The Relationship Between Thinking Maps And Florida Comprehensive Assessment Test Reading And Math Scores In Two Urban Middle Schools

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THE RELATIONSHIP BETWEEN THINKING MAPS® AND FLORIDA COMPREHENSIVE ASSESSMENT TEST® READING AND MATHEMATICS SCORES IN TWO URBAN MIDDLE SCHOOLS

by

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ABSTRACT

The purpose of this study was to determine what difference, if any, exists between the implementation and use of Thinking Maps® and students' academic achievement in Reading and Mathematics as measured over time by the Florida Comprehensive Assessment Test® (FCAT). Thinking Maps® is a registered trademark of Thinking Maps, Inc. The data were examined after three years of Thinking Maps® implementation and instruction. The design of this study was quantitative, with a nonrandomized control group, pretest-posttest design (Ary, Jacobs, & Razavieh, 2002) that examined the effects on student Reading and Mathematics FCAT scores in one middle school that implemented Thinking Maps® throughout all grade levels and core subjects for three years as compared to student Reading and Mathematics FCAT scores in a second middle school that did not implement the Thinking Maps® program throughout all grade levels and core subjects for three years. MANOVA and Chi-square tests were used to examine student FCAT scores. This study focused on one major question: Do students who have been instructed in the use of Thinking Maps® have higher academic achievement as measured by the Florida Comprehensive Assessment Test® (FCAT) than those that have not been instructed in the use of Thinking Maps®? Results of this study indicated that students who have been instructed in the use of Thinking Maps® do not have higher academic achievement as measured by the Florida Comprehensive Assessment Test® (FCAT) than those who have not been instructed in the use of Thinking Maps®. The researcher concluded that other methods of evaluating the implementation of Thinking Maps® and student achievement should be explored.

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CHAPTER ONE: INTRODUCTION

Conceptual/Theoretical Framework

According to Ausubel, an individual's existing cognitive structure, organization, stability, and clarity of knowledge are the principal factors influencing the learning and retention of new material (Driscoll, 2005). The theoretical framework for this study was Ausubel's Subsumption Theory, also known as Assimilation Theory (Ausubel, 1960, 1963, 1968, 2000). Subsumption occurs in the already existing cognitive structure of the learner under one or more of the learner's inclusive concepts. When a new idea enters the learner's consciousness and is processed and classified through the existing structure then subsumption or assimilation, as Ausubel preferred to call it, occurs (Ivie, 1998). A major factor in the learning and retention of new material is the cognitive structure a learner possesses. New information can only be subsumed if there are relevant major concepts that already exist in the learner's cognitive structure in which new ideas can anchor (Ausubel, 1960, 1963, 1968, 2000). Subsumers provide a basic structure around which information is organized and are like cerebral linchpins that hold the learner's cognitive structure together. Subsumption facilitates learning and the retention of knowledge (Ivie, 1998). The instructional program used in this study was Thinking Maps® which uses subsumption as basis for student learning. Thinking Maps® is a registered trademark of Thinking Maps, Inc.

Thinking Maps® are instructional visual tools that help learners organize their thinking. These visual tools are represented by eight "graphic primitives" (Appendix A) that may be used together or in isolation. Thinking Maps® may be adapted to fit content. They are learner generated and provide the learner with a view of their own thinking (Hyerle, 2004).

Statement of the Problem

Facilitating a student's acquisition of powerful and valid conceptual frameworks is difficult. There are innumerable ways to go wrong and there is no foolproof set of traditional instructional strategies (Novak, 2002). The challenge is how to teach students to construct and reconstruct their individual conceptual frameworks that will lead to increasing cognitive competence and higher academic achievement. Teachers may use advance organizers, graphic organizers, and concept maps to assist their students in the learning process. This study focused on one instructional program called Thinking Maps®. Thinking Maps® are eight fundamental thinking skills defined and animated by maps, and are introduced to teachers and students as a common visual language for thinking and learning. These eight visual tools enable learners to communicate what and how they are thinking (Hyerle, 2004).

Purpose of the Study

The purpose of this study was to determine what difference, if any, exists between the implementation and use of Thinking Maps® and students' academic achievement in reading and mathematics as measured over time by the Florida Comprehensive Assessment Test® (FCAT). This longitudinal study examined 6^{th}, 7^{th}, and 8^{th} grade FCAT Reading and Mathematics scores for students who received three years of Thinking Maps® instruction while attending a middle school that implemented Thinking Maps® throughout all grade levels and core subjects during the 2005-2006, 2006-2007, and 2007-2008 school years.

Significance of the Study

Learning begins at birth and the process quickens as we acquire language to code meaning for events and objects around us (Novak, 2002). Problems occur when the learner constructs a consistent representation of information while deeply misunderstanding the new information presented. When this occurs misconceptions are formed and the learner does not realize that true understanding has not occurred (Bransford, Brown, & Cocking, 1999).

Ausubel believed that a learner's cognitive structure must be organized, stable, and clear to facilitate the learning and retention of new concepts. A cognitive structure that is confused and disorganized inhibits learning (Ausubel, 1960, 1963, 2000). If students have constructed unsuitable meanings for standards, such as those tested on Florida's Comprehensive Assessment Test®, the consequences can be grave. Florida's Comprehensive Assessment Test® (FCAT) is a high stakes test. Schools are held accountable for the achievement of their students. Students are tested in reading, writing, mathematics, and science. There are two types of performance tasks that include short and extended responses. Students are expected to describe a character in a story, write a mathematical equation after reading a word problem, explain a scientific concept, compare two passages, create a graph, or describe the steps for an experiment. These performance tasks require students to demonstrate knowledge learned (FLDOE, 2008). Teachers need instructional tools that will assist them in teaching students how to construct and reconstruct their individual conceptual frameworks. Construction and reconstruction of conceptual frameworks lead to increased cognitive competence.

