on tasks.

Step 3: Establish a plan- a set of steps to reach the goal, i.e., develop a checklist of strategies to sustain effort (ask for help; try independently, then ask teacher to check for accuracy).

Step 4: Supervise the child following the steps (a) remind the child to begin the procedure, (b) prompt the child to perform each step of the plan, (c) observe the child as each step is performed, (d) provide feedback to improve performance, (e) praise the child during each step of the process and when procedure is completed.

Step 5: Evaluate the process and make needed changes.

Step 6: Fade supervision and prompts to point where the child is able to independently follow the steps.

*Note:* Adapted from (Dawson & Guare, 2004).
Table B-2

*Screening, Pre-Intervention, and Intervention Measures*

<table>
<thead>
<tr>
<th>Screening measures</th>
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<tbody>
<tr>
<td>Attention Deficit Hyperactivity Disorder Symptom Checklist-4 (ADHD-S4)</td>
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<tr>
<td>AIMSweb Math Computation -Curriculum Based Measurement (M-CBM Benchmark Probes)</td>
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<tr>
<td>Parent Mathematic Assessment Questionnaire</td>
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<td>Teacher Mathematic Assessment Questionnaire</td>
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<tr>
<th>Pre-intervention measures</th>
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<tbody>
<tr>
<td>Woodcock Johnson III Tests of Achievement (WJ-III ACH)</td>
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<tr>
<td>Applied Problems subtest</td>
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<tr>
<td>Calculation subtest</td>
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<tr>
<td>Math Fluency subtest</td>
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<tr>
<td>Academic Competence Evaluation Scales (ACES: Teacher and Students forms)</td>
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<tr>
<td>Mathematics subscale</td>
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<tr>
<td>Motivation subscale</td>
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<tr>
<td>Study Skills subscale</td>
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<tr>
<td>Multidimensional Scales of Perceived Self-Efficacy (MSPSE)</td>
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<td>Self-Efficacy for Academic Achievement (AEE)</td>
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<tr>
<td>Self-Efficacy for Self-Regulated Learning (SRL)</td>
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<td>Single-Skill Math Probes from the Curriculum-Based Assessment Math Probe Generator</td>
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<table>
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<th>Dependent Measures</th>
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<tr>
<td>AIMSweb Math Fact Probes</td>
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</table>
Motivation Probe

Behavioral Observation of Students in Schools (BOSS)

Social Acceptability Measures

Children’s Intervention Rating Profile (CIRP)

Intervention Rating Profile for Teachers (IRP-15)

Note. CIRP and IRP-15 were adapted for the study.
Table B-3

Participants’ Pre- and Post-Intervention Teacher Ratings for the ACES Motivation and Study Skills Subscales

<table>
<thead>
<tr>
<th>Participant</th>
<th>Pre-Intervention</th>
<th>Post-Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Decile</td>
<td>Range</td>
</tr>
<tr>
<td>Jon</td>
<td>2</td>
<td>Developing</td>
</tr>
<tr>
<td>Dick</td>
<td>2</td>
<td>Dev/Competent</td>
</tr>
<tr>
<td>Harry</td>
<td>1</td>
<td>Developing</td>
</tr>
<tr>
<td>Jim</td>
<td>2</td>
<td>Developing</td>
</tr>
</tbody>
</table>

**Motivation Subscale**

**Study Skills Subscale**

Note. Dev/Competent= confidence intervals from the participant’s raw score fell in the Developing range and expanded into the Competent range.
Table B-4

*Participants’ Improvement on Items from the ACES Motivation Subscale*

<table>
<thead>
<tr>
<th>Scale Item</th>
<th>Jon</th>
<th>Dick</th>
<th>Harry</th>
<th>Jim</th>
<th>Participants Improved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is motivated to learn</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>3</td>
</tr>
<tr>
<td>Prefers challenging tasks</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Produces high quality work</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Attempts to improve in previous performance</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Makes the most of learning experiences</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Looks for ways to academically challenge self</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Assumes responsibility for own learning</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>4</td>
</tr>
<tr>
<td>Is goal-oriented</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>3</td>
</tr>
<tr>
<td>Stays on task</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Critically evaluates own work</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Persists when tasks are difficult</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Participants’ Total Items Improved</td>
<td>11</td>
<td>6</td>
<td>6</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* + = Yes, - = NO.
Table B-5

$Participants’$ Improvement on $Items$ of the ACES Study Skills Subscale

<table>
<thead>
<tr>
<th>Scale Item</th>
<th>Jon</th>
<th>Dick</th>
<th>Harry</th>
<th>Jim</th>
<th>Participants Improved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completes homework</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Corrects own work</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>2</td>
</tr>
<tr>
<td>Finishes class work on time</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Prepares for tests</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Prepares for class</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Turns in homework on time</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Takes care of materials (e.g., textbooks, desk)</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Pays attention in class</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Completes assignments according to directions</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>2</td>
</tr>
<tr>
<td>Takes notes in class</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Reviews materials</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>3</td>
</tr>
<tr>
<td>Participants’ Total Items Improved</td>
<td>11</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* + = Yes, - = No.
Table B-6

*Participants’ Results on the SAP*

<table>
<thead>
<tr>
<th>SAP Results</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dick</td>
</tr>
<tr>
<td>Mean DCPM Goal Attainment</td>
<td>100%</td>
</tr>
<tr>
<td>Learning Strategy (LS)</td>
<td>-Extra CCC</td>
</tr>
<tr>
<td></td>
<td>practice*</td>
</tr>
<tr>
<td></td>
<td>-Study math facts</td>
</tr>
<tr>
<td></td>
<td>-Class</td>
</tr>
<tr>
<td></td>
<td>-Positive self-talk participation</td>
</tr>
<tr>
<td>Number of LS observed</td>
<td>21</td>
</tr>
</tbody>
</table>

*Students completed and returned extra CCC homework.*
Appendix C: Parent and Teacher Questionnaires

Teacher Questionnaire for Assessment of Mathematics

Student Name ______________________ Grade _______________ Date ___________

Curriculum series__________________________________________________________

Describe the student’s specific difficulties in math ____________________________
_____________________________________________________________________

How often does math occur in class? _______________________________________

How is time divided? (Independent seatwork, Small group? Large group? Cooperative
group?)_______________________________________________________________

How would you rate the following skills of the referred student? Please circle:

Addition facts: Frustration Level  Instructional Level  Mastery Level

Subtraction facts: Frustration Level  Instructional Level  Mastery Level

Multiplication facts: Frustration Level  Instructional Level  Mastery Level

Division facts: Frustration Level  Instructional Level  Mastery Level

Addition computation with regrouping:                                    
Frustration Level  Instructional Level  Mastery Level

Subtraction computation with regrouping:                                  
Frustration Level  Instructional Level  Mastery Level

Multiplication computation with regrouping:                               
Division computation:  Frustration Level  Instructional Level  Mastery Level

Solving math word problems:  Frustration Level  Instructional Level  Mastery Level

Are your students grouped in math?________________________________________

If so, how many groups do you have, and in which group is the referred student placed?
Does this student participate in Chapter 1 or special education services?

Group standardized test results (if available)

Contingencies for accuracy?

Contingencies for completion?

**BEHAVIOR DURING MATH**

Rate the following areas from 1 to 5 (1 = very unsatisfactory, 3 = satisfactory, 5 = superior)

MATH Group (large)

- Volunteers answers
- When called upon gives correct answer
- Attends to other students when they give answers

MATH Group (small)

- Volunteers answers
- When called upon gives correct answer
- Attends to other students when they give answers

**INDEPENDENT SEATWORK**

- Stays on task
- Completes assigned work in required time
- Work is accurate
- Follows directions
- Works quietly
- Remains in seat when required
Does this student demonstrate any difficulties with attention and focusing? NO YES

If yes, please describe__________________________________________________________

____________________________________________________________________________

Any difficulties with hyperactivity/impulsivity? NO YES If yes, please describe_______

____________________________________________________________________________
Parent Questionnaire for Assessment of Mathematics

Child’s Name____________________ Grade_______________ Date____________

How well is your child performing in the subjects listed below:

- Reading
  - Failing
  - Below Average
  - Average
  - Above Average

- Math
  - Failing
  - Below Average
  - Average
  - Above Average

- Written Language
  - Failing
  - Below Average
  - Average
  - Above Average

- Science
  - Failing
  - Below Average
  - Average
  - Above Average

- Social Studies
  - Failing
  - Below Average
  - Average
  - Above Average

Does your child receive special education or remedial services or attend a special class?

NO   YES  If yes, please explain kind of services or class_________________________

_______________________________________________________________________

Has your child repeated any grades:  NO   YES  If yes, grades and reasons

_______________________________________________________________________

Has your child had any academic problems in math or other problems in school?

NO   YES  If yes, please describe_____________________________________________

________________________________________________________________________

For how long have these problems been apparent? How old was your child when he/she first started having problems in math or other areas?_________________________________

_______________________________________________________________________

Does your child have any illnesses or disability (physical or mental)?  NO   YES

If yes, please describe____________________________________________________

________________________________________________________________________

Does this student demonstrate any difficulties with attention and focusing?  NO   YES

If yes, please describe____________________________________________________
Any difficulties with hyperactivity/impulsivity? NO YES If yes, please describe

What concerns you most about your child

What are your child’s strengths?

What are your child’s interests?
Appendix D: (Bandura, 1989b)

These questionnaires are designed to help us get a better understanding of the kinds of things that are difficult for students. Please rate how certain you are that you can do each of the things described below by circling the number that tells how well you can do each item.

Self-Efficacy for Academic Achievement

1. Learn math

   1 3 5 7

   Not well at all  Not too well  Pretty well  Very well

2. Learn reading

   1 3 5 7

   Not well at all  Not too well  Pretty well  Very well

3. Learn writing

   1 3 5 7

   Not well at all  Not too well  Pretty well  Very well

4. Learn spelling

   1 3 5 7

   Not well at all  Not too well  Pretty well  Very well

5. Learn science

   1 3 5 7

   Not well at all  Not too well  Pretty well  Very well

6. Learn social studies

   1 3 5 7

   Not well at all  Not too well  Pretty well  Very well
Self-Efficacy for Self-Regulated Learning

1. Finish my homework assignments by deadlines
   Not well at all  Not too well  Pretty well  Very well
   1  3  5  7

2. Get myself to study when there are other interesting things to do
   Not well at all  Not too well  Pretty well  Very well
   1  3  5  7

3. Always concentrate on school subjects during class
   Not well at all  Not too well  Pretty well  Very well
   1  3  5  7

4. Plan my schoolwork for the day
   Not well at all  Not too well  Pretty well  Very well
   1  3  5  7

5. Organize my schoolwork
   Not well at all  Not too well  Pretty well  Very well
   1  3  5  7

6. Get myself to do schoolwork
   Not well at all  Not too well  Pretty well  Very well
   1  3  5  7

7. Arrange a place to study without distractions
   Not well at all  Not too well  Pretty well  Very well
   1  3  5  7

8. Use the library to get information for class assignments
<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>3</th>
<th>5</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>Not well at all</em></td>
<td><em>Not too well</em></td>
<td><em>Pretty well</em></td>
<td><em>Very well</em></td>
</tr>
</tbody>
</table>
Appendix E: Motivation Probe

1. How well can you ask for help when you get stuck on schoolwork?

   1 3 5 7

   Not well at all  Not too well  Pretty well  Very well

2. How well do you succeed in cheering yourself up or giving yourself a pep talk when something negative happens or you don’t do well in school?

   1 3 5 7

   Not well at all  Not too well  Pretty well  Very well

3. How satisfied are you with your schoolwork in math?

   1 3 5 7

   Not well at all  Not too well  Pretty well  Very well

4. How much responsibility do you take for your own learning?

   1 3 5 7

   Not well at all  Not too well  Pretty well  Very well

5. Do you set personal goals?

   1 3 5 7

   Not well at all  Not too well  Pretty well  Very well

6. How often do you do good work?

   1 3 5 7

   Not well at all  Not too well  Pretty well  Very well

7. How often do you keep on trying when you are bored or something is hard?

   1 3 5 7

   Not well at all  Not too well  Pretty well  Very well
8. How well do you finish all your work on time?

1 3 5 7

Not well at all Not too well Pretty well Very well

9. How often do you double-check your answers?

1 3 5 7

Not well at all Not too well Pretty well Very well

10. How often do you organize your schoolwork and materials (pencil, homework, etc.)?

1 3 5 7

Not well at all Not too well Pretty well Very well

11. How often do you arrange a place to study without distractions?

1 3 5 7

Not well at all Not too well Pretty well Very well

12. How well do you motivate yourself do to your schoolwork/homework?

1 3 5 7

Not well at all Not too well Pretty well Very well
Appendix F: BOSS Coding Sheet

Form 6

BEHAVIORAL OBSERVATION OF STUDENTS IN SCHOOLS (BOSS)

Child Observed: ___________________  Academic Subject: ___________________
Date: ___________________  Setting: __ ISW:TPsnt __ SmGp:TPsnt
Observer: ___________________  __ ISW:T5mGp __ LgGp:TPsnt
Time of Observation: ___________________  Interval Length: _______  Other: _______

| Moment | 1   | 2   | 3   | 4   | 5*  | 6   | 7   | 8   | 9   | 10* | 11  | 12  | 13  | 14  | 15* | S   | P   | T   |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| AET    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| PET    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Partial|     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| OFT-M  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| OFT-V  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| OFT-P  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| TDI    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

| Moment | 16  | 17  | 18  | 19  | 20* | 21  | 22  | 23  | 24  | 25* | 26  | 27  | 28  | 29  | 30* | S   | P   | T   |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| AET    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| PET    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Partial|     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| OFT-M  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| OFT-V  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| OFT-P  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| TDI    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

| Moment | 31  | 32  | 33  | 34  | 35* | 36  | 37  | 38  | 39  | 40* | 41  | 42  | 43  | 44  | 45* | S   | P   | T   |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| AET    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| PET    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Partial|     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| OFT-M  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| OFT-V  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| OFT-P  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| TDI    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

| Moment | 46  | 47  | 48  | 49  | 50* | 51  | 52  | 53  | 54  | 55* | 56  | 57  | 58  | 59  | 60* | S   | P   | T   |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| AET    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| PET    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Partial|     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| OFT-M  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| OFT-V  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| OFT-P  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| TDI    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

Target Student | S AET | % AET | S AET | % AET | S AET | % AET |
Teacher | S TDI | % TDI |

*Peer Comparison | S PET | % PET | S PET | % PET |

Total Intervals | S OFT-M | % OFT-M | S OFT-M | % OFT-M |

Observed | S OFT-V | % OFT-V | S OFT-V | % OFT-V |

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Appendix G: Adapted Children’s Intervention Rating Profile (CIRP: Witt & Elliot, 1985)

Directions to administer the Adapted CIRP.

I am going to ask you to mark whether you agree or disagree with a statement using this type of line. Do you agree with this statement? If so, mark here (point). If not, mark here (point). Or you can mark somewhere in the middle. Ask the student to practice rating items by marking the following sample items.

I like to eat cookies.

I agree I do not agree
I-------------------I-------------------I-------------------I-------------------I-------------------I

I like to eat dirt.

I agree I do not agree
I-------------------I-------------------I-------------------I-------------------I-------------------I

Clarify student response:

Your mark tells me you ‘like to eat cookies/dirt,’

Your mark tells me you ‘kind of like to eat cookies/dirt’,

Your mark tells me you ‘can’t decide whether you like to eat cookies/dirt’,

Your mark tells me you ‘kind of don’t like to eat cookies/dirt’,

Your mark tells me you ‘don’t like to eat cookies/dirt’

If clarification was correct, move to next sample item.

If incorrect, show student where he/she should have marked to accurately rate how much he/she agrees or disagrees, and then move to next sample item.

Now I will ask you to rate items about the math fact and motivation intervention the same way.

The method used to increase math facts and motivation was fair.

I agree I do not agree
Coaching was a comfortable way to receive help.
I agree  I do not agree

The method used to increase math facts and motivation may cause problems with my friends.
I agree  I do not agree

There are better ways to handle this problem than using Cover, Copy, & Compare and motivation coaching.
I agree  I do not agree

The method used to increase math facts and motivation would be a good one to use with other children.
I agree  I do not agree

I like the method used for helping students get better at math facts and increasing motivation.
I agree  I do not agree

I think that the method used for getting better at math facts and increasing motivation helped me do better in school.
I agree  I do not agree
Appendix H: CCC+MC Intervention Description and the Adapted Intervention Rating


Dear Teacher:

Please help assess the value of the following intervention:

A Multi-Dimensional Intervention for Students with Low Math Performance and ADHD-Like Symptoms: Cover-Copy-Compare Math Intervention Combined with Motivation Coaching

Intervention Description

Students are seen in individual sessions three times a week, which focus on increasing math fact fluency in the math operation at their frustration level. The math intervention called Cover Copy Compare is used to enhance math fact fluency by asking the student to learn five math facts to automaticity by looking at a math fact, covering the fact, writing down the fact with the answer from memory, and comparing their answers to the original fact. In addition, the student is provided with an individually-designed motivation coaching protocol, which focuses on coaching the student to increase personal self-efficacy in math by learning to set personal goals, developing strategies to help them meet their goals, linking their effort to their progress, experiencing early and sustained success, developing positive self-talk to encourage perseverance and investment, and graphing personal results on math fact and computation probes, scores on motivation probes, and percentages of active and passive student engagement rated by research assistants during independent math seatwork through classroom observations.

Please complete the Intervention Rating Profile on the following page. Thank you for your input regarding the efficacy of this intervention.
Teacher Evaluation of Intervention

Please circle the number that best describes your agreement or disagreement with each statement using the scale below:

1=strongly disagree  2=disagree  3=slightly disagree  4=slightly agree  5=agree  6=strongly agree

1. This is an acceptable intervention for a student with low math performance and ADHD-like symptoms. 1 2 3 4 5 6

2. Most teachers would find this intervention appropriate for academic difficulties and behavior problems in addition to the one described. 1 2 3 4 5 6

3. This intervention should prove effective in changing the child’s math performance and motivation. 1 2 3 4 5 6

4. I would suggest the use of this intervention to other teachers. 1 2 3 4 5 6

5. Students who participated in the study demonstrate problems serious enough to warrant use of this intervention. 1 2 3 4 5 6

6. Most teachers would find this intervention suitable for the difficulties described. 1 2 3 4 5 6

7. I would be willing to have this intervention used with the student individually outside of the classroom setting. 1 2 3 4 5 6

8. This intervention would not result in negative side effects for the child. 1 2 3 4 5 6

9. This intervention would be appropriate for a variety of children. 1 2 3 4 5 6

10. This intervention is consistent with those I have used in a
classroom setting.

11. The intervention was an effective way to handle the child’s difficulties.

12. This intervention is reasonable for the child’s academic and motivation difficulties.

13. I liked the procedures used in this intervention.

14. This intervention was a good way to handle the child’s academic and motivation difficulties.

15. Overall, this intervention was beneficial for the child.
Appendix I: Intervention Manual

Procedures for Cover, Copy, and Compare (CCC; Coddington et al., 2006; Skinner et al., 1997)

Directions for Individual Sessions

Assess unknown math facts for targeted math operation on an ongoing basis.

1. During intervention sessions, use the next-audiotape procedure to determine unknown math facts on an as needed basis to make certain each participant has a sufficient amount of unknown math facts to practice using the CCC worksheets:
   a) Develop a time tape that prompts the participant with Next to attempt a problem every 1.5 seconds.
   b) Provide the participant with a brief, math fact probe containing 20 math facts from the 100 single math facts in their targeted operation.
   c) Repeat the following directions:
      1) “When I say, ‘Begin,’ do a problem, but move on to the next problem when the tapes says, “Next”. The word “Next” will sound every 1.5 seconds.
      2) If the problem is not finished by the work ‘Next’, you must go on.
      3) When I say, ‘Stop,’ put your pencil down”.
   d) Start the next-audiotape and tell the participant to begin. Stop the participant after the last problem in the last row is attempted on the short math fact probe.
   e) Have the student pick out five unanswered problems and insert them into his CCC worksheet.
Standard CCC Session

1. Take the CCC worksheet from the student’s packet and hand it to the student. Reserve the AIMSweb CBA math fact probe for later. Explain and demonstrate the following five steps prior to implementation for the first three sessions using the following script: “We are going to be working together three times a week for a couple of months to help you improve your math. We will be using a special strategy to help you learn your math facts so you can recall them quickly. This is called Cover, Copy, and Compare. I would like you to practice your math facts using the following five steps:
   a. “Look at the math fact problem with the answer
   b. Cover the math problem with the answer with an index card
   c. Write the math problem with the your answer
   d. Uncover the original math problem with the answer
   e. Compare your answer to check if it is correct
   f. Repeat the process if the answer is incorrect”

   Eliminate these instructions after the first three sessions or until the student knows them.

2. Instruct the student to practice selected math facts for five minutes using the CCC strategy by completing the CCC worksheet. Say, “For the next five minutes use the CCC strategy to practice these problems. The goal is to learn the facts so they just ‘pop out’ without using your fingers and become a ‘popper.’ Provide usual and customary recognition and praise when the student exhibits effort in performance and follows directions.
3. Administer a CCC fact probe (popper test) containing the five targeted facts on the CCC worksheet dispersed with other math facts cued by the next-audiotape to determine if targeted unknown facts became known (i.e., become poppers).

4. Begin the next-audiotape. Stop the participant when the tape ends. Correct the CCC fact probe with the participant and identify which unknown math facts became known. The previously unknown facts are transferred from the Unknown Fact column to the Known Fact column on the Math Fact Record Sheet (see Appendix I, Intervention Manual for a copy of the Math Fact Record Sheet). Recognize the participant when unknown facts become known.

5. Administer the AIMSweb math fact probe within a two-minute time frame using the following script: “I’m going to give you a two-minute math fact test. All of the problems are (addition or subtraction or multiplication or division) facts. Look at each problem carefully before you answer it. Complete each problem in sequence, only skip problems that you cannot do after trying. When I say ‘start,’ begin answering the problems. Start at the first problem on the left on the top row [point]. Work across and then go to the next row. If you finish one side, do the problems on the back.”

6. Thank the student for his hard work and cooperation, but do not give any feedback on how he performed on the probe. Remind the student when you will be seeing him for his next session.

7. Score and record the student’s AIMSweb math fact probe by summing the DCPM. The following responses are scored as correct: a) individual digits, b) “place holder” numbers, and c) digits below the line.
8. Place the CCC worksheet, the CCC fact probe, and the AIMSweb Math Fact probe in the participant’s binder.
# Math Fact Record Sheet

Name__________________________________________________________

*Targeted Operation(s): Addition, Subtraction, Multiplication, Division Number Range _______

<table>
<thead>
<tr>
<th>Unknown Math Facts</th>
<th>Check When Known</th>
<th>Date</th>
<th>Known Math Facts</th>
<th>Known Math Facts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
### Sample CCC Worksheet

**Name_____________________________ Date______________________**

<table>
<thead>
<tr>
<th>Look at problem</th>
<th>Cover problem</th>
<th>Write the problem</th>
<th>Compare Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 6</td>
<td>-2</td>
<td>4</td>
<td>Redo</td>
</tr>
<tr>
<td>2. 4</td>
<td>-2/2</td>
<td></td>
<td>Redo</td>
</tr>
<tr>
<td>3. 17</td>
<td>-8/9</td>
<td></td>
<td>Redo</td>
</tr>
<tr>
<td>4. 16</td>
<td>-8/8</td>
<td></td>
<td>Redo</td>
</tr>
<tr>
<td>5. 9</td>
<td>-3/6</td>
<td></td>
<td>Redo</td>
</tr>
</tbody>
</table>
Sample CCC Math Fact Probe (Popper Test)

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>9</td>
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<td>10</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>-5</td>
<td>-6</td>
<td>-8</td>
<td>-2</td>
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<td></td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>12</td>
<td>7</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>-2</td>
<td>-6</td>
<td>-8</td>
<td>-3</td>
<td>-5</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>9</td>
<td>17</td>
<td>9</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>-5</td>
<td>-6</td>
<td>-8</td>
<td>-3</td>
<td>-2</td>
<td></td>
</tr>
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<tr>
<td>-6</td>
<td>-3</td>
<td>-2</td>
<td>-8</td>
<td>-9</td>
<td></td>
</tr>
</tbody>
</table>
Motivation Coaching Protocol

General Strategies for Strategy Action Plan

Strategies to increase academic self-efficacy.

- Decide on personal skills to develop and set performance goals
- Graph personal progress on performance and skill goals
- Develop internal locus of control by linking progress to effort, practice, development of skills, and level of motivation to do well
- Increase positive self talk by translating negative thoughts about school performance into positive thoughts
- Verbalize realistic, expected outcomes regarding performance
- Visualize self as being capable and able to complete expected work
- Congratulate oneself in response to doing good work or getting better grades

Self-regulated learning strategies.

- Ask for help (peers or teachers)
- Check answers
- Ask myself does this answer make sense when completing math problems
- Practice math facts using CCC to over learn until automatic
- Organize my work, papers, and materials so I can find them to use to study
- Be prepared for school with materials
- Find a quiet place to study without distractions
- Break big assignments into small steps
- Make a list of assignment responsibilities, check off as complete each step
- Participate in class discussions
• Volunteer to answer in class
• Finish homework and hand in on time
• Finish schoolwork in class and hand in on time
• Find out how to do work I don’t understand and practice doing it the correct way
• Find personally interesting topics when completing a class project

Procedures for Initial Coaching Session

1. Explain the motivation coaching process: The script for initiating motivation coaching with participants is below:

   “We will be starting our motivational coaching sessions today, which we will do after your CCC work. That means our sessions will now go for 30 minutes instead of 15. Coaching is a special time when I will be teaching you how to coach yourself to do your best work. Doing well makes us feel good about ourselves. Doing well is all about using strategies, developing plans, and putting our plans into action to help us do better. We will figure out what is not working well for you and what strategies would help you do better in school. We will be following five steps: 1) Discuss what the problem is, 2) Set up a goal each week to address the identified problem, 3) Pick strategies to help you make your goal, 4) Review your scores from the math and motivation probes and your on-task engagement score during ISW (if applicable) and graph your progress to watch your growth. We will graph your DCPM score from the math fact probe each time we meet to see if you reached your DCPM goal on your SAP and determine whether you need to change it to a higher goal or keep it the same. Once a week during one of our sessions, we will graph your score on the Motivation Probe and your score in
student engagement (only mention this if the participant being addressed is one of the two participants who had classroom observations completed during math ISW). 5) During this weekly session, you will evaluate how well you think you did using your strategies and meeting your goal(s) by counting up the tally marks on your Goal/Strategies Index Card. At that time, we will decide whether to have you pick a new goal or continue with the same goal to help you do better at meeting that goal before moving onto a new one.”

2. Show the participant how the SAP (Appendix I) and Goal/Strategies Index Card (Appendix I) will be used to develop a goal(s) and action plan and self-evaluate progress.

3. Review the participant’s results from the pre-intervention battery (i.e., responses and scores on the ACES and MSPSE subscales, and on-task percentage scores from classroom observations during ISW (if applicable) as input to help the participant set his first goal(s) and select self-regulated learning strategies for his SAP. The input from the motivation pre-assessment measures will also help the coach determine what motivational coaching components should be part of each participant’s individualized coaching protocol.

4. Establish the SAP (see Appendix I for a copy of the SAP form), which is a set of steps to help the participant reach his goal(s).
   a. Help the participant establish a goal(s) and write it on the SAP form. Review the General Strategies for Student Strategy Plan (see Appendix I) for a list of academic self-efficacy and self-regulated learning strategies with the participant to pick strategies to support the participant’s goal.
b. Ask the participant to sign the SAP form to obtain his written commitment to work on his goal(s) and implement his selected learning strategies. The coach signs the SAP contract, as well.

c. Write the strategies on the Goal/Strategies Index (see Appendix I) for the participant to put in his desk to continually review as a prompt to use his selected learning strategies in class. Ask the participant to put a tally mark next to each strategy on his card as he uses them in class. Ask him to bring the Goal/Strategies Index Card to his next session to review his progress with using his learning strategies in class.

d. Thank the participant for cooperating and working hard on starting his new plan (SAP) to help himself do better in math and increase his motivation. Emphasize looking forward to working with him and watching his progress.

Procedures for Ongoing Coaching Sessions

1. Exchange general conversation and warm greetings to start session.

2. Obtain an update on progress and assesses for problem behaviors or situations:
   a. Reviews reason for coaching with student:
      i. To teach you to coach yourself to do your best work.
      ii. Doing well makes you feel good about yourself.
      iii. Making a strategy plan and putting it into action helps us to our best work.

b. Ask the participant whether he has been using CCC outside of the sessions.

c. Ask if the participant brought his Goal/Strategy Card with him to the session to review.

d. Ask the participant whether he has been implementing his recent SAP to meet his
goal(s) to _______________. Review how many tally marks he
made on his Goal/Strategies Index Card to indicate how often he used his
strategy(ies) in class. Verbally recognize participant’s demonstrated responsibility in
bringing the Goal/Strategies Index Card to session and for keeping a record of when
he used his selected learning strategies in class. Praise his use of learning strategies in
class.

3. Review results from math fact probe.
   a. Help the participant graph his DCPM performance on math fact fluency probe
      (see Appendix I for math fact fluency graph).
   b. Recognize the participant’s progress if DCPM increased from last session. If the
      participant surpasses his SAP DCPM goal, help him designate a new, realistic
      goal. If the participant’s DCPM decreased, explains how progress is not always a
      straight, upward trend but can dip and increase the next time. Remind the
      participant that he has progressed so far from when he first started.

4. Encourage success:
   a. Recognize effort and links effort to progress.
   b. Coach the participant to use strategies if he has not been implementing them
      routinely. Discuss how he can increase the use of designated strategies.
   c. Coach the use of positive self-talk to increase motivation to do well in math
      and increase use of strategies

5. Celebrate the participant’s success using verbal recognition and praise and link doing
   well with his effort and use of strategies.

6. Ask the participant to identify and describe any current problem
behaviors/situations that might be interfering with doing well in math. Discuss possible strategies.

7. Eventually and when appropriate, fade supervision and prompt to enable the participant to follow the steps to his SAP independently.

**Procedures for Weekly Individual Sessions When a New SAP Is Developed**

1. Obtain an update on progress and assesses for problem behaviors or situations:
   a. Ask the participant if he has been implementing his recent SAP to meet his goal to _____________.
   b. Ask how the participant’s SAP is working. Discuss any problem areas or situations.
   c. Review results from progress monitoring probes (math fact fluency and Motivation Probe) and ISW observation (if applicable) to determine if the participant has met his goal(s).
   d. Help the participant graph his performance on the math fact fluency probe and Motivation Probe measures and his student engagement score from the classroom observation (if applicable; see Appendix I for graphs).
   e. Direct the participant to evaluate his individual performance regarding meeting his specific goal(s) and implementing selected learning strategies. Review how many tally marks he made on his Goal/Strategies Index Card to indicate how often he used his strategy(ies) in class.
   f. Direct the participant to rate his progress on his SAP for meeting his goal(s) and implementing selected learning strategies using the following scale for meeting his goal:
5=Met Goal, 3=Partial Goal, and 1=Try Again and the following scale for implementing learning strategies: 1=Never, 3=Sometimes, or 5=Everyday.

g. Highlight the participant’s success using verbal recognition and praise and link doing well with the participant’s effort and use of strategies.

h. Ask the participant to identify and describe any current problem behaviors/situations that might be interfering with doing well in math.

2. Help the participant set a goal(s) and select learning strategies for his new SAP:

   a. Use input from recent progress monitoring probes and from participant’s self-evaluation on his current SAP to help the participant set a goal(s), no more than three, to work towards for the next three sessions.

   b. Ask the participant to design a measurable goal(s) directly related to the problem behavior, academic difficulty, or desire to beat his previous scores.

3. Establish the SAP/completes the SAP form

   a. Help the participant establish a goal(s) and write it on the SAP form.

   b. Help the participant select strategies to support him with attaining his designated goal(s). Review the General Strategies for Student Strategy Plan, a reference which lists suggested academic self-efficacy and self-regulated learning strategies, with the participant to pick effective strategies.

   c. Ask the participant to sign the SAP form to obtain his written commitment to work on his goal(s) and implement the selected learning strategies. Coach signs the SAP form as well.

4. Complete a Goal/Strategies Index Card
a. Write the participant’s goal(s) and strategies on his Goal/Strategies Index Card for the participant to put in his desk and asks him to continually review it to prompt him to use his learning strategies in class.

b. Ask the participant to put a tally mark next to any strategy on his Goal/Strategies Index Card when he uses it in class.

c. Ask the participant to bring his Goal/Strategies Index Card with him to his next session to review his progress on implementing his selected learning strategies.

5. Thank the participant for cooperating and working hard on his SAP and making a new SAP.

6. During each session, supervise the participant on how he implements CCC and his SAP:

   a. Remind the participant to use his strategies, if not self initiated
   
   b. Provide feedback to improve performance and praises and recognizes if the participant displays the strategies and meets his goal(s).

7. Fade supervision and prompts to allow the participant to be able to follow the steps on his SAP independently.
## Strategy Action Plan Form

<table>
<thead>
<tr>
<th>Strategy Action Plan</th>
<th>Date:</th>
<th>Week:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Self-Evaluation</td>
<td>Progress Monitoring Scores</td>
</tr>
<tr>
<td><strong>Goal:</strong></td>
<td>5 3 1</td>
<td>Math (___)</td>
</tr>
<tr>
<td></td>
<td>Met Partial Try</td>
<td>Motiv (___)</td>
</tr>
<tr>
<td></td>
<td>Goal Goal Again</td>
<td>ISW (___)</td>
</tr>
</tbody>
</table>

**Strategy A**

<table>
<thead>
<tr>
<th>Step 1</th>
<th>5 3 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Always Some* Never</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 2</th>
<th>5 3 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Always Some Never</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 3</th>
<th>5 3 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Always Some Never</td>
</tr>
</tbody>
</table>

**Strategy B**

<table>
<thead>
<tr>
<th>Step 1</th>
<th>5 3 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Always Some Never</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 2</th>
<th>5 3 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Always Some Never</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 3</th>
<th>5 3 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Always Some Never</td>
</tr>
</tbody>
</table>

We agree to this plan:

Student Signature _______________________________

Coach Signature _______________________________

*Some=Sometimes
Goal/Strategies Index Card

<table>
<thead>
<tr>
<th>Name:</th>
<th>Strategy Action Plan</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal:</td>
<td>Check Each Time I Do These</td>
<td></td>
</tr>
<tr>
<td>Strategy A</td>
<td>Strategy B</td>
<td></td>
</tr>
<tr>
<td>Step 1</td>
<td>Step 1</td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td>Step 2</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>Step 3</td>
<td></td>
</tr>
</tbody>
</table>
Participant Progress Monitoring Graphs

Math Fact Progress

Session

DCPMM
Motivation Progress

Session

Total Score
Student Engagement Progress
Appendix J: Hypothetical Example of a Motivational Coaching Session

During the coaching session, the student participant reported making many errors on quizzes in his math work and identified rushing his work as problematic. During pre-intervention assessments, multiplication was assessed to be at an instructional level and selected as the math operation to be targeted, and numerous math facts in the 3xs table were identified as unknown. Pre-intervention assessment additionally revealed that the participant rarely checked his work or practiced his math facts on his own. The participant reported limited personal goal setting and use of positive self-talk. The coach and student identified the following coaching items from the General Strategies for Action Plan list to incorporate in his Strategy Action Plan: self-regulated learning strategies (i.e., Check answers, Ask myself does this answer make sense with math work, Practice facts using CCC to over learn until automatic) and academic self-efficacy strategies (i.e., Set challenging/attainable performance goals, Graph personal progress, Link increased effort with success, Verbalize realistic expected outcomes regarding performance, and Recognize and congratulate self on meeting goals). Based on this information, the SAP was developed as follows:
### Strategy Action Plan (SAP)

#### Goal(s):  
1. Attain 60 DCPC or higher on the AIMSweb math fact probe during treatment sessions.  
2. Increase monitoring my progress through using my SAP and congratulating myself on improved frequency.  
3. I will expect myself to learn and recall my math facts better each time I use the strategies and meet the goals on my SAP.

<table>
<thead>
<tr>
<th>Strategy A</th>
<th>Practice the 3xs table using CCC until automatic.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>Practice 2-5 x3 facts using CCC until automatic (Monday Homework: 10 minutes). Quiz myself on 2-5x3 facts</td>
</tr>
<tr>
<td>Step 2</td>
<td>Practice 6-9x3 facts using CCC until automatic (Tues. Homework: 10 minutes). Quiz myself on 6-9x3 facts</td>
</tr>
<tr>
<td>Step 3</td>
<td>Practice 10-12x3 facts using CCC until automatic (Wed. Homework: 10 minutes). Quiz myself on 10-12x3 facts</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Strategy B</th>
<th>Check answers on math quizzes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>Ask self if answer makes sense</td>
</tr>
<tr>
<td>Step 2</td>
<td>Make a check mark at bottom of quiz if checked every math calculation.</td>
</tr>
<tr>
<td>Step 3</td>
<td>Expect to learn 2 more facts every time I practice with CCC</td>
</tr>
</tbody>
</table>

We agree to this plan:  
Student Signature___________________________  
Coach Signature____________________________

<table>
<thead>
<tr>
<th>Date: 4/15/09</th>
<th>Week: 1</th>
<th>Self-Evaluation</th>
<th>Monitorin g Scores</th>
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<tbody>
<tr>
<td>5 3 1</td>
<td>Met Partial Try Goal Goal Again</td>
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<td></td>
</tr>
<tr>
<td>5 3 1</td>
<td>Met Partial Try Goal Goal Again</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 3 1</td>
<td>Met Partial Try Goal Goal Again</td>
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</table>

<table>
<thead>
<tr>
<th>Math____</th>
<th>Motiv___</th>
<th>ISW____</th>
</tr>
</thead>
<tbody>
<tr>
<td>_</td>
<td>_</td>
<td>_</td>
</tr>
</tbody>
</table>
The following Goal/Strategies Index Card was developed for the participant based on his SAP and was kept in the participant’s desk to remind him of his goals and strategies and for him to record when he accomplished items in his SAP.

**Goal/Strategies Index Card**

<table>
<thead>
<tr>
<th>Name: Kris Kringle</th>
<th>Strategy Action Plan</th>
<th>Date: 12/25/09</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goal:</strong></td>
<td>Make a check each time you do one of these</td>
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</tr>
<tr>
<td>1. Reach 60 DCPM or higher on math fact probes during treatment sessions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Increase monitoring my progress with using my SAP and congratulate myself on increased frequency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Expect and tell myself I will improve each day I implement my SAP</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Strategy A</strong></th>
<th><strong>Strategy B</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice the 3xs table using CCC until automatic.</td>
<td>Slow down response process by checking all answers on math quizzes</td>
</tr>
</tbody>
</table>

| Step 1. Practice 2-5 x3 facts using CCC until automatic (Monday Homework: 10 minutes). Quiz myself on 2-5x3 facts | Step 1. Ask self if answer makes sense |
| Step 2. Practice 6-9x3 facts using CCC until automatic (Tues. Homework: 10 minutes). Quiz myself on 6-9x3 facts | Step 2. Make a check mark at bottom of quiz if checked every math calculation. |
| Step 3. Practice 10-12x3 facts using CCC until automatic (Wed. Homework: 10 minutes). Quiz myself on 6-9x3 facts. | Step 3. Congratulate myself if data shows I’m checking answers more often |
| Step 4. Expect to learn 2 more facts every time I practice with CCC | |

The participant graphed his DCPM scores on the AIMSweb math fact probe, total scores on the Motivation Probe and his frequency scores for student engagement during classroom observations (if this data was available). The coach helped the participant recognize and commend himself for his success and progress and supported him in assessing whether he was ready to set new goals and/or continue with unmet goals. In addition, the coach linked the
student’s increased effort and use of particular self-regulated learning strategies to his success.

The coach and participant developed a new SAP to be implemented immediately with progress to be reviewed during next session.
Appendix K: Referral and Consent Forms

Student Referral Form Letter

Department of Counseling and Applied Educational Psychology
Northeastern University, 302 Lake Hall
Boston, MA 02115

To the Educational Personnel at the___________ School:

RE: Student Referral Form for Dissertation Study

My name is Maureen Piana and I am a doctoral graduate student in the Counseling and School Psychology Ph.D. program at Northeastern University. I have received permission from the _____________ School District and from Principal ________________ to conduct a study in the _____________ School for my dissertation. This study will explore the effects of implementing a multi-dimensional intervention for boys in the third with high levels of inattention, impulsivity, and over activity and low math fact fluency. Participants are limited to male students due to the difficulty identifying a sufficient number of female students, who would meet the study’s criteria for inattention, impulsivity, hyperactivity and low math performance. This project involves having students receive a research-based math intervention together with motivation coaching in an attempt to increase math skills, academic self-efficacy, and student implementation of self-regulated learning strategies. Separate intervention phases involve students receiving a math fact intervention alone in one phase and the math fact intervention plus motivation coaching in another phase. A comparison of student results on progress monitoring probes measuring math fact fluency and motivation will help determine if the multi-dimensional intervention (math intervention plus motivational coaching) is more effective in improving students’ academic performance. It will take 15-30 minutes, three times a week for
approximately 10 weeks to complete the study during which time the participants will spend roughly two weeks receiving progress monitoring without intervention during baseline, and then progress monitoring will continue for four weeks for each one of the two phases of intervention. Individual sessions will be conducted by me before or after school on school premises or at Northeastern University so as not to interfere with class instruction time or the regular school day. In addition, participants will be observed by research assistants in their individual classrooms for 15 minutes once a week during math independent seatwork to measure student on-task engagement. Students and their parents can terminate participation at any time during this study.

I am asking school personnel to refer students who might qualify. Your decision to refer or not refer will have no reflection on your work status. Once a student is referred, I will contact his parents to obtain parental consent for screening their child as a potential participant. Once parent permission is obtained, I will implement a screening procedure, which will involve administering math and behavioral questionnaires to parents and teachers, as well as a math computational probe to the students. Due to the limits of the study, only four students will be selected. I will be providing feedback and recommendations to parents whose children are screened but do not meet criteria. Should these parents require further professional input, they will be referred to an outside professional recommended by the school psychologist for further evaluation. If you have a student who you think would benefit from participating in this study, please complete the form at the bottom of this letter and return it to me in the self-addressed stamped envelope.

Students participating in the study will be receiving additional assessments and progress monitoring measures beyond the screening assessments. Student results on all measures will be
shared with school personnel pending parent permission. I will be providing input to parents on
the performance of their children and am available to school personal should any questions or
concerns arise regarding this study.

Thank you for your time and participation,

Maureen Piana, CAGS, LMHC

100 Elm Street Goffstown, NH 03045  piana.m@neu.edu  Cell phone: 603-660-017

________________________________________________________________________

See referral forma attached.

Student Referral Form

Student Name __________________________ Grade ____ School _________________

Teacher Name _______________________ School Telephone _____________________

Best Time to Be Reached ________________

Reason for Referral _______________________________________________________

________________________________________________________________________

If you have any questions or concerns please contact Maureen Piana at piana.m@neu.edu or
603-660-0177.
Parental Consent Form for Screening and/or Participation in the Study

Department of Counseling and Applied Educational Psychology

Northeastern University, 302 Lake Hall

Boston, MA 02115

Date:

RE: Informed Consent to Participate in a Research Study

Dear Parent or Guardian,

My name is Maureen Piana and I am a doctoral graduate student in the Counseling and School Psychology Ph.D. program at Northeastern University. I am inviting your child to take part in a research study. This letter will tell you about the study. Your child’s participation is totally voluntary and is ultimately based on your decision to grant permission if you would like him to participate. If you decide to have your child participate, you will be asked to sign the permission forms at the end of this letter and be given a copy to keep.

The purpose of this research

As part of my dissertation, I am conducting a study to develop a multi-dimensional math and motivation intervention for third grade boys with high levels of inattention, impulsivity, over activity and low math performance to help students increase their math fact fluency and motivation level as a way of improving their math performance. Participants are limited to male students due to the difficulty identifying a sufficient number of female students, who would meet the study’s criteria for inattention, impulsivity, hyperactivity and low math performance. The __________ Public School District administration and principal of the __________ Elementary School are fully aware of this project and have allowed me to conduct this research. My
Dissertation Chairman, Robert Volpe, PhD, Associate Professor in my doctoral program at Northeastern University, will be supervising this dissertation study.

**Why your child is being asked to participate**

Your child has been referred by school personnel to be screened for possible participation in my dissertation study. Teachers and school staff were asked to refer third boys who exhibit high levels of inattention, impulsivity, and over activity along with low math performance.

**What you and your child will be asked to do**

I am requesting permission to screen your child by administering parent and teacher math questionnaires and behavioral checklists and a brief student math assessment to see if your child meets criteria for participation in this study. Specifically, these assessments provide information about your child’s math skills and levels of inattention, impulsivity, and over activity. For referred students who do not meet criteria, I will meet with parents to provide feedback on their child’s assessment results and recommend outside referral sources for further professional evaluation, if needed or requested.

Should your child meet criteria and parent permission is further granted, I will initially ask your child’s teacher and child to complete additional questionnaires about your child’s math and motivation skills. In addition, your child will be administered standardized math assessments. Results from these pre-intervention measures will be used to provide a better understanding of what to specifically target for your child when implementing the study’s math/motivation intervention.

**Where will this take place and how much time will this take for my child and me?**

I will ask you to complete the screening questionnaires to see if your child meets criteria to participate by calling you ahead of time and asking you whether you would like to receive
questionnaires by mail followed by a phone call by me to see if you have any questions, concerns, or need assistance on answering any of the questions. Another option would be for you to meet with me at your child’s school to help you fill out the questionnaires, answer any questions, and have you submit the questionnaires directly to me at that time. Should you decide to have the questionnaires mailed to you, there will be a self-addressed stamped envelope to return the questionnaires by mail to me at Northeastern University c/o of my adviser, Dr. Robert Volpe.

All individual sessions with your child will take place before or after school on school premises or at Northeastern University, so as not to interfere with class instruction or the regular school day. Your child will receive a math intervention to help him practice and increase his math fact fluency without motivation coaching for four weeks. During a separate segment of four weeks, your child will receive this math intervention with motivation coaching. During motivation coaching, your child will be taught how to set goals to do better in math, talk to himself in an encouraging manner, and learn how his increased effort is helping him improve his math performance. He will also be helped to develop a Strategy Action Plan with strategies to help him improve his self-regulated learning in class. Your child will keep a Goal/Strategies Card in his desk for him to check off each time he tries one of the helpful strategies listed on his card. During individual sessions, your child will be administered a math fact probe to monitor his progress in math fact fluency and a motivation probe once a week to monitor self-rated changes in motivation behaviors. Once a week your child will be observed in his class by a school psychology graduate student from Northeastern University confidentially (without your child or other classmates knowing) during independent math seatwork for 15 minutes to assess how frequently he stays on task. Your child will be shown how to graph his results from these
measures to help him see his progress. Individual sessions will occur three times a week and last approximately 15 minutes to receive the math intervention alone or 30 minutes to receive the math intervention plus motivation coaching.

**The benefits of your child being in this research**

The possible benefits expected from your child’s participation in this study are specific increases in his/her math fact fluency, academic motivation, and use of self-regulated learning strategies, as well as possible generalized effects resulting in improved overall math performance and increased student engagement during math independent seatwork. Should your child become disinterested in participating in the intervention sessions, he will be allowed to stop participating at any time during the study. Your child will be informed that he can discontinue participating at any time over the course of the study and assessment of student comfort level regarding continued participation will be ongoing throughout the study.

**Who will see the information about my child?**

I will share results about your child’s responses to the screening measures with you only, unless you request and sign permission for this information to be shared with his teacher and preferred school staff. Should your child meet criteria for the intervention part of the study, I will share your child’s results to the interventions in an individual parent session at the end of the study and welcome questions, concerns, and feedback throughout the course of the study, as they arise. Contact information is provided at the end of this letter. Once again, information on your child’s results from the intervention will only be shared with school staff with your request and signed permission.

I would greatly appreciate your permission to work with your child on this project. Please sign and date below both copies of the parent consent forms if you would like your child to
participate. Please keep one copy for your records and return the other copy to me by sending the signed permission form to me in the enclosed, self-addressed/stamped envelope. You can also return this form to the main office and the secretary will put it in the Northeastern Students’ mail box.

If you any questions, please contact me at piana.m@neu.edu or 603-660-0177. Questions or concerns about your child’s rights as a participant can also be addressed to Andrea B. Goldstein, Coordinator Human Subject Research Protection, Division of Research Integrity Northeastern University, 413 Lake Hall, 360 Huntington Ave. Boston, MA 02115-5000, 617.373.7570, email: an.goldstein@neu.edu.

Sincerely,
Maureen Piana, CAGS, LMHC
Attention: Robert Volpe, PhD
Northeastern University 302 Lake Hall Boston, MA 0211

See permission forms attached.
Please fill out the following permission forms only if you want your child to participate in the research study and please provide a way to contact you in the future:

Name: __________________________ Telephone: _______________ Email _______________

Please return these forms to me in the enclosed, self-addressed, stamped envelope, or to the school secretary to place in the Northeastern University student mailbox at your child’s school, or mail it to this address: Maureen Piana, Attention: Robert Volpe, PhD, 302 Lake Hall, Northeastern University, Boston, MA 02115

PERMISSION FOR SCREENING

I give my permission for my child __________________________ to be screened by Maureen Piana for possible participation in the math and motivation study. My child will be administered a brief math computation assessment. His teacher and you as a parent will be asked to complete math questionnaires and behavioral checklists to determine if your child meets criteria for this study.

Parent/Guardian Signature ____________________________ Date __________________

Sign here if you want your child’s screening results shared with his teacher or preferred school staff:

Parent/Guardian Signature ____________________________ Date __________________

Please contact me if you change your mind about sharing your child’s information

***************************************************************************************************************
**PERMISSION FOR PARTICIPATING IN THE STUDY**

I give my permission for my child __________________________ to participate in the math and motivation study. My child will receive an evidence-based math intervention without motivation coaching for four weeks and motivational coaching plus the math intervention for four weeks plus an initial baseline period of receiving assessment without interventions for two weeks for a total of 10 weeks.

Parent/Guardian Signature________________________________ Date_________

Sign here if you want your child’s results shared with his teacher or preferred school staff:

Parent/GuardianSignature________________________________ Date____________________

*Please contact me if you change your mind about sharing your child’s information.*
PARENT COPY

Department of Counseling and Applied Educational Psychology
Northeastern University, 302 Lake Hall
Boston, MA 02115

Please fill out the following permission forms only if you want your child to participate in the research study and please provide a way to contact you in the future:

Name: __________________________ Telephone: __________________________ Email: ________________

Please return these forms to me in the enclosed, self-addressed, stamped envelope, or to the school secretary to place in the Northeastern University student mailbox at your child’s school, or mail it to this address: Maureen Piana, Attention: Robert Volpe, PhD, 302 Lake Hall, Northeastern University, Boston, MA 02111

PERMISSION FOR SCREENING

I give my permission for my child __________________________ to be screened by Maureen Piana for possible participation in the math and motivation study. My child will be administered a brief math computation assessment. His teacher and you as a parent will be asked to complete math questionnaires and behavioral checklists to determine if your child meets criteria for this study.

Parent/Guardian Signature_____________________________ Date__________________

Sign here if you want your child’s screening results shared with his teacher or preferred school staff:

Parent/Guardian Signature ________________________________ Date_______________

Please contact me if you change your mind about sharing your child’s information

***************************************************************************
PERMISSION FOR PARTICIPATING IN THE STUDY

I give my permission for my child __________________________ to participate in the math and motivation study. My child will receive an evidence-based math intervention without motivation coaching for four weeks and motivational coaching plus the math intervention for four weeks plus an initial baseline period of receiving assessment without interventions for two weeks for a total of 10 weeks.

Parent/Guardian Signature_________________________________ Date_________

Sign here if you want your child’s results shared with his teacher or preferred school staff:

Parent/GuardianSignature_________________________________ Date____________________

Please contact me if you change your mind about sharing your child’s information.
Child Assent Form

Dear______________,

My name is Maureen Piana and I am a graduate student at Northeastern University. I am doing a project on math and motivation. I will be working with other students in your school on this project. I would like you to help me with this project. If you would like to help, I will need you to give me permission to include you and for us to work together in individual sessions for 10 weeks. During our sessions, I will be spending about 15-30 minutes three times a week before or after school at your school working with you on your math and motivation to help you do better in school.

Your teacher and parents know about my study, and your parents said it was ok for you to help. It is important for you to understand that your help is by choice, and it is ok to say no. At any time, you can choose to stop participating by informing your teacher or me. If you have any questions, please ask your teacher or me.

If you agree to work in the study by participating in individual sessions with me to work on your math and doing better in school, please mark the circle “yes” below. If you do not want to participate, circle “No”. Sign your name on the line below.

Thank you for your help

Sincerely,

Maureen Piana

YES    NO

Name______________________ Date_____________
Dear Principal________________:

My name is Maureen Piana and I am a graduate student in the Counseling and School Psychology Ph.D. program at Northeastern University. I am requesting your permission to recruit four male students in the third grade with high levels of inattention, impulsivity, and over activity and low math performance to conduct a study on students with ADHD and low math performance at your school in the _______ school district. Participants are limited to male students due to the difficulty identifying a sufficient number of female students, who would meet the study’s criteria for inattention, impulsivity, hyperactivity, and low math performance. The purpose of the study is to investigate whether children with ADHD and low math performance would better respond to a multi-dimensional intervention that included an evidenced-based math intervention plus motivational coaching as opposed to receiving the math intervention without motivational coaching.

Once the students are selected, I would send permission forms to their parents to obtain their consent. In addition, before beginning the study, I would explain the study to the students, as they will have the option to decline to participate in the study. To identify students who meet criteria for ADHD and low math performance, I will need to screen students referred by asking parents to complete a standardized ADHD checklist and informal math questionnaires to obtain information regarding behavioral symptoms of ADHD and the student’s math skills. Students
will be administered a curriculum-based measurement (CBM) math probe to assess competency in math computation. Parents of screened students who do not meet criteria for my study will be provided resources should further evaluation be warranted. In addition, teachers of student participants accepted into the study will be asked to complete standardized questionnaires on student motivation and math performance.

To complete the study I will need to see each of the participants three times a week for ten weeks for approximately 15-30 minutes per day depending on the particular intervention phase being implemented at the time. Student participants will participate in individual sessions with me before and after school so as not to interfere with class instruction and the regular school day. Individual sessions with students will take place on school premises should there be space available before and after school, if deemed appropriate by the school principal. Otherwise, I will work individually with students at Northeastern University. In addition, student participants will be observed by a trained, school psychology graduate student in their classrooms once a week during math independent seatwork using a structured observational system to measure frequency of engaged behavior. The purpose of this study is to determine if a multi-dimensional intervention combining math fact fluency support with motivational coaching would increase math performance, motivation, and student engagement during independent seatwork.

I will be teaching the student to learn unknown math facts using the Cover, Copy, and Compare (CCC) method in combination with motivational coaching focusing on increasing academic self-efficacy and the use of self-regulated learning strategies. CCC is an evidence-based intervention, which asks the student to practice unknown math facts by first copying the math fact with the correct answer from a provided prompt, covering over the prompt and copy response, then writing the math fact with the correct answer, and finally comparing this answer
with the uncovered model. Motivation coaching will involve having the student develop a weekly Student Strategy Plan by choosing goals focusing on improving math fact fluency, developing and using self-regulated learning strategies, using positive self-talk to replace negative thinking, and linking increased effort to success to develop an internal locus of control towards learning and performing. In addition, students will graph scores from their math fact and motivation probes and their percentage scores of on-task behaviors measured during classroom observations completed by a school psychology graduate research assistant during independent math seatwork to track their progress.

Students will be randomly assigned to different sequences of separate intervention phases. Two students will be assigned to an intervention sequence that involves the student receiving a math fact intervention alone in the first phase, and then receiving the math fact intervention plus motivation coaching in the second phase. The other two students will receive the math intervention plus motivation coaching first, followed by receiving the math fact intervention alone. A comparison of student results on progressing monitoring probes measuring math fact fluency and motivation will help determine whether the multi-dimensional intervention (math intervention plus motivation coaching) is more effective in improving students’ academic performance than providing a math intervention without motivation coaching.

Enclosed is a copy of a letter from the Office of ______________ accepting my dissertation study in the ____________ Public School District. If you have any further questions or comments please contact me via email, piana.m@neu.edu, or by phone at 603-660-0177. I would greatly appreciate your permission to work in your school on this project. Please sign and date below if you would agree for students in your school to participate and return a copy of this permission letter to me in the enclosed, self-addressed and stamped envelope.
Thank you for your time, effort, and cooperation.

Respectfully,

Maureen Piana

Signature of Building Principal ________________________________

Date: ______________
School District Permission Letter

Department of Counseling and Applied Educational Psychology
Northeastern University, 302 Lake Hall
Boston, MA 02115

Date:

Dear Superintendent ______________:

My name is Maureen Piana and I am a graduate student in the Counseling and School Psychology Ph.D. program at Northeastern University. I am requesting permission from the ______________ Public School District to recruit four male students in the third grade with high levels of inattention, impulsivity, and over activity and low math performance to conduct a study on students with ADHD and low math performance at the ______________ School. Participants are limited to male students due to the difficulty identifying a sufficient number of female students, who would meet the study’s criteria for inattention, impulsivity, hyperactivity, and low math performance. The purpose of the study is to investigate whether children with ADHD and low math performance would better respond to a multi-dimensional intervention that included an evidenced-based math intervention plus motivational coaching as opposed to receiving the math intervention without motivational coaching.

Once the students are selected, I would send permission forms to their parents to obtain their consent. In addition, before beginning the study, I would explain the study to the students, as they will have the option to decline to participate in the study. To identify students who meet criteria for ADHD and low math performance, I will need to screen students referred by asking parents to complete a standardized ADHD checklist and informal math questionnaires to obtain information regarding behavioral symptoms of ADHD and the student’s math skills. Student will
be administered a curriculum-based measurement (CBM) math probe to assess competency in math computation. Parents of screened students who do not meet criteria for my study will be provided resources should further evaluation be warranted. In addition, teachers of student participants accepted into the study will be asked to complete standardized questionnaires on student motivation and math performance.

To complete the study I will need to see each of the participants three times a week for ten weeks for approximately 15-30 minutes per day depending on the particular intervention phase being implemented at the time. Student participants will participate in individual sessions with me before and after school so as not to interfere with class instruction and the regular school day. Individual sessions with students will take place on school premises should there be space available before and after school, if deemed appropriate by the school principal. Otherwise, I will work individually with students at Northeastern University. In addition, student participants will be observed by a trained, school psychology graduate student in their classrooms once a week during math independent seatwork using a structured observational system to measure frequency of engaged behavior. The purpose of this study is to determine if a multi-dimensional intervention combining math fact fluency support with motivational coaching would increase math performance, motivation, and student engagement during independent seatwork.

I will be teaching the student to learn unknown math facts using the Cover, Copy, and Compare (CCC) method in combination with motivational coaching focusing on increasing academic self-efficacy and the use of self-regulated learning strategies. CCC is an evidence-based intervention, which asks the student to practice unknown math facts by first copying the math fact with the correct answer from a provided prompt, covering over the prompt and copy response, then writing the math fact with the correct answer, and finally comparing this answer
with the uncovered model. Motivation coaching will involve having the student develop a weekly Student Strategy Plan by choosing goals focusing on improving math fact fluency, developing and using self-regulated learning strategies, using positive self-talk to replace negative thinking, and linking increased effort to success to develop an internal locus of control towards learning and performing. In addition, students will graph scores from their math fact and motivation probes and their percentage scores of on-task behaviors measured during classroom observations completed by a school psychology graduate research assistant during independent math seatwork to track their progress.

Students will be randomly assigned to different sequences of separate intervention phases. Two students will be assigned to an intervention sequence that involves the student receiving a math fact intervention alone in the first phase, and then receiving the math fact intervention plus motivation coaching in the second phase. The other two students will receive the math intervention plus motivation coaching first, followed by receiving the math fact intervention alone. A comparison of student results on progressing monitoring probes measuring math fact fluency and motivation will help determine whether the multi-dimensional intervention (math intervention plus motivation coaching) is more effective in improving students’ academic performance than providing a math intervention without motivation coaching.

If you have any further questions or comments please contact me via email, piana.m@neu.edu, or by phone at 603-660-0177. I would greatly appreciate your permission to work in your school district on this project. Enclosed are copies of my Dissertation Approval Form and IRB Advisor Assurance Form as well as my Application to Conduct Research in the _________ Public Schools.

Thank you for your time, effort, and cooperation. Respectfully, Maureen Piana
Appendix L: Cover, Copy, Compare Alone Intervention Integrity Checklist (CCC Alone)

Assessment of unknown math facts

1. ___ On an ongoing bases during CCC sessions, determine a set of unknown math facts for the participant to practice using the CCC worksheets through implementing the next-tape procedure:

___ Provide the participant with a short math fact probe containing 20 math facts from the 100 single math facts in his targeted operation.

___ Start the next-audiotape to prompt the participant to attempt a problem every 1.5 seconds

___ Repeat the following directions:

___ “When I say, ‘Begin,’ do a problem and move onto the next problem when the tape says ‘next.’ The word ‘next’ will sound every 1-2 seconds.

___ If the problem is not finished when the tape says ‘next,’ you must go on.

___ When I say, ‘Stop,’ put your pencil down.

___ Write down five of the problems you did not know or were incorrect in the numbered boxes on the CCC worksheet.

___ Then, begin the CCC worksheet.”

___ Start the next-audiotape and tell the participant to begin. Stop the participant after the last problem in the last row is attempted on the math fact probe.

___ Have the participant pick out five blank problems to practice on the CCC worksheet.
Standard CCC Session

1. ___ Welcomes the participant warmly and exchanges brief casual conversation regarding topics that are of interest to the participant (i.e., Red Sox score from last night’s game, etc.), checks in with how participant is doing in math and if the student is using CCC method in class to practice math facts.

2. ___ Hands out participant’s CCC packet.

3. ___ Explains and demonstrates the five CCC steps prior to implementation for the first three sessions.

4. ___ Repeats the CCC procedure script verbatim.

5. ___ Demonstrates all five CCC steps:
   ___ Look at the math fact problem with the answer
   ___ Cover the math problem with the answer with an index card
   ___ Write the math problem with the your answer
   ___ Uncover the original math problem with the answer
   ___ Compare answer to check if it is correct
   ___ Repeat the process if the answer is incorrect

6. ___ Eliminates CCC instructions after the first three sessions or when the participant knows the CCC procedures automatically without cuing.

7. ___ Instructs the participant to practice math facts for five minutes using the CCC method by completing the CCC worksheet.

8. ___ Repeats the directions for the CCC worksheet verbatim.

9. ___ Administers a CCC fact probe containing the five targeted facts on the CCC
worksheet dispersed with other math facts cued by the next-audiotape to determine if targeted unknown facts became known after practicing with the CCC strategy.

10. ___ Scores the participant’s CCC fact probe. The participant and researcher determine if targeted math facts became known. If so, the unknown facts are transferred from the Unknown Fact column to the Known Fact column on the Math Fact Record Sheet (see Appendix I Intervention Manual).

11. ___ Recognizes the participant’s achievement of known facts.

12. ___ Administers the AIMSweb math fact probe.

13. ___ Repeats the probe administration script verbatim.

14. ___ Monitors participant’s performance to ensure the participant works problems in rows and does not skip around by answering the easier problems first.

15. ___ Times and stops the participant after two minutes for addition and subtraction problems or four minutes after multiplication and division problems. Records the time the participant finishes if all problems are completed before time limit.

16. ___ Thanks the participant for working hard and cooperating.

17. ___ Reminds the participant about the time and date of next individual session.
Appendix M: Cover, Copy, and Compare + Motivation Coaching Intervention Treatment

Integrity Checklist (CCC+MC)

Part I: Complete the CCC Alone Treatment Integrity Checklist (see Appendix I for CCC Alone Checklist)

Part II: Complete the CCC+MC Treatment Integrity Checklist (See Appendix I for CCC+MC Checklist)

Procedures for Initial Coaching Session Implemented during the Second Part of the CCC+MC Intervention after the CCC Alone Procedures:

1. ___ Explains the process of coaching:

   ___ Uses script verbatim: Script for participants starting with Intervention CCC alone followed by CCC+MC: *(If a participant is starting with CCC+MC followed by CCC alone, instead of saying “We will be starting,” substitute, “Today, we will be beginning our sessions together where you will be learning a math strategy and receive coaching for 30 minutes.”)*

   ___ “We will be starting our motivational coaching sessions today, which we will do after our CCC work.

   ___ That means our sessions will go for 30 minutes instead of 15. Coaching is a special time when I will be teaching you how to coach yourself to do your best work. Doing well make us feel good about ourselves. Doing well is all about using strategies, making actions plans, and putting our plans into action to help us do better.

   ___ We will figure out what is working and not working well for you and what strategies would help you do better.
We will be following five steps:

1) Discuss what the problem is
2) Set up a goal(s) each week to address the identified problem
3) Pick strategies to help you make your goal(s)
4) Review your scores from the math and motivation probes and your student engagement score during ISW and graph your progress to watch your growth. We will graph your DCPM score from the math fact probe each time we meet to see if you reached your DCPM goal on your SAP and need to change it to a higher goal or keep it the same. Once a week during one of our sessions, we will graph your scores on the Motivation Probe and in student engagement (only mention this if the participant being addressed is one of the two participants who had classroom observations completed during math ISW). During this weekly session you will evaluate how well you think you did using your strategies and meeting your goal(s) by counting up the tally marks on your Goal/Strategies Index Card. At this time we will decide whether to have you pick a new goal or continue with the same goal to help you to do better at meeting that goal before moving onto a new one.

Shows the participant how the SAP form (Appendix I) and Goal/Strategies Index Card (Appendix I) will be used to develop a goal(s) and action plan and self-evaluate progress.

Reviews the participant’s results from the pre-intervention battery (CBM math fact probe, answers and scores on the ACES and MSPSE subscales, and student engagement
percentage scores from classroom observations during ISW) as input to help the participant set his first goal(s) and determine strategies for his SAP.

3. ___ Establishes the SAP/completes the SAP form
   ___ Helps the participant establish a goal(s) and writes it on the SAP form.
   ___ Helps the participant select strategies to support him with attaining his designated goal(s). Reviews the *General Strategies for Student Strategy Plan*, a reference which lists suggested academic self-efficacy and self-regulated learning strategies, with the participant to pick effective strategies.
   ___ Asks the participant to sign the SAP form to obtain his written commitment to work on his goal(s) and implement the selected learning strategies. Coach signs the SAP form as well.

4. ___ Completes a Goal/Strategies Index Card
   ___ Writes the participant’s goal(s) and strategies on his Goal/Strategies Index Card for the participant to put in his desk and asks him to continually review it to prompt him to use his learning strategies in class.
   ___ Asks the participant to put a tally mark next to any strategy on his Goal/Strategies Index Card when he uses it in class.
   ___ Asks the participant to bring his Goal/Strategies Index Card to his next session to review his progress on implementing his selected learning strategies.

5. ___ Thanks the participant for cooperating and working hard on starting his new plan to help himself do better in math and increase his motivation. Emphasizes looking forward to working with him and watching him progress.
Procedures for Ongoing Coaching Sessions

1. ___ Exchanges general conversation and warm greetings to start session.

2. ___ Obtains an update on progress and assesses for problem behaviors or situations:
   ___ Reviews reason for coaching with student:
   ___ To teach you to coach yourself to do your best work.
   ___ Doing well makes you feel good about yourself.
   ___ Making a strategy plan and putting it into action helps us to our best work.
   ___ Asks the participant whether he has been using CCC outside of the sessions.
   ___ Asks if participant brought his Goal/Strategy Card with him to the session to review.
   ___ Asks participant whether he has been implementing his recent SAP to meet his goal(s) to _______________. Reviews how many tally marks he made on his Goal/Strategies Index Card to indicate how often he used his strategy(ies) in class. Verbally recognizes participant’s demonstrated responsibility in bringing the Goal/Strategies Index Card to session and keeping a record of when he used his selected learning strategies in class. Praises his use of learning strategies in class.

3. ___ Reviews results from math fact probe.
   ___ Helps the participant graph his DCPM performance on math fact fluency probe (see Appendix I for math fact fluency graph).
   ___ Recognizes the participant’s progress whether DCPM increased from last session. If surpasses SAP DCPM goal, helps the participant designate a new, realistic goal. If the participant’s DCPM decreased, explains how progress is not always a straight,
upward trend but can dip and increase the next time. Reminds the participant that he has
progressed so far from when he first started.

4. ___ Coaches for increased success:
   ___ Recognizes effort and links effort to progress.
   ___ Coaches the participant to use strategies if he has not been implementing them
   routinely. Discusses how he can increase the use of designated strategies.
   ___ Coaches the use of positive self-talk to increase motivation to do well in math
   and increase use of strategies
   ___ Celebrates the participant’s success using verbal recognition and praise and links
   doing well with his effort and use of strategies.
   ___ Asks the participant to identify and describe any current problem
   behaviors/situations that might be interfering with doing well in math.
   Discusses possible strategies.

5. ___ Eventually and when appropriate, fades supervision and prompts to enable the
   participant to follow the steps to his SAP independently.
Procedures for Weekly Individual Sessions When a New SAP Is Developed

1. ____ Obtains an update on progress and assesses for problem behaviors or situations:
   ___ Asks the participant if he has been implementing his recent SAP to meet his goal to ________________.
   ___ Asks how the participant’s SAP is working. Discusses any problem areas or situations.
   ___ Reviews results from progress monitoring probes (math fact fluency and Motivation Probe) and ISW observation (if applicable) to determine if the participant has met his goal(s).
   ___ Helps the participant graph his performance on the math fact fluency probe and Motivation Probe measures and his student engagement score from the classroom observation (if applicable; see Appendix I for graphs).
   ___ Directs the participant to evaluate his individual performance regarding meeting his specific goal(s) and implementing selected learning strategies. Reviews how many tally marks he made on his Goal/Strategies Index Card to indicate how often he used his strategy(ies) in class.
   ___ Directs the participant to rate his progress on his SAP for meeting his goal(s) and implementing selected learning strategies using the following scale for meeting his goal: 5=Met Goal, 3=Partial Goal, and 1=Try Again and the following scale for implementing learning strategies: 1=Never, 3=Sometimes, or 5=Everyday.
   ___ Highlights the participant’s success using verbal recognition and praise and links doing well with the participant’s effort and use of strategies.
___ Asks the participant to identify and describe any current problem behaviors/situations that might be interfering with doing well in math.

2. ___ Helps the participant set a goal(s) and select learning strategies for his new SAP:
   ___ Uses input from recent progress monitoring probes and from participant’s self-evaluation on his current SAP to help the participant set a goal(s), no more than three, to work towards for the next three sessions.
   ___ Asks the participant to design a measurable goal(s) directly related to the problem behavior, academic difficulty, or desire to beat his previous scores.

3. ___ Establishes the SAP/completes the SAP form
   ___ Helps participant establish a goal(s) and writes it on the SAP form.
   ___ Helps the participant select strategies to support him with attaining his designated goal(s). Reviews the General Strategies for Student Strategy Plan, a reference which lists suggested academic self-efficacy and self-regulated learning strategies, with the participant to pick effective strategies.
   ___ Asks the participant to sign the SAP form to obtain his written commitment to work on his goal(s) and implement the selected learning strategies. Coach signs the SAP form as well.

4. ___ Completes a Goal/Strategies Index Card
   ___ Writes the participant’s goal(s) and strategies on his Goal/Strategies Index Card for the participant to put in his desk and asks him to continually review it to prompt him to use his learning strategies in class.
   ___ Asks the participant to put a tally mark next to any strategy on his Goal/Strategies Index Card when he uses it in class.
Asks the participant to bring his Goal/Strategies Index Card with him to his next session to review his progress on implementing his selected learning strategies.

5. Thanks the participant for cooperating and working hard on his SAP and making a new SAP.

6. During each session, supervises the participant on how he implements CCC and his SAP:
   - Reminds the participant to use his strategies, if not self initiated
   - Provides feedback to improve performance and praises and recognizes whether the participant displays the strategies and meets his goal(s).

7. Fades supervision and prompts to allow the participant to be able to follow the steps to his SAP independently.
Appendix N: Eliminated Results for Participants Receiving Intervention Sequence, 

CCC+MC, then CCC Alone

Figure 1a. Rob’s digits correct per minute for math facts.

Figure 1b. Ed’s digits correct per minute for math facts.
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