Promoting Strategic Thinking Skills in Middle-School Students Using *Set: The Family Game of Visual Perception*®

Games are a natural expression of children's playfulness and energy. Excitement, joy, and involvement motivate them to continue to play until they have mastered the game. Strategy games, in particular, address development of mental acuity and intellectual maturity essential to academic success. Consequently, educators, particularly in the primary and elementary grades, may incorporate subject-specific games into classroom practices to support cognitive and academic development. For example, math bingo, math specific board and card games, and interactive educational software may reinforce knowledge of mathematical operations (Falco, 2001). Crossword puzzles and word searches increase and strengthen vocabulary in both language arts and science. Riddles introduce metaphors, similes, analogies, and descriptive language as well as assessing reading comprehension (Zipke, 2007). However, as children enter the middle and upper grades, game usage declines as classroom teachers shift from teaching learning strategies to instructing in content (Joseph, 2006). This study asks the question: What are the effects, if any, of a curriculum using *Set: A Family Game of Visual Perception*® (Copyright ©1988, 1991 Cannei, LLC) on strategic thinking skills of middle school students?

Metacognitive Awareness and Strategic Thinking

Many of educators hold the misperception that direct instruction in teaching strategic thinking stops at the end of elementary school (Joseph, 2006). As a result, less proficient students may fall behind because they are struggling to grasp unfamiliar material without in-depth comprehension (Day, 1994; Vaidya, 1999). Teachers may rely upon a more traditional teaching model that follows the pattern of giving an assignment with the expectation that the

student will produce the work. The teacher then evaluates the product and assigns a grade. A student may rely upon rote memorization and fact regurgitation rather than developing a deeper and more substantive understanding of the subject (Day, 1994). In short, the student becomes a passive participant in her education because she does not understand how or why she learns (Joseph, 2006). Deepening her awareness of her cognitive processes and developing appropriate learning strategies may engage the student more fully and enhance her educational experience. The student builds metacognitive awareness, which according to Joseph, is "the ability to be self-reflective learners by thinking about their own thinking…they are able to reflect upon their cognitive processes" (Joseph, 34). Strategic thinking, an integral part of metacognitive awareness, allows learners to access prior knowledge, monitor comprehension, correct misconceptions, synthesize information, draw inferences, and ask questions. As a result, they begin to understand and own their cognitive processes. Strategy games, such as *Set: The Family Game of Visual Perception*® may support the production of strategic thinking skills and possibly increase metacognitive awareness. Finally, skills acquired playing *Set*® may transfer or generalize to academic endeavors in the classroom.

Background of Study

Attributes of Set®

As an educational therapist, I have observed that incorporating *Set*® into student sessions appears to have had positive effects on the students' metacognitive awareness and strategic thinking abilities. Additionally, students enjoy the challenge and playfulness of the game. *Set*® consists of eighty-one cards with four variable features:

Symbols—One of the following: ovals, squiggles, or diamonds

- Colors—Symbols are either red, green, or purple

- Number—Each card has one, two, or three symbols

- Shading—Symbols are either solid color, striped, or outlined with one of three colors

Players search for three cards that represent a set based on specific criteria. Sets may consist of similarities, differences, or a combination of both. In order to be successful, players must be aware of how they form sets and engage in strategic thinking to find them.

Purpose of the Study

Learning non-academic strategy games such as *Set: The Family Game of Visual Perception*® may more fully teach and integrate strategic thinking into a student's academic life. This study proposes to explore the relationship, if any, between increased proficiency in *Set*®, and enhancement of strategic thinking in middle school students. Models for metacognitive instruction used to teach strategic thinking share common characteristics: teacher directed instruction and modeling of strategic thinking skills, student/teacher guided practice and application, and independent student activity. For the purposes of this instruction, I used the Metacognitive Training Framework (MTF) used by Kelley and Clausen-Grace (Kelley, 2008), which incorporates teacher instruction and self-talk, teacher directed practice, and independent student practice. I selected *Set*® as it incorporates the following cognitive skills: temporal-sequential ordering, spatial ordering, memory, concept formation, creativity, reasoning or logical thinking, shifting mental representations, and critical thinking—abilities that are essential academic and life skills (Falco, 2001). Using the explicit methods of strategy games may more

fully integrate these learning processes and provide a cognitive framework that transfers to other subjects (de Bruin, 2007; Engle, 2006; Kramakski, Mevarach, & Lieberman, 2001; Rogers, 1994). Additionally, incorporating *Set*® into the classroom as a learning activity may provide a non-traditional, multidimensional approach to cognitive tasks, including memory, organization, strategy development, and abstract thinking skills. Just as simple word games, rhymes, and poems lay the foundation for learning for young children (Zipke, 2007), *Set*® might change the way in which older children achieve metacognitive awareness and strategic thinking skills.

Effective Learning Skills

In order to learn effectively and efficiently, individuals need cognitive skills anchored in metacognitive awareness and strategic thinking (Day, 1994; Joseph, 2006). In learning to play *Set*® proficiently, students engage in an analysis of how they think about set formation. They explain strategies that they use and modify them to increase success at the game. This researcher has discovered that engaging students in a discussion of how they perceive the sets enhances their enjoyment and success with the game. In order to do so, they need to think about how they think or, in other words, increase metacognitive awareness. As an educator, I have observed that as students move towards mastery, children who lack academic self-confidence begin to take pride in their abilities to excel at the game and appear to become more proficient strategic thinkers. This researcher's experiences suggest that *Set*® teaches and reinforces:

- Abstract or meta reasoning through strategy development and card sorting
- Metacognitive awareness through student evaluation of strategies
- Development and understanding of strategic thinking skills

Additionally, as players become more proficient, I have observed that students begin to process visual cues more rapidly in order to become competitive players. They may also cultivate the ability to swiftly interpret, remember, and create new information—required academic skills for mature and independent learners. Game players also order objects into patterns and learn to recognize card sets simultaneously, attributes of mathematics, science, and reading comprehension (Kramakski, Mevarach, & Lieberman, 2001). Finally, they learn to independently organize and create their own sets, by applying specific rules. Due to the emphasis on metacognitive awareness and strategic thinking skills, it is hoped that these skills will be applied beyond *Set*® and into the classroom.

Definition of Terms

Metacognitive Awareness

Metacognitive awareness, for the purposes of this study, is defined as the ability to be a self-reflective and self-regulated learner who considers and comprehends her cognitive processes (Day, 1994). She is able to understand and use self-knowledge about cognitive strengths and weaknesses to develop additional skills and move towards intellectual maturity. She builds the ability to think about and comprehend how she approaches learning as well as the ability to plan, monitor, and evaluate her learning. These skills aid students in reading comprehension, writing, memory, problem solving, and related areas of education (Joseph, 2006).

Strategic Thinking

Strategic thinking, for the purposes of this study, is defined as a cognitive process thatallows a student to access prior information, monitor comprehension, correct misunderstandings,

synthesize and extrapolate information, and ask relevant clarifying questions. Strategic thinking may be taught by training students in metacognitive awareness (Day, 1994).

Literature Review

Metacognitive Awareness, Strategic Thinking, and Knowledge Acquisition

For the past thirty years, the role of metacognitive awareness and strategic thinking in the classroom has been one of the major focuses of educational research (Beyer, 2008; Wong, 1993). According to Beyer (2008), cognition, a multifaceted and complex mental phenomenon, requires the mastery and integration of four basic thinking skills: comparing, classifying, sequencing, and predicting. Metacognitive awareness requires that students recognize and understand their cognitive processes as well as how they apply those skills. Beyer asserts that students who do not acquire these skills seldom become thoughtful and independent learners. He continues that skill subsets such as decision-making, problem solving, drawing conclusions, analyzing, and identifying cause and effect develop critical thinking skills. He states further that direct instruction in metacognitive awareness and strategic thinking increases academic proficiency. Additionally, he concludes that this instruction must include further explicit strategies for transferring the newly learned thinking skills to other domain-specific contexts (Beyer, 2008). The cognitive researchers and educators cited below have become involved in developing and introducing metacognitive curricula with the goal of integrating strategic thinking skills into classrooms.[1] The purpose of this literature review is to examine several of these approaches

Metacognitive Awareness Defined

In order to create successful learners, educators attempt to arm their students with skills necessary for critical evaluation, attainment of new knowledge, and a dedication to life-long learning. Metacognitive awareness, the ability to plan, monitor, and evaluate one's learning, aids students in reading comprehension, writing, memory, problem-solving, and related areas of education (Beyer, 2008; Day, 1994; Joseph, 2006). Students become aware of how their ability to comprehend tasks and make judgments about possible outcomes through building strategic thinking skills affects their ability to more fully understand and internalize knowledge. Joseph (2006) states that, "studies of adolescent learning behavior describe that metacognitive behavior can be taught, resulting in practical skills to use throughout their lives" (Joseph, p. 34). Joseph maintains that the failure to establish and maintain an effective focus may lead to frustration, confusion, and lack of academic self-confidence. On the other hand, metacognitive awareness and strategic thinking assist in learning how to access academic strengths and recognize weaknesses (Day, 1994; Vaidya, 1999). Combined, the students attain intellectual maturity. Joseph continues that metacogtnitively aware students learn to access prior knowledge, monitor comprehension, correct misunderstandings, synthesize information, draw inferences, ask questions, and internalize effective strategies for approaching learning (Joseph, 2006).

Metacognition and Cognition Defined

In order to grasp the relevance of teaching metacognitive awareness, both cognition and metacognition need to be differiated and defined. Sungar (2007) states that metacognition differs from cognition in that, "cognitive strategies are task-related strategies such as note-taking, summarizing, and outlining, while metacognitive strategies emphasize planning and monitoring one's learning and being aware of which strategies are suitable for use across academic tasks"

(Sungur p. 316). Vaidya (1999) adds that cognitive learning tends to be specific to the learning task. As a result, some cognitive strategies may apply only to learning that particular task (Vaidya, 1999). On the other hand, metacognition helps a student to recognize her cognition and control it. She develops the ability to plan, sequence, and monitor her cognition, thereby enhancing the academic outcome (Beyer, 2008; Day, 1994; Pressley, 1990; Protheroe, 2008). In short, the student is learning about effective and efficent learning. Unlike cognitive strategies, metacognitive strategies may be modified and transferred to other subjects or tasks (Day, 1994). While cognitive strategies represent concrete actions required for learning, metacognition delves into the more abstract and conscious control of material. Sungur (2007) asserts that metacognitive activities involve, "conscious experiences, which can be either cognitive or affective, pertinent to ongoing cognitive processes…likely to occur in situations that provide opportunities for thoughts and feEvanng about one's own thinking to arise" (Sungur, p. 316). Research has shown the introducing a metacognitive model into the classroom supports the development of metacognitive awareness and strategic thinking skills (Joseph, 2006; Kelley, 2008; McMahon, 2008; Vaidya, 1999). In order for students to build metacognitive awareness, teachers may construct an educational experience using specific metacognitive frameworks from which creative, thoughtful, engaged and strategic learners emerge.

Strategic Thinking

An intergral component of metacognitive awareness is strategic thinking—a system of a well-thought out learning approachs that permit learners to effectively move from one point to another. Strategic thinking consists of learning behaviors that direct and influence how the student processes information (Wong, 1993). Proetheroe and Clark (2008) further define

learning strategies as ways in which an individual approachs a task and how that person might think and act when planning, executing, and evaluating tasks (Protheroe, 2008). Vaidya (1999) notes that, "when these strategies are integrated into content area learning, the learning outcomes are successful" (Vaidya, p. 187). She also bEvaneves that an individual's interpretation of these strategies influence future learning behavior.

According to Day and Elksmin's research (1994), low achieving students "often experience continued frustration and failure in an academic setting" (Day, 264). They found that these students frequently do not have a comprehensive system for planning, organizing, rehearsing recalling information, and monitoring their performance. In short, they lack thinking strategies that might reduce frustration and increase success. They may become passive and dependent learners, incapable of learning independently (Day, 1994; Joseph, 2006; Vaidya, 1999). Successful strategy instruction that focuses on how to learn effectively guides students towards metacognitive awareness. They also learn to modify acquired strategic thinking skills to meet the needs of any classroom (Sungur, 2007). It is essential that students grasp the concept that strategies are useful in approaching, completing, or modifying task performance. They must comprehend the rationale behind a strategy's use and become intrinsically committed to using learning strategies (Beyer, 2008; Pressley, 1990).

Metacognitive Experiences

Day and Elksmin (1994) delineate several steps required for effective strategic learning. First, the students actively analyze their cognitive strengths and weaknesses; they are encouraged to set realistic goals that enhance motivation, focus attention, and provide incentives. Next, the instructor models strategy development through self-talk as she explains her own thought

process. The teacher invites the students to participate in deciding what strategies the instructor intends to try. Both students and teacher provide examples of strategies and discuss various ways in which they may be used at school, in their homes, and within the community. Once the students have determined which strategies they might use, they create memory prompts such as bulletin boards or charts and mnemonic devices. The teacher continues to monitor student efforts. Finally, they begin to explore and experiment with specific strategies based on the content and context, discarding those that are ineffective and retaining the ones that enhance their comprehension. By engaging in a metacognitive exercise, or thinking about thinking, the students become active participants in their educations. Kelley and Clausen-Grace (2008) concur in this assessment of appropriate methodology.

Metacognitive Framework (MTF)

The Metacognitive Teaching Framework (MTF) employed by Kelley and Clausen-Grace (2008) in their 2007 action research study of metacognitive transfer mirrors several aspects of the Day and Elksmin methodology. Kelley and Clausen-Grace examine the effects of teaching middle school students to be strategic thinkers in overall reading comprehension, particularly non-fiction. Kelley and Clausen-Grace note that, "most of the texts used were related to the science and social studies concepts being taught and included relevant textbooks, trade books, and student periodicals, such as Weekly Reader" (Kelley, p. 24). Kelley introduced the MTF curriculum to Clausen-Grace's middle school language arts classroom. [2] Kelley and Clausen-Grace use the Developmental Reading Assessment (DRA) designed for grades 4-8 for both pre- and post-evaluation. Kelley states that, "this assessment tool places students at either intervention, instructional, independent, or advanced levels in the areas of engagement, fluency, and comprehension" (Kelley, p. 23). The assessment revealed that all students in the class would

benefit from direct instruction in connecting, predicting, questioning, visualizing, and summarizing. As with Day's structure (1994), the teacher initially demonstrates, defines, and explains the introduced strategies. She may analyze what makes the task challenging and suggest possible strategies for attaining a particular outcome or goal. The students then begin to assist in strategy development through discussion and practice. The teacher may ask the students questions about how they arrived at a particular conclusion, offering assistance, and encouraging the students to engage in strategic thinking. Finally, as the students gain competency in assessing strategies, they perform tasks independently. They consider their thought processes and apply them to attaining their academic goals (Joseph, 2006; Kelley, 2008). Ultimately, strategic thinking will become intrinsic and transferable to other tasks (Beyer, 2008, Day, 1994; Kelley, 2008; Protheroe, 2008). [3]

Kelley and Clausen-Grace (2008) expressed concern that students may not be transferring the strategic thinking to other areas of independent reading. Therefore, specific discussions of strategy use, observations, and evidence and use of tally sheets measured acquisition and integration of strategies. In addition, the researchers designed self-assessment goal sheets for each strategy, mirroring the tally sheets used in their direct instruction. Kelley and Clausen-Grace concluded that introducing the MTF to their students enhanced their abilities to delve into any text at a deeper level. They also assert that metacognitive strategies, once they became intrinsic, will transfer to other academic tasks as the MTF promotes inquiry, provides a routine for strategic learning, and builds a metacognitive vocabulary that can be applied to all academic endeavors (Kelley, 2008). Nancy Protheroe, et al's (2008) research supports the Kelley hypotheses and she notes that strategic thinking skills acquired through metacognitive instruction may transfer to other academic and non-academic tasks (Protheroe, 2008). In short,

educators can create a community of thoughtful strategic thinkers (Kelley, 2008). Further research by Kramakski, Mevarach, & Lieberman (2001) supports the importance of building cross-curricular strategies.

Active physical participation in learning may have further benefits in enhancing strategic thinking. Rogers and Aston's research (1994) explores four different learning strategies based on Craik's theory of memory and children's learning. Craik's theory contains four major components: remembering or learning, close attention, elaborate encoding consisting of depth and spread or embedding, and fully descriptive encoding (Rogers, 1994). Rogers and Aston's study relies upon a concrete activity that involves physical interaction with a learning environment. Two hundred fifty-ten and eleven year olds participated in the study. Four heterogeneous groups were assigned to one of four instructional interventions: formal teaching based on a guided tour with no active student participation, guided discovery using teacher-generated worksheets with specific questions on salient features, free discovery with little instruction or direction, and finally, special learning games that focused the participants attention on salient information. The results indicated that formal and guided discovery worked for concrete information and recording of facts, but did not require independent thinking. The participants often missed salient points and failed to recall them after a two-week interval. Free discovery, on the other hand, supported analytical thinking and independent extrapolation of information but failed in helping participants to formulate learning strategies for information retention. Finally, those students involved in special learning games retained information and recalled relevant details more readily. The researchers concluded that unstructured learning had little benefit while a combination of formal instruction, guided inquiry, and learning games enjoyed the most positive effects. Rogers and Aston also noted that the learning games required

more strategic thinking than the other three methods and had the highest rate of retention (Rogers, 1994).

Transfer and Generalization Effects

Kramakski, Mevarach, & Lieberman (2001) studied the effects of two levels of metacognitive training on mathematical reasoning. Participants from six-seventh grade classrooms were assigned to one of three groups—multilevel, unilevel, or control. Participants in the multilevel metacognitive training group (MMT) received metacognitive instruction in both math and English classes. Those in the unilevel training group (UMT) received metacognitive instruction in just mathematics. The control group had no metacognitive training. Kramanski, et al (2001) hypothesize that providing metacognitive training in both math and English (MMT) would lead to significant gains in achievement. On the other hand, those who participated in UMT classes or had no training would have lower levels of achievement. In fact, the results of their study indicated that the MMT group not only outperformed the UMT and control groups, but were able to transfer their strategic thinking skills to foreign language acquisition, solving complex tasks, or solving more conventional problems. Additionally, the researchers discovered no significant difference between the UMT and control groups the ability to transfer strategies from one domain to another . Consequently, while some UMT participants showed improvement in mathematics, similar gains in other academic subjects did not occur. However, they suggest that future researchers might develop more appropriate domain-specific metacognitive training frameworks in order to support cross-curricular transfer.

Explicit training in metacognitive awareness and strategic thinking encourages students to become independent and self-aware learners (Beyer, 2008; Day, 1994; Joseph, 2006; Protheroe, 2008). The research cited above suggests that strategic thinking skills may be

transfered or generalized from on domain to another. [4] Several of the cited researchers theorize that because direct instruction in strategic thinking focuses on understanding the cognitive process , transfer between domain specific tasks may occur (Day, 1994; de Bruin, 2007; Kramakski, Mevarach, & Lieberman, 2001). DeBruin (2007) requires that participants analyze strategic moves in a chess endgame. Participants' strategic training focuses on self-reflection and self-regulation as well as prediction and judgement. De Bruin (2007) believes that these insights into cognitive processing might transfer to educational settings and improve academic outcomes. Day agrees that, "strategy instruction in specific academic areas has not only increased student performance, but has also fostered greater involvement in learning, yielded higher frequency of strategy use, and created greater awareness of strategic approaches" (Day, p. 267). He further asserts that strategic instruction aids students in developing transferrable metacognitive techniques that may be modified and adapted to different learning situations (Day, 1994). Sungar (2007) concurs that students trained in metacognition and strategic thinking have learned to "emphasize planning and monitoring one's learning and being aware of which strategies are suitable for use across academic tasks" (Sungur, p. 315). Therefore, the successful strategic thinker has internalized the value of learning in addition to factual knowledge. She may also learns to control the outcome of endeavors through metacognition and self-efficacy—the capacity to learn proficiently (Sungur, 2007).

Kramarski, et.al.'s study (2001) of multilevel metacognitive training (MMT) submits that cross-domain training strenghtens strategic thinking skill. Their research hypothesizes that students receiving MMT would successfully generalize strategic thinking skills from one domain to another. They found that students not only internalized the methodology, but also effectively modified and adapted techniques between mathematics and English classes. The study

partcipants learned to analyze problems, activate prior knowledge, and select appropriate strategies (Kramakski, Mevarach, & Lieberman, 2001). Engle's (2006) study of fifth graders also directly addressed skill transfer and generalization. Her findings support the Kramarski, et.al's(2001) conclusion that skills may be transferrable from one domain to another. However, Engle's procedure contrasts with cognitive models that rely upon what students do or say. Instead, Engle believes that the educational setting, or stituational context, determines the level of transfer. She found that "transfer is more likely to occur when learning contexts are framed as part of a larger ongoing intellectural conversation in which students are actively involved" (Engle, p. 451). She continues that, "generative learning—learning that results in the flexible use of what has been learned in a wide range of relevant future situations" has a greater impact on generalization (Engle, p. 451). She believes that intercontextuality is essential and hypothesizes that the learning environment must be designed to enhance transfer to a larger intellectual venue.

Summary

Metacognitive awareness provides the framework for building strategic thinking skills. Current research indicates that training students in strategic thinking has wider application in the classroom and the community. Through direct and explicit instruction in these skills, students lay the foundation for thoughtful, critical, and independent learning. They develop the ability to make decisions, solve problems, draw conclusions, analyze information, and identify cause and effect. In short, students may increase their academic proficiency and become self-regulated, autonomous learners who have the skills to direct their own learning. As noted in the cited research, acquiring these skills goes beyond single-subject competency. Students who have developed metacognitive awareness and efficient learning strategies may be able to transfer or

generalize from one specific domain to another. However, further research needs to be done in facilitating the integration of strategic instruction into classrooms. As Beyer (2008) notes, "there are gaps and omissions even in research that exists. Educational research is an ongoing enterprise changing with the educational interests of the times" (Beyer, p. 231).

Methodology

Promoting Strategic Thinking Skills in Middle-School Students Using *Set: The Family Game of Visual Perception*®

Research Question

The study addresses the following research question:

What are the effects, if any, of a curriculum using *Set: A Family Game of Visual Perception*® on strategic thinking skills in middle school students?

Instructional Materials

The instruction relied upon *Set: The Family Game of Visual Perception*®, which provides a concrete and hands-on experience. The game focused on strategy development, visospatial competency, working memory, and organizational skills. The card game consists of eighty-one cards with four variable features:

- Symbols—One of the following: ovals, squiggles, or diamonds
- Colors—Symbols are either red, green, or purple

- Number—Each card has one, two, or three symbols

- Shading—Symbols are either solid color, striped, or outlined with one of three colors

The object of the game is to select three cards from a grid that constitute as set. The grid begins with twelve cards. Three additional cards are added when a set is discovered and removed, or when there is no set in the grid. Sets rely on a combination of differences and similarities in symbols, colors, number of symbols, and shading. The game continues until all the cards have been used and no further sets can be constructed. The player with the most sets is declared the winner. The participants receive a rule sheet that contains examples of what constitutes a set (Appendix I). *Set*® may supportdirect development of language and math-relevant skills sets and strategies by using a concrete cognitive activity. However, the successful player must use metacognitive and strategic thinking skills to become proficient in the game. The purpose of the study is to explore the effect of the game on the following:

- Abstract reasoning as it applies to strategy development through card set sorting

- Working and long-term memory as it applies holding types of sets in memory and learning rules

- Organizational skills as it applies to sorting by symbols, numbers, colors, and shadings

- Metacognitive awareness as it applies to student evaluation and comprehension of strategic thinking

Procedures

The instruction was divided into three segments: (a) pre-instruction assessment using the pre-instruction participant questionnaire (b) training by the researcher and independent play, and (c) post-instruction assessment using the post-instruction questionnaire. Participants met with the researcher twice weekly for two-thirty minutes sessions for seven weeks for a total of fourteen sessions. The original study design included an optional sixteenth session for the participants to train their classmates in playing *Set*®. However, the anticipated eight weeks was reduced to seven. Therefore, supervised student-to-student training did not occur.

The instruction used the metacognitive teaching framework (MTF) as described by Kelly and Clausen-Grace (2008). This model encourages and may train participants to think actively about strategies that they might employ to become competent players. This is in contrast to a cognitive model that teaches the rules and application without developing strategic thinking skills. During the first stage, the researcher explicitly instructs the participants by demonstrating and defining strategies needed for knowledge acquisition. This includes a description of the researcher's own strategies in identifying sets. The researcher and participants then perform the task together through guided practice in which the researcher oversees play and continues direct instruction. Finally, the participants practice independently as they gain confidence and competency in specific skill sets required for playing the game. During the last phase, the researcher passively observes the participants although she may answer specific questions about the game. Pre-instruction requires an informal assessment of the participants using the pre-instruction teacher and participant questionnaires. The participant questionnaire was designed to determine participant awareness of strategic thinking and individual learning styles. The researcher scored each assessment and entered the results onto the data collection log. See Appendix J for the complete curriculum.

Audio recordings

The researcher recorded participant interactions during actual play and the focus group. The purpose was to provide data supporting the researcher's observations in the process journal. The recordings were not tabulated

Set® *Study Results*

Introduction: Metacognitive awareness and strategic thinking are central to a student's academic success (Beyer, 2008; Protheroe, 2008; Vaidya, 1999). Students not only need to learn to decode, recode, and organize information; they need to be able to analyze, interpret, and apply knowledge to both academics and the outside world. Fostering metacognitive knowledge and self-awareness in middle school students takes many forms. It can be modeled through a specific task in which the students learn to plan, monitor, evaluate, and reflect upon their work. The purpose of this study was to investigate teaching strategic thinking skills to middle school students through playing *Set: A Family Game of Visual Perception*®. The researcher employed a metacognitive model to facilitate the acquisition of these skills. The study included engaging students in collaborative planning, self- assessment, and collective reflection with the stated goal of improving strategic thinking skills through metacognitive awareness.

This study proposed an alternative method for teaching strategic thinking skills through direct instruction using the strategy card game, *Set: The Family Game of Visual Perception*®. I anticipated that participants would become more proficient in using strategic thinking, an essential skill in most academic endeavors, as they master *Set*®. I hypothesized that acquired

expertise would be reflected in the ability to apply *Set*® strategies automatically as the participants began to master the game. I also predicted that participants would gain a better understanding of strategic thinking and their individual learning styles. Further, I expected that participants would perceive an improvement in their strategic thinking abilities in their academic classes. However, transfer or generalization of strategic thinking skills to the classroom is outside the scope of this study. Consequently, analysis of strategic thinking skills was confined to the game.

Description: The study engaged students in collaborative planning, self- assessment, and collective reflection with the stated goal of improving strategic thinking skills through metacognitive awareness. Assessment tools included pre-and post intervention student questionnaires (Appendices E and F), weekly student journal entries, weekly group discussions, and researcher observations of each student. Audio recordings and a researcher process journal supported these.

The instruction used the Metacognitive Teaching Framework (MTF) as described by Kelley and Clausen-Grace (2008). The MTF has three phases of instruction:

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Summary

The purpose of this study was to investigate an alternative method of teaching strategic thinking skills to middle school students through playing *Set: A Family Game of Visual Perception*®. The researcher selected an exploratory and qualitative design with a specific instructional model. In addition, the study addressed the feasibility of using an alternative method of training using *Set* ®. The qualitative data collection was based on the researcher

observations, student journals, student questionnaires, and audio tapes that recorded responses to the instruction. The researcher began with the premise that individuals could acquire and develop strategic thinking skills through playing *Set* ®. She anticipated that participants would become more proficient in using strategic thinking as they mastered the game. She also predicted that participants would gain a better understanding of strategic thinking and metacognition. She further hypothesized that as they acquired expertise, the participants would gain an ability to applystrategies to the game automatically. Finally, she expected that participants would perceive an improvement in their strategic thinking abilities and begin to use them in their academic classes. The results indicate that these goals may have been achieved. Formal assessments of strategic thinking skills may further support the results.

Although the sample size was small, the participants represented a diverse demographic, which may have compensated for the size of the study group. The participants included equal numbers of boys and girls as well as a varied racial and ethnic mix. In addition, the researcher selected participants with varied learning modalities. Lincoln had been diagnosed with attention deficit disorder and social challenges, while Rowena and Evan had suspected learning disabilities. Joelle, Melinda, and Blaine balanced them out by having by no discernible learning challenges (Table 1). Finally, Evan, one of the participants, received a diagnosis of executive functioning disorder , slow processing speed, and attention deficit disorder when formally assessed post study. The researcher's informal assessment of this participant supported the diagnosis. As can be seen in Evan's case study, these challenges initially affected his performance. Despite this, Evan showed an improvement in his strategic thinking skills. By the end of the study, he was processing information more quickly and beginning to think strategically. The researcher speculates that Evan may benefit from continued training in

strategic thinking as a means of remediation. Rowena also may have had undiagnosed challenges with processing speed. As with Evan, her processing speed increased during the study. She began to think about how she learned and how to apply that self-knowledge. As a result, she learned to enjoy the game.

As the researcher anticipated, the participants became more proficient in strategic thinking by the end of the study. A comparison of the journal entries indicated that they all made gains in strategic thinking and metacognition. Lincoln, Blaine, Rowena, and Evan's the journal entries became progressively more complex and thoughtful while Joelle and Melinda continued to make detailed entries that reflected their metacognitive awareness. By the fourth week, all participants began to engage in independent play with one another. They started to analyze the cards actively, extrapolate information, and apply it. In addition, the ability to recognize patterns and develop a strategy began to emerge. However, participants could not determine whether strategy use had transferred to their academics or improved their grades. Additional research in this area is suggested. By week five, play became faster and more competitive indicating that the players had begun to integrate their strategies and apply them automatically. They became proficient in discussing their thought processes and were able to explain them to others. In spite of this, the participants did not recognize these shifts as changes in their strategic thinking. However, when the researcher began to question them more closely, most agreed that there had been a change both in their approach to the game and to their class work. The post-instruction questionnaire gave the participants an opportunity to analyze and discuss their experiences. Tables for each individual are included in the case studies. With the exception of Evan, the other participants indicated that they had seen an improvement in their ability to play the game.

Interestingly, none of the participants recognized their strategy shifts as changes in strategic thinking.

The exploratory and qualitative design with a specific instructional model addressed the feasibility of using an alternative method of training students to be strategic thinkers. Despite the limitations, this study may provide the foundation for future studies in using non-computerized strategy games as a means of teaching strategic thinking skills. The researcher hopes that educators may be inspired to explore alternative methods of incorporating strategic training into their curricula. However, formulating clearer educational implications is not possible at this point without an experimental design. This study is a starting point for further exploration of strategic thinking and metacognitive awareness.

Discussion

I first became intrigued with using non-computer strategy games as teaching tools while teaching study skills classes and working with private clients. As a result, I began incorporating games like chess, checkers, backgammon, *Risk*®, *Battleship*®, and *Set: A Family Game of Visual Perception*® into my curricula. However, anecdotal evidence suggested that *Set*®, in particular, encouraged the development of a multifaceted and complex mental phenomenon requiring the mastery and integration of four basic thinking skills—comparing, classifying, sequencing, and predicting. These basic skills contain subsets including decision-making, problem solving, drawing conclusions, and analyzing, all part of strategic thinking, which are central to a student's academic success Further, students not only need to learn to decode, recode, and organize information; they need to be able to analyze, interpret, and apply knowledge to both academics and the outside world. My experiences indicate that direct

instruction in metacognitive awareness and strategic thinking increased academic proficiency. Developing and introducing a metacognitive curriculum that integrates strategic thinking skills into play has been the primary goal of this study. I chose to use exploratory and qualitative model that asked the following question: What are the effects, if any, of using a curriculum using *Set: A Family Game of Visual Perception*®. The instruction included explicit strategies for teaching and accessing the participants' metacognitive and strategic thinking. However, the study had some unexpected results and suggested further areas for study including executive function, sex and age based learning differences, processing speed, attention-deficit disorder, dyslexia, and social interactions. Finally, additional research regarding using *Set*® as a diagnostic tool might be pursued.

Executive Functioning An individual's executive functioning influences his ability to process and use information efficiently. A central component involves holding information in the working memory and organizing it into a coherent form. In *Set*®, a disorganized array interferes with a player's capacity to locate and identify sets. The disorganized array affected organization, self-regulation, and self-awareness. For instance, participants Evan and Blaine initially laid too many cards in the array. This created visual confusion by introducing too many variables, which reduced the probability of identifying a set. As the creators of *Set: A Family Game of Visual Perception*® determined, the mathematical probabilities of finding set decreased as the number of cards in the grid increased (Falco 2001). Intervention helped the boys to recognize that too many cards interfered with applying strategies needed to identify sets. Once they began using the appropriate grid layout, their skills improved as did their interest and enjoyment of the game. Further, both boys became more self-confident and began to recognize and verbalize their strategies more clearly. A more in-depth analysis can be found in the individual case studies.

Additional investigation into using strategy games as part of remediation of executive functions disorders may be appropriate.

Sex-Based Differences Sex-based differences occurred in the course of the study. During the sorting phase of the intervention, the three girls cooperated in determining the sorting categories. First, they discussed possible criteria for sorting. After selecting color as the first determinant, they divided the cards evenly by color and formed orderly piles based on their initial sorting criteria. They collectively refined the stacks first by shapes, then symbol fillings, and finally number of symbols. When asked what they thought might constitute a set, they discussed this amongst themselves and were able to successfully demonstrate and explain their hypothesis. This self-sufficiency continued throughout the study. The three male participants, on the other hand, randomly divided their cards into three stacks and each devised his own criteria. Lincoln chose to separate himself from Evan and Blaine because he disagreed with them and was unable to articulate his technique. When asked to integrate their cards, they argued about whose method would prevail. Finally, they spread all the cards on the floor in what appeared to be a random pattern. Photographs of the first card arrays are part of the record. During play, the boys often squabbled about what constituted a set, who spotted it first, and the number of cards present in the card grid. As a result, they often requested mediation. In addition, the two of the boys, Evan and Blaine, began to create new card games using the *Set*® deck. The female participants, on the other hand, acted more independently. When disputes arose in both Phases One and Two of the activity, they would refer to the rule sheet and discuss what elements were needed to create a set. Intervention by the researcher was seldom needed or requested. A more detailed discussion of sex-based competitive behavior can be found in the section on interpersonal dynamics. These behaviors are consistent with pre-study trials with seventh and eighth grade students.[7]

Additional study into sex-based decision-making and conflict resolution using games such as *Set*® may be beneficial.

Age-Based Difference. Participant age may have affected their abilities to articulate their metacognitive strategies both in verbal and written form. When compared with the seventh and eighth graders in the pre-study trial, the researcher noticed that the older students needed less direction in assessing and verbalizing their metacognitive strategies. During the formal study, I found that articulating strategic thinking skills proved more difficult for the participants if done independently. As a result, I promoted verbalization of strategic thinking skills by asking clarifying questions about the participants' strategies while they were actively engaged in play. I also encouraged exploring alternative processes both individually and as a group. However, the three male participants required more active intervention. I employed the same methods with participants' journal responses. Both boys and girls required this type of assistance. Some of these interactions are included in the audio recordings. The differences between the sixth graders and the seventh and eighth grader may due to the cognitive shift from concrete to abstract thinkers that begins with puberty. However, it was not within the scope of this limited study to pursue this path. A comparative study of different age groups might be beneficial.

Processing Speed Playing *Set*®, competitively requires good visual acuity and fast reaction time. I noticed that as participants became more proficient, their processing speed increased. This was particularly true with Rowena who needed time to integrate the rules of the game and strategies. I also found that participants who had slower speeds benefitted from learning to play the game either by themselves or with a more proficient player. The proficient player, in turn, learned to articulate his or her strategies to the slower player. Anecdotal evidence from my

practice supports these conclusions and I often use the game for remediation. Finally, *Set*® may be used as an informal assessment tool for processing speed. Discussion of *Set*® as a diagnostic tool can be found later in this paper.

Attention-Deficit Disorder I found that individuals with this disorder frequently do not have a comprehensive system for planning, organizing, rehearsing, recalling information, and monitoring their performance. In short, they lack thinking strategies that might reduce frustration and increase success.Lincoln, a study participant, had been diagnosed with ADD, the inattentive type. Lincoln found that playing *Set*® increased his ability to stay focused for longer periods. This is consistent with what I found in pre-study test group and in my practice. Evan, who did not have a formal diagnosis at the beginning of the study, also exhibited symptoms of ADHD. He could not sustain focus long enough to become proficient and became easily frustrated. Because many individuals with ADHD also have some executive functioning problems, playing the game may aid in developing better organizational and working memory skills for this boy. However, the length of the study was inadequate for specific remediation. Further discussion of both boys can be found in the study results. The evidence is antidotal; consequently, future studies into the application of this study's protocols may be helpful in developing remediation strategies for these learning disorders.

Interpersonal *Set*® is an interactive game requiring cooperation among the players during the learning phase when participants need to communicate effectively. They learn to share knowledge, monitor play, and analyze information. When they begin to play competitively, it is essential that they behave with civility towards one another. The boys, in particular, may learn appropriate interactions from structured play. For instance, when Blaine and Evan began

roughhousing during play, Joelle asked them to settle down. In the case of Lincoln, the study participant who was isolated from his peers and considered odd, the game gave him a structured way in which to interact with his classmates. In this context, fellow participants accepted him into the group and would often request him as a partner. More detail about this participant can be found in the study results. Finally, Joelle, who tended to be bossy, learned to be more considerate and willing to listen to other participants' suggestions and input. As she said, "I'm getting better at cooperating even when I want to win (audio recording)."

Competition plays an important role in most games and *Set*® is no exception. However, even here, the boys and girls differed in execution. Joelle and Melinda were fierce competitors with each other and the shouts of "Set!" filled the room when they played together. When one disputed a set, they stopped playing and analyzed the disputed cards. More often than not, they used this opportunity to refine their skills by deciding what cards were needed to correct the error. After coming to an agreement, they returned to the game with renewed vigor. Additionally, both girls selected partners with whom they were evenly matched. Consequently, they chose Blaine and Lincoln as partners rather than Evan. The boys, on the other hand, settled disagreements by yelling at one another. Even quiet Lincoln engaged in angry accusations claiming that, "Blaine cheats and steals cards!" (student journal). During one dispute, Evan swept the cards to the ground and refused to continue to play. Interestingly, the behavior desisted when Blaine and Lincoln were playing with the girls. Instead, they adopted the more civilized approach. Evan, on the other hand, refused to compete with Joelle, Melinda, and Rowena.

Diagnostic Although it was not the intent, the study suggested that *Set*® might be an effective informal diagnostic tool for learning disorders such as executive function, processing speed, attention-deficit disorder, and visual acuity. My experiences indicate that games like *Set*® may be helpful with informal assessments, which are designed to assess a student's ability to master several items within a narrow band of skills. They may use direct measurements that track progress using instructional materials. I suggest a less traditional means of assessment by using *Set*®, to assess a student's processing speed, visual acuity, executive functioning, and learning modalities through task analysis that breaks a task to the smallest components. For instance, during the study, I observed that Evan appeared to be challenged with basic organizational skills. In addition, he became easily frustrated because he could not locate sets as quickly as the other participants could. I guessed that he might have both executive functioning challenges and issues with processing speed. Subsequently, he was formally assessed and the results confirmed that he had executive function disorder, was a slow processor, and had attention deficit disorder. Further studies regarding the accuracy of this type of use would be beneficial to educators who want a simple informal tool prior to assessment that is more formal.

Recommendations

This study examined the feasibility of using a game to develop metacognitive awareness and build strategic thinking skills. The intervention was exploratory and limited by time and the number of participants. However, the results of the study indicate that students may be able to enhance their strategic thinking through directed play of non-computerized strategy games. As a result, middle-school students may become aware of how their ability to comprehend tasks and make judgments about possible outcomes affects their ability to more fully understand and

internalize knowledge. Joseph states that, "studies of adolescent learning behavior describe that metacognitive behavior can be taught, resulting in practical skills to use throughout their lives" (Joseph, 2006, p. 34). I suggest that the development of a curriculum that integrates several non-computer strategy games into the entire school year may produce more discernible results. In order for students to build metacognitive awareness, teachers may construct an educational experience using specific metacognitive frameworks from which creative, thoughtful, engaged and strategic learners emerge. Because of individual differences, one game may not adequate for producing the desired effects. The games may include, but not be limited to, chess, checkers, *Go*®, *Set*®, card games that require planning, backgammon, *Risk*®, and *Battleship*®. To this end, teachers may modify any games that require strategic thinking skills to meet the needs of any classroom. Finally, although computer-based strategy games can be effective, they do not require social interactions or invite players to share strategies with one another. This may limit a student's metacognitive awareness and self-reflection. Incorporating strategy games into the middle school curriculum to enhance metacognitive reasoning is not the only use.

My study began with a simple premise that educators can promote strategic thinking skills in middle-school using *Set* ® *The Family Game of Visual Perception.* As I pursued my study, I discovered that the game had far more applications that needed to be explored.. I propose that *Set*® may be used as one of the informal screening tools for learning disabilities such as executive function disorder and processing speed. I also suggest that the game can be part of a remediation strategy for these disorders as well as for visual processing and attention-deficit disorder as students who face these challenges may respond more positively to a playful approach to learning. Currently, most of my evidence is anecdotal and this study has been the first step in exploring the feasibility of using *Set* ® as an educational and remedial tool. In

addition, my observations of boys and girls engaged in non-computer game play suggest that additional examination in this area may provide more information on sex-based cognitive differences. Finally, further studies regarding games as a means of addressing social deficits may be appropriate. Continued study in this area may mitigate social isolation and maladjustment. Games are a part of our lives and as educators, our responsibility requires that we examine how games can be integrated into the classroom, a private educational therapy practice, and the home as a teaching tool.

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[2] Kelley, et. al. did not specify the number of participants in the study, nor their specific grade level.

[3] A more comprehensive discussion of transfer and generalization effects begins on p. 15.

[4] The differences between the terms transfer and generalization are minimal; therefore, they are frequently used interchangeably in the cited references.

[5] Shortly after the study, Evan was assessed for specific learning disabilities. Test results indicated that he has an executive function, attention deficit disorder, and problems with processing speed.

[6] The term "Tiger Mother" comes from a book that is currently popular and describes a rigid approach to child-rearing that excludes social interactions and emphasizes academics and music.

[7] I conducted pre-study trials in 2010 with students entering seventh grade and eighth graders during a study skills class at the same school site. I also use *Set*® in my private practice for diagnosis and remediation.