Thinking Maps® reconciles students' thinking, learning, and metacognitive behaviors (Hyerle, 2004). They can be used for content-specific learning such as reading comprehension, writing processes, mathematics, and technology. Thinking Maps® instruction teaches students thinking skills that allow for independent transfer across disciplines while directly meeting state standards (Hyerle, 2004).

Hyerle provides data that when the Thinking Maps® program is implemented school-wide; students' performance on state assessments has improved (Hyerle, 2000; Hyerle & Yeager, 2000). In the large urban school district where the study was conducted there were over 300 Thinking Maps® trainers throughout 180 schools. Thinking Maps® have been used in some of the large urban school district schools since 2002. In this school district there had not been a study to determine what difference, if any, exists between the implementation and use of Thinking Maps® and students' academic achievement as measured over time by the Reading and Mathematics Florida Comprehensive Assessment Test® (FCAT). This study adds to the research on the instruction and implementation of Thinking Maps® at the middle school level.

Research Questions

The researcher sought to answer the following question:

1. Do students who have been instructed in the use of Thinking Maps® have higher academic achievement as measured by the Florida Comprehensive Assessment Test® (FCAT) than those who have not been instructed in the use of Thinking Maps®? Specific questions included:

1.1 Was there a difference between the 2008 FCAT Reading scores of 8th grade students who received Thinking Maps® instruction since 2006 and those who did not receive Thinking Maps® instruction since 2006?

1.2. Was there a difference between the 2008 FCAT Mathematics scores of 8th grade students who received Thinking Maps® instruction since 2006 and those who did not receive Thinking Maps® instruction since 2006?

1.3. Were there differences in student's 2006, 2007, 2008 learning gains on FCAT Reading between schools (School A [treatment site] and School B [control site])?

1.4. Were there differences in student's 2006, 2007, 2008 learning gains on FCAT Mathematics between schools (School A [treatment site] and School B [control site])?

1.5. Were there differences in student's 2006, 2007, 2008 learning gains on FCAT Reading between subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students)?

1.6. Were there differences in student's 2006, 2007, 2008 learning gains on FCAT Mathematics between subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students)?

1.7. Were there differences in student's 2006, 2007, 2008 learning gains on FCAT Reading across subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students)?

1.8. Were there differences in student's 2006, 2007, 2008 learning gains on FCAT Mathematics across subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students)?

Definition of Terms

Annual Yearly Progress (AYP) - The Federal No Child Left Behind Act of 2001 (NCLB) requires states to assess the performance of all students in all public schools in order to determine whether schools, school districts, and the state have made Adequate Yearly Progress (AYP) towards enabling all students to meet the state's academic achievement standards. AYP measurements target the performance and participation of various subgroups based on race or ethnicity, socioeconomic status, disability, and English proficiency. The goal of NCLB is to have 100 percent of students at proficiency by 2013-14 on state reading assessments. The data used for the basis of AYP incorporates the assessment results in grades 3-10 from the Florida Comprehensive Achievement Test® (FCAT) and alternate assessments given to Exceptional Education Students (ESE) and English language learners (ELLs). Not meeting AYP does not mean that a school is failing. It means that the school has not met a certain standard for at least one group of students (FLDOE, 2008).

Achievement Levels - Five categories of achievement that represent the success students demonstrate with the Sunshine State Standards (SSS) content assessed on the FCAT. The achievement levels for FCAT Reading, FCAT Mathematics, FCAT Science, and FCAT Writing+ were established using the input of classroom teachers, curriculum specialists, education administrators, and other involved citizens (FLDOE, 2008).

Assimilation Theory - Refers to the idea that learning involves relating new, potentially meaningful material to existing knowledge (Mayer, 1979).

Benchmark - A specific target that describes what students should know and be able to do. The benchmarks are part of the Sunshine State Standards (SSS) (FLDOE, 2008).

Content Area - The information or skills contained in an area of study. The content areas (or subject areas) assessed on the Florida Comprehensive Achievement Test® (FCAT) are reading, writing, mathematics, and science (FLDOE, 2008).

Content Subscores - The number of raw score points earned by a student in each sub-content area of FCAT SSS Reading, Mathematics, Science, and Writing+ (multiple-choice questions only). Content subscores are reported for clusters in FCAT Reading and FCAT Science, for strands in FCAT Mathematics, and by reporting category in FCAT Writing+. For example, in Mathematics, subscores are reported for number sense, measurement, geometry, algebra, and data analysis and probability (FLDOE, 2008).

Demographic Reports - Summary reports that represent the scores of various subgroups of the students tested. The information collected about students at the time they take the FCAT includes: name, student identification number, race/ethnicity, gender, and other demographic information. This demographic information and other information is established from existing Florida Department of Education and school district databases before the reports are produced (FLDOE, 2008).

Developmental Scale Score (DSS) - A type of scale score used to determine a student's annual progress from grade to grade. The FCAT Developmental Scale for Reading and Mathematics ranges from 86 to 3008 across Grades 3-10. On the Sunshine State Standards Reading and Mathematics Student and Parent Report, the developmental scale score is called the FCAT Score (FLDOE, 2008).

Developmental Scale Score (DSS) Change - A calculation made by the subtraction of two years' developmental scale scores, which yields the amount of change across the two years, e.g., 2008 DSS – 2007 DSS = DSS Change. This number can be large for students who move from a low Achievement Level 1 score to a low Achievement Level 2 score. It also can be small for a student who sustains a high score in Achievement Level 4. The DSS Change can be understood best when also considering the achievement level scores for the two years (FLDOE, 2008).

English language learners (ELLs) - Students who are classified as English language learners and are enrolled in the English for Speakers of Other Languages (ESOL) program are permitted testing accommodations when taking the Florida Comprehensive Achievement Test® (FCAT). All ELLs are required to take the FCAT. Students who have been in an approved ESOL program for 12 months or less may be exempted from taking the FCAT by a majority decision of the ELL Committee. The ELL Committee is comprised of parents, teachers and other school based personnel. ELLs exempted from the FCAT must be tested using an approved alternative assessment (FLDOE, 2008).

Exceptional Student Education (ESE) - Special educational services that are provided to eligible students, e.g., visually impaired, hearing impaired. These services are required by Federal law and are provided to Florida students according to the State Board of Education Rule 6A-6.0331, FAC. Students demonstrate the conditions required for the services, and services are provided as described in an Individual Education Plan (IEP). The IEP also specifies the testing accommodations a student needs for classroom instruction and assessments (FLDOE, 2008).

FCAT Score - The FCAT Scores for Science and Writing+ are scale scores which range from 100 to 500. The FCAT Scores for Sunshine State Standards (SSS) Reading and SSS

Mathematics are reported using the Developmental Scale Score (DSS). The DSS ranges from 86 to 3008 across Grades 3-10 and provides a way for parents to track their student's annual academic progress from grade to grade.

Learning Gains - As part of the school grading system, annual learning gains can be shown three ways:

1. Improving an achievement level, e.g., from Achievement Level 1 to Achievement Level 2.
2. Maintaining an Achievement Level 3, 4, or 5. Maintaining high scores with harder content each year shows an increase in learning.
3. Showing adequate DSS Change if a student remains in Achievement Levels 1 or 2 (FLDOE, 2008).

Load-Reducing Methods - Automaticity and constraint removal strategies (Mayer & Wittrock, 2006).

Meaningful Learning - Meaningful learning occurs when the learner chooses conscientiously to integrate new knowledge to existing knowledge the learner possesses (Novak, 1994).

No Child Left Behind Act of 2001 (NCLB) reauthorized the Elementary and Secondary Education Act (ESEA) - The main federal law impacting education from kindergarten through high school. Proposed by President Bush, NCLB was signed into law on January 8th, 2002. NCLB focused on accountability for results, more choices for parents, greater local control and flexibility. There is an emphasis on doing what works based on scientific research (USDOE, 2007).

Norm-Referenced Test (NRT) - A test designed to compare the performance of one set of students to a national sample of students, called the norm group (FLDOE, 2008).

Points Possible - The number of “Points Possible” shows that total number of machine-scorable test questions and performance task points on a test. The number of “Points Earned” shows how many of these points the student earned. These scores are reported only for the content subscores. The number of points possible in a subscore may change each year (FLDOE, 2008).

Scale Score - The score used to report test results on the entire test. Florida Comprehensive Achievement Test® (FCAT) Sunshine State Standards (SSS) scale scores range from 100 to 500 for each grade level and content area. The Reading and Mathematics scale score is only provided to schools and is not provided on the Student and Parent Report. FCAT NRT scale scores are determined by raw score point totals (FLDOE, 2008).

Schema-Activation Methods - Advance organizers, pretraining, and cueing (Mayer & Wittrock, 2006).

Schema Theory - Individual pieces of information cannot exist in the mind on their own, they have to be integrated into an organized and coherent cognitive structure (Hossein, 2007).

Subsumers - Provide a basic structure around which information is organized (Ivie, 1998).

Subsumption - When a new idea enters consciousness it is processed and classified under one or more of the inclusive concepts existing in the learner’s cognitive structure (Ivie, 1998).

Sunshine State Standards (SSS) - Florida's curriculum framework that includes content areas, strands, standards, and benchmarks (FLDOE, 2008).

Thinking Maps® - Eight fundamental thinking skills defined and illustrated by maps that are introduced to administrators, teachers, and students as a common visual language for thinking and learning (Hyerle, 2004). These include:

1. The Circle Map is used for seeking context. This tool, (often used for brainstorming), enables students to generate relevant information about a topic as represented in the center of the circle (Hyerle, 2004).
2. The Bubble Map is designed for the process of describing attributes. This map is used to identify character traits (language arts), cultural traits (social studies), properties (sciences), or attributes (mathematics) (Hyerle, 2004).
3. The Double Bubble Map is used for comparing and contrasting two things, such as characters in a story, two historical figures, or two social systems (Hyerle, 2004).
4. The Tree Map enables students to do both inductive and deductive classification. Students learn to create general concepts, (main) ideas, or category headings at the top of the tree, and supporting ideas and specific details in the branches below (Hyerle, 2004).
5. The Brace Map is used for identifying the part-whole, physical relationships of an object. By representing whole-part and part-subpart relationships, this map supports students' spatial reasoning and understanding of how to determine physical boundaries (Hyerle, 2004).
6. The Flow Map is based on the use of flowcharts. It is used by students for showing sequences, order, timelines, cycles, actions, steps, and directions. This map also focuses

students on seeing the relationships between stages and substages of events (Hyerle, 2004).

7. The Multi-Flow Map is a tool for seeking cause and effect. The map expands when showing historical causes and for predicting future events and outcomes. It can also expand to show the interrelationships of feedback effects in a dynamic system (Hyerle, 2004).
8. The Bridge Map provides a visual pathway for creating and interpreting analogies. This map is also used for developing analogical reasoning and metaphorical concepts for content learning (Hyerle, 2004).
9. The “metacognitive” Frame is not one of the eight Thinking Maps®. It may be drawn around any of the maps at any time as a “meta-tool” for identifying and sharing one’s frame of reference for the information found within one of the Thinking Maps®. These may include personal experiences, culture, belief systems, and influences such as peer groups and the media (Hyerle, 2004).

Assumptions

The first assumption was that the Florida Comprehensive Achievement Test® (FCAT) data collected from the Florida Department of Education was accurate and reliable.

The second assumption was that the data collected from the large urban school district in this study was accurate and reliable.

The third assumption was that students attending School A who started out as sixth graders in 2005-2006 were eighth graders in 2007-2008.

The fourth assumption was that students attending School B who started out as sixth graders in 2005-2006 were eighth graders in 2007-2008.

Delimitations and Limitations

Delimitations of this study included:

1. The population in this study was delimited to two middle schools in a large urban school district in Florida.
2. The population was delimited to 2006 grade six students, 2007 grade seven students and 2008 grade eight students in each of the two schools with Florida Comprehensive Assessment Test® scores for Reading and Mathematics for all years of the study.
3. The population was delimited to students in grade six in 2006, students in grade seven in 2007 and students in grade eight in 2008 who were in attendance during the Full Time Equivalency attendance periods of October and February for the school years 2005-2006, 2006-2007, and 2007-2008 in their respective schools.

There may be other limitations that the researcher missed. Some limitations of this study included:

1. Students in this study may not have had the same teachers and teaching styles and abilities may have varied among 6th, 7th , and 8th grade teachers (all Reading and Mathematics teachers held an acceptable bachelor's or higher degree, and held a valid Florida Temporary or Professional certificate, in addition to passing their subject area test (http://www.fldoe.org/eias/dataweb/database_0708/st170_1.pdf, pg 170-2) and had to meet highly qualified teacher status to teach in schools designated Title I (FLDOE, 2009).

2. Internal validity threats to the nonrandomized control group, pretest-post test design used may have included:
    a. Interaction of Selection and Maturation - students may not have been taught the use of Thinking Maps® at the same time everyday or during the same class period.
    b. Interaction of Selection and Regression - the treatment group and the control group may have different mean scores on their Florida Comprehensive Achievement Test® (FCAT) 2006, 6th Grade Reading and Mathematics Scores and any increase may be erroneously attributed to the effect of the treatment.
    c. Interaction of Selection and Instrumentation – the learning gains on the FCAT are limited by the FCAT posttest's ceiling and the magnitude of the pretest's FCAT scores. Students that were close to the ceiling in the FCAT pretest may show little gains on the FCAT posttest compared to students that were further away from the ceiling.
3. The results of this study can be generalized only for the population being studied.
4. The delivery of Reading and Mathematics curriculum may have varied from school to school and from grade level to grade level.

<u>Summary</u>

This study is divided into five chapters. It begins with Chapter One that includes an introduction to the study with an explanation of the Thinking Maps® program. Chapter One also includes the conceptual/theoretical framework, statement of the problem, purpose of the study, significance of the study, research questions, definitions of terms, assumptions, delimitations, and limitations of the study. Chapter Two presents a review of literature that lays out the groundwork for the reader to understand the context of the Thinking Maps® program. The review of literature includes; Ausubel's Subsumption Theory, meaningful learning, Subsumption Theory and instruction, advance organizers, graphic organizers, concept maps, Thinking Maps®, the Title I program and the Florida Comprehensive Assessment Test®. Chapter Three presents the methodology and procedures that the researcher used in this study to obtain the data needed. It includes the research design, population, profiles of schools in study, instrumentation, overview of FCAT test, reliability and validity of FCAT, data collection, and null hypotheses. Chapter Four contains the presentation, analysis, and interpretation of the findings and Chapter Five presents the summary, conclusions, and recommendations resulting from this study.

CHAPTER TWO: REVIEW OF LITERATURE

Introduction

This chapter includes the literature review that lays the context for the Thinking Maps® program. The theoretical framework for this study was Ausubel's Subsumption Theory, (Ausubel, 1960, 1963, 1968, 2000). Ausubel laid the conceptual framework for the purpose of organizers. His theory viewed thinking as an orderly activity where knowledge is arranged in a hierarchical structure or pattern. This review of literature includes research from others that have expanded upon Ausubel's theory and includes; Subsumption Theory, meaningful learning, Subsumption Theory and instruction, the history of organizers to include, advance organizers, graphic organizers, and concept maps. Thinking Maps® and the eight maps that illustrate the eight cognitive concepts found in the Thinking Maps® program was examined along with the Title I Program and the Florida Comprehensive Assessment Test®.

In the *Educational Psychology: A Cognitive View*, David Ausubel stated, "If I had to reduce all of educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly" (Ausubel, 1968, p.vi). On July 9, 2008, David Paul Ausubel died at age 90 (Tasar, 2008). He was known for his scholarly work in the field of educational psychology and came to education through psychiatry. After working with World War II veterans he became disillusioned with psychiatry. He used his G.I. Bill to earn a Ph.D. in Developmental Psychology from Columbia University (Ivie, 1998). His psychological professorships included the University of Toronto and European universities such as Berne, Salesian University in Rome, and the Officer's Training College at Munich.

Ausubel's writings on cognitive psychology began while he served as a professor at the University of Illinois from 1950-1966. It is during this time that "Subsumption Theory" and "Advance Organizer's" were conceived. In 1968 he began his chairmanship of the doctoral program in educational psychology with City University of New York and in 1975 retired from education to ironically return to practice psychiatry (Ivie, 1998; Tasar, 2008). Ausubel retired from psychiatry in 1994 and continued to write theoretical works on ego development, acquisition and retention of knowledge, death and human condition, and the theory and practice of adolescent development (Ausubel, 2008).

> My first seven retirement years (1994-2001) were devoted to writing basic new theoretical works that I had always intrinsically wanted most to write about but didn't do so because of the pressure to produce books that mostly met the informational needs of students, and colleagues, (http://www.davidausubel.org/newProjects. html, pg.1).

It is based on Ausubel's earlier work on thinking and learning that this study finds its theoretical framework.

Subsumption Theory

Facilitating student's acquisition of powerful and valid conceptual frameworks is difficult. There are innumerable ways to go wrong and no one set of traditional instructional strategies that are perfect (Novak, 2002). The challenge is how to teach students to construct and reconstruct their individual conceptual frameworks that will lead to increasing cognitive competence. Ausubel believed that it is by the intensification of relevant aspects of cognitive structure that new learning and retention can be facilitated.

In their practice teachers may use advance organizers, graphic organizers, and concept maps to assist their students in learning (Mayer & Wittrock, 2006). Ausubel laid the conceptual framework for the purpose of organizers. These have evolved through the years and have become instructional apparatus teachers use to deliver instruction (Ivie, 1998). Ausubel believed that a cognitive structure needs to be clear and well organized to facilitate the learning and retention of new information as opposed to a confused and disorderly cognitive structure that inhibits learning (Ausubel 1960, 1963, 1968, 2000; Hossein, 2007). His Subsumption Theory viewed thinking as an orderly activity where knowledge is arranged in a hierarchical structure or pattern. The hierarchical structure of knowledge can be illustrated in the shape of a pyramid. Higher level concepts are located at the top of the pyramid, with lower level concepts that possess specific details subsumed under them. Retention of knowledge occurs when the learner is able to anchor new knowledge with the learner's prior knowledge and is influenced by three factors. These factors are the availability in cognitive structure of relevant subsuming concepts at an appropriate level of inclusiveness, the stability and clarity of these concepts, and their discriminability from the learning task (Ausubel, 1960, 1963, 1968, 2000; Ivie 1998).

Learning can be either rote or meaningful. Ausubel made a clear distinction between rote learning and meaningful learning. Rote learning is when new knowledge is arbitrarily and non-substantively incorporated into long term-memory. Rote learning is appropriate when automaticity of concepts is required. Automaticity can serve as a load-reducing method that frees up cognitive structure for more complex concepts (Mayer & Wittrock, 2006). Meaningful learning occurs when the learner chooses conscientiously to integrate new knowledge with knowledge that the learner already possesses (Ausubel, 1960, 1963, 2000; Novak, 2002).

Meaningful Learning

Meaningful learning is when the learner can make interrelationships between two or more concepts, old and new. The learner must be capable of making some connections to the new concept with existing concepts. The new concept must be fitted into a larger pattern or whole that already exists in the learner's cognitive structure. This fitting is called anchoring. Finally, the learner must make a decision and actually attempt to relate, in some sensible way, the new concept to the old concepts (Ausubel 1960, 1963, 1968, 2000). Learners anchor new knowledge through meaningful learning (Ivie, 1998).

If any of these conditions are missing rote learning has occurred where new knowledge is arbitrarily and non-substantively integrated into cognitive structure (Novak, 2002). When rote learning occurs there is no integration of new concept meanings and existing cognitive structure are not expanded or reconstructed (Novak, 2002).

Subsumption Theory and Instruction

The role of teachers is to assist their students in acquiring new knowledge. Ivie (1998) offered five steps for instruction based on Ausubel's Subsumption Theory that would facilitate this process:

1. Determine if the learner possesses the relevant concepts in their cognitive structure.
2. Provide appropriate advance organizers that can anchor the new information within the existing cognitive structure.
3. Present the new material in an organized manner to allow the learner to subsume the new information under appropriate cognitive organizers.

4. Provide sufficient practice so that the material is thoroughly learned, and becomes an integrated part of the learner's cognitive structure.
5. Guide the learner through a problem solving situation that utilizes higher order thinking skills (Ivie, 1998, p. 13).

These five steps, when followed, lead the learner to anchor new concepts.

History of Organizers

Advance Organizers

Ausubel proposed that new learning and retention could be facilitated through the use of organizers (Ivie, 1998). Organizers are introduced prior to the lesson. They are presented at a higher level of abstraction, generality, and inclusiveness than the new material. The content of the advance organizer must be appropriate to explain, integrate, and interrelate the material they precede. An advance organizer provides students with a conceptual view of what is to come and helps prepare them to identify, package, and store the content in their cognitive structure for later retention. Advance organizers should be used when the learner does not possess the relevant concepts needed to integrate new information into their cognitive systems. The instructional material being presented to the learner should be untried, complex, technical, and unconnected to areas of knowledge that learners already have (Ausubel, 1960, 1963, 2000; Mayer, 1979).

Research on Advance Organizers

Results from a study reported by Ausubel in 1960 concluded that students that used advance organizers performed better than students that did not. In the study 120 college students read a 2500-word text on metallurgy. Prior to reading the text the treatment group was given a 500-word expository organizer with underlying concepts. The control group was given a

500-word historical passage. The advance organizer group (AO) performed better than the control (C) on a post-test (AO = 47% correct, C = 40% correct) (Mayer, 1979). The content of the advance organizer used in depth information that was abstract, general, and inclusive as compared to the 2500-word text. The obtained effect was attributed to the learners being able to subsume the new information with existing concepts in their cognitive structure (Mayer, 1979).

In 1979 Richard E. Mayer published a review of forty-four published research studies involving advance organizers. Twenty-seven studies included an advance organizer vs. a control group (standard advance organizer study) and 17 studies included an advance organizer vs. a post organizer group (one group receives an advance organizer (AO) prior to instruction) while the other group receives the same information after instruction (PO) but before the test. Mayer used the term “Assimilation Theory” instead of the term “Subsumption Theory” to refer to the idea that learning involves relating new, potentially meaningful material, to an assimilative context of existing knowledge. Based on Ausubels’ theory Mayer proposed that conditions of meaningful, assimilative learning are:

1. Reception - The new material must be received by the learner.
2. Availability - Prior to learning, the learner must possess meaningful assimilative context for integrating the new material.
3. Activation - The learner must actively use this context during learning to integrate the new information with old information (Mayer, 1979, p. 134).

Mayer (1979) suggested that when using advance organizers “availability” and “activation” are conditions that must be present. He further proposed that advance organizers would increase learning only when “availability” and “activation” would not occur without the use of advance organizers. If advance organizers are to have a positive impact on learning the following criteria need to be met: information must be unfamiliar; potentially meaningful or conceptual; provide context; encourage the learner to use that context during learning; and the learner must not possess relevant conceptual context for the material (Mayer, 1979).

Advance organizers do not assist in learning when the material used provides remediation to learners when they lack prerequisite concepts. The inappropriate use of advance organizers also includes a collection of facts with no unifying organization such as the Periodic Table in Chemistry. Another example would be if pre-med students were given an advance organizer on anatomy or physiology. The advance organizer would be inappropriate because the learners already possess the concepts presented in the advance organizer.

Mayer (1979) concluded that advance organizers will result in broader learning outcomes when the learner does not normally possess the concept of the new information. If the concept being introduced appears unorganized or unfamiliar to the learner the use of advance organizers will result in learning. An appropriate advance organizer provides an organized conceptual framework that is meaningful to the learner, and allows the learner to relate concepts in the instructional material presented. Good organizers include discussions, examples and sets of general higher order rules. Inappropriate advance organizers include specific facts, summaries, outlines, and directions that draw the learner to specific key facts or terms.

Graphic Organizers

The origin of graphic organizers stems from Ausubel's advance organizers (Alvermann, 1981). Graphic organizers use a spatial format to show the relationship and interrelations of concepts, while advance organizers use linear prose (Guri-Rosenblit, 1989). Stull and Mayer

(2007) defined a graphic organizer as one that consists of spatial arrangements of words or word groups where relations among elements are indicated by the spatial arrangement of the elements on the page, and represents the conceptual organization of text. Hyerle (2009) describes graphic organizers as visual tools that are designed for the purposes of analytically structuring and displaying information. Graphic organizers are formal, teacher created, and specific to content learning (Hyerle, 2009). Graphic organizers are not linear, and do not require learners to generate their own visual construction of knowledge.

Research on Graphic Organizers

Robinson and Kiewra (1995) conducted two experiments involving 153 undergraduate educational psychology students and the use of graphic organizers. They found that a set of graphic organizers is more effective than advance organizers or the text alone for learning the following: (a) hierarchical relations, (b) coordinate relations, (c) the application of introduced knowledge given new examples, and (d) the composition of essays expressing coordinate relations in an integrated manner. Other factors that impacted the effectiveness of the graphic organizers were time given students to review and study the graphic organizers. They noted that graphic organizers are no more effective than outlines if the goal of instruction is for students to learn represented facts.

Graphically displaying spatial arrangements and organizing related key concepts facilitates learning of expository material (Simmons, Griffin, & Kameenui, 1988). Alvermann (1981) investigated the use of graphic organizers to compensate for text that was not well organized. The study involved 114 tenth graders who were given two versions of an expository passage that differed in structure (comparison vs. description). The experimental group studied a graphic organizer that reflected the comparison text structure. The experimental group recalled significantly more than the control group only under the descriptive text condition. Results suggest that graphic organizers add recall when readers must recognize information but do not help when reorganization is unnecessary. All students in the study benefitted from the use of graphic organizers.

Horton, Lovitt, and Bergerud (1990) investigated the effectiveness of graphic organizers. Three separate experiments were done with middle and high school students who were classified as students with learning disabilities, remedial students, and regular education students. All of these groups were in content area classes. The investigators reported that the use of graphic organizers yielded significantly higher performance in all three groups compared to self-study. These results were higher whether the instruction was teacher-directed, student-directed with text references, or student-directed with clues.

When to use Graphic Organizers

Marzano, Pickering & Pollock (2001) believe that graphic organizers may be used for acquiring, integrating, refining, and knowing how to use knowledge appropriately. Problem-solving graphic organizers provide a system for working through a problem. Students that have not developed their own organizational structures may become frustrated when attempting to complete the task of problem-solving with complex steps. Graphic organizers assist students as they proceed through a series of steps to achieve certain objectives or standards (Costa, 2008).

Others have argued that the major benefit of graphic organizers is helping students learn relationships among concepts (Robinson & Kiewra, 1995). Students benefit from accurate, coherent representation of expert knowledge that focuses learners on integrated concepts rather than disconnected facts (Stull & Mayer, 2007).

When not to use Graphic Organizers

A potential risk of providing the learner with a graphic organizer is that it may overwhelm or confuse the learner with knowledge that is in conflict with his or her own knowledge structure (Stull & Mayer, 2007). When using graphic organizers the length of text must be taken into consideration because short passages do not require any particular learning strategies (Robinson & Kiewra, 1995). Learning to construct this visual representation of text appropriately may take considerable time that may not be available. The use of graphic organizers must be weighed against the time invested in creating them (Anderson & Armbruster, 1982).

Concept Maps

According to Novak (2002) concepts are combined to form statements or propositions. Knowledge stored in our brain consists of networks of concepts and propositions. As meaningful learning occurs, new concept meanings are integrated into our cognitive structure. The quantity and quality of existing relevant cognitive structure and the effort put forth by the learner impact integration.

Concept maps are a knowledge representation tool showing concepts and explicit propositions that form a hierarchical structure. The feature of a concept map that sets it apart from other graphic organizers is the use of labeled nodes. These nodes connect or link the relationships among the concepts and may be either directional or nondirectional (Nesbit &

Adesope, 2006). Concept maps may include the use of shapes, colors, and groupings for nodes that represent different concepts (Wallace & West, 1998).

Concept maps are unlike outlines, lists, and other graphical organizers, because they are to be created in triplets of concept-relationship-concept. These triplets contain complete propositions and are learner generated. Since concept maps are learner generated, students must be able to extract meaning from text in order to construct these (Nesbit & Adesope, 2006). The use of nodes may reduce cognitive load or memory required to distinguish or recognize similar concepts. Winn (1991) reviewed research suggesting that visual chunking of collocated objects may lead to efficiencies that cannot be obtained from text. Concept maps provide for an efficient visual search that allows associations to be created among concepts (Nesbit & Adescope, 2006). Concept maps promote generative learning. The learner's understanding can be assessed through these learner generated maps. Teachers can correct learner's misconceptions, and assist students in making connections with existing concepts the learners possess (Stull & Mayer, 2007).

In the 1980s Novak (2002) conducted a study to identify the concept and propositional frameworks that students use to explain science concepts through the use of interviews. After working with approximately 200 students in a 12-year longitudinal study, and interviewing these students several times during the first year of the study, the researchers became overwhelmed. It became difficult to observe specific changes that were occurring in the children's understanding of science concepts. It was then that concept mapping was born (Novak & Musonda, 1991).

Research on Concept Maps

Horton, McConney, Gallo, Woods, Senn, & Hamelin (1993) conducted a meta-analysis of 18 classroom-based concept map studies. They reported that in over 14 studies concept mapping by students raised posttest achievement scores by a mean of .42 standard deviations. For students to benefit the most from the use of concept maps they must be instructed in their use.

Hilbert and Renkl (2007) offered several recommendations for concept mapping training when only fifty percent of 38 college student subjects were considered successful in their study. For effective concept map training careful attention to labeling links must be emphasized. The importance of planning the mapping process and ongoing improvement of the concept map must be stressed to the learner. Learners must be guided to focus on learning the content and not the design of the concept map.

After instructing 126 fifth graders in the use of concept mapping Chang, Sung, & Chen (2002) tested the learning effects of concept mapping on text comprehension. To determine the effects of concept mapping on students' text comprehension and summarization abilities the researchers designed three concept mapping strategies, these included map correction, scaffold fading, and map generation. The map correction procedure involved using an expert (teacher) created concept map that had incorrect information and an article for the students to read. Students were instructed to correct the concept map using content from the article provided. The scaffold fading group was provided expert maps that were gradually replaced by less complete maps and the learners had to reconstruct maps as fading occurred. The map generating group was only provided an article to read and had to construct a concept map from the text read.

The map correction group demonstrated more improvement in text comprehension than the map generation and control groups did. Chang et al, (2002) found that such a framework functions as a structure to demonstrate the context and enhances comprehension of text by creating associations between ideas. By deconstructing an expert map and reconstructing it by correcting misplaced concept nodes and links, the learner is able to correct possible misconceptions. The experimental results demonstrated that the map correction method enhanced text comprehension and summarization abilities while the scaffold-fading method facilitated summarization ability.

Concept mapping has also proven to assist students in retaining and transferring knowledge. An investigation conducted by Berkowitz (1986) involved 99 sixth grade students and compared two methods of using concept maps (learner constructed maps and studying pre constructed maps - expert maps). After a six week instructional program, students who constructed their own maps based on expository passages scored significantly higher on free recall than students that used the other study procedures. Nesbit and Adescope (2006) conducted a meta-analysis of experimental and quasi-experimental studies in which students learned by constructing, modifying, or viewing node-link diagrams to determine if concept maps improve the ability of the student to retain and transfer knowledge. The researchers examined 55 studies involving 5,818 participants. Students ranged from fourth grade to postsecondary. Students in the various studies used concept maps to learn across disciplines such as science, psychology, statistics, and nursing. Across several instructional conditions, settings, and methodological features, the use of concept maps was associated with increased knowledge retention. Mean effect sizes varied from small to large depending on how concept maps were used and on the type of comparison treatment. Nesbit concluded that concept mapping activities are more effective for attaining knowledge, retention, and transfer. Concept mapping was found to benefit learners across a broad range of educational levels, subject areas, and settings.

Bascones and Novak (1985) found that concept mapping assisted students with retaining information over a long period of time. In this study high school physics students that incorporated concept maps in their learning performed better on problem solving tests than high school physics students that had traditional physics instruction. The data also show that over the 8 study units of the school year, the concept mapping students continued to improve, and differences in ability, as measured, had little effect on achievement.

Concept maps have also been known to help low-achieving students. Guastello, Beasley and Sinatra's (2000) study involved 124 low-achieving seventh-grade students from an urban parochial school that were randomly assigned to two equally sized groups (n=62 each group). One group was taught by reading, followed by a teacher led discussion. The second group, given the same type of introductory lesson as the first, with a model of concept mapping that connected major and minor concepts. A criterion-referenced test based on the content of a science chapter served as the dependent variable. Prior to any teaching, a pretest was administered. An analysis of covariance with pretest scores as the covariate showed a statistically significant difference in comprehension between the pretest and posttest for the treatment group. Effect size estimates revealed that concept mapping can be expected to improve comprehension scores of low-achieving seventh graders by approximately six standard deviations over traditional instruction. The study found that when students lack background information on a topic, the construction of concept maps may assist them in forming a cognitive schema to assimilate and relate the new concept.

The use of concept maps in conjunction with other instructional strategies has shown positive results. In a study conducted by Novak (1994) 30 student teachers were involved in a nine week media and technology course. The teachers were divided into two groups. The control group received instruction using lecture format. The treatment group was divided into five cooperative groups that were instructed in the use of concept maps. Group concept mapping scores were compared to group achievement, self-efficacy, and educational reference. There were no significant differences found between the two instructional strategies when analyzed using 2 x 2 ANOVAs. There were no statistical differences identified between concept map scores and achievement, self-efficacy, and educational preference. Qualitative data revealed positive student attitudes toward cooperative learning and concept mapping.

When to use Concept Maps

Examples of well constructed concept maps need to be shared with students so that they understand what a concept map is and what a concept map is not (O'Donnell, Dansereau & Hall 2002). Concept maps should be used for retention and transfer of knowledge (Nesbit & Adesope, 2006). Teachers need to understand and be able to remediate misconceptions of learning. Since concept maps are learner generated, teachers can see where the misconceptions are and assist the learner in remediating any misconceptions. Novak (2002) proposes that during the course of the remediation of misconceptions several cognitive processes described by Ausubel may be necessary. These include progressive differentiation through subsumption, integrative reconciliation and superordinate learning.

Progressive differentiation of existing concepts may occur through the process of subsumption. Subsumption is when new concepts are linked with existing concepts. For example, elaboration of the concept of mammals may entail the study of additional representatives of this concept such as bears, orcas and monkeys while including some examples of non-mammals such as fish, reptiles, and insects. Integrative reconciliation occurs when the learner is able to compare and contrast concepts from two different knowledge domains. An example provided by Novak (2002) would be when dolphins and sea lions are recognized as similar to and related to other mammals, and different from fish. Superordinate learning occurs when several concepts are recognized as subconcepts of some more inclusive concept within a knowledge domain such as the concept of invertebrates. Learners have engaged in superordinate learning when they understand that invertebrates are animals without a backbone and are able to classify starfish, crabs, spiders and octopus as such. The meaning for any concept is framed by the set of propositions, in which that concept is embedded. When attempting to correct a misconception, the entire relevant cognitive framework for a given concept must undergo some restructuring. The more elaborated and persistent the misconception the more effort it takes to remediate (Novak, 2002).

In a study involving 539 students in fourth through eighth grade from 18 classrooms in 10 different states students were asked to clarify and articulate their understanding of the earth's shape and concepts of gravity (Shneider & Ohadi, 1998). The treatment was an astronomy unit in which students were provided with opportunities to clarify and articulate their understanding of the earth's shape and gravity concepts. The purpose of the study was to determine if treatment would have any impact on the reconstruction of misconceptions. Results from a chi-square analyses showed that a significant number of students at all grade levels shed their misconceptions concerning both the earth's shape and gravity concepts. Shneider and Ohadi (1998) noted that fourth and fifth graders were as knowledgeable as seventh and eighth grade students concerning the earth's shape and gravity. They noted that the younger students responded more positively to treatment than the older students. These findings may be why misconceptions are so difficult to remediate with traditional instruction, and why some of these misconceptions persist for the rest of an individual's life.

When not to use Concept Maps

Rote learning occurs when learners process information automatically without stressing their cognitive capacity and when learning becomes habitual to the extent that attention requirements are minimal. Concept maps should not be used when rote learning is appropriate. For example, when it is necessary to over learn information or when the formation of generalizations is what is expected from the learner and not in depth concept attainment (Shiffrin & Schneider, 1977).

Thinking Maps®

As a student teacher in the early 1980s Hyerle used brainstorming webs with his students to visually represent their thinking. Every web started in the middle and branched out. He found that the repetitive visual patterns did not reflect a range of thinking patterns in content areas. There were not enough coherent ideas and there was too much information that was irrelevant. Hyerle continued to seek better ways to visually represent thinking. In 1983 he attended several seminars led by Arthur Costa who developed 16 characteristics that develop cognitive thinking (Hyerle, 2009). These 16 characteristics are called Habits of Mind.

A Habit of Mind is composed of many skills, attitudes, cues, past experiences, and proclivities. Costa claims that habits are behaviors that are exhibited reliably, on appropriate occasions, and executed without pain. A Habit of Mind is as natural as saying please and thank you. A Habit of Mind means that one pattern of intellectual behavior is valued over another; therefore, it implies making choices about which patterns should be used at certain times. The 16 Habits of Mind developed by Costa (2008) include:

1. Persisting - Sticking to a task until it is completed
2. Managing Impulsivity - Thinking before you act
3. Listening with Understanding and Empathy – Spending an inordinate amount of time and energy listening
4. Thinking Flexibly - Having the capacity to change your mind as you receive additional data
5. Thinking About Thinking (Metacognition) - The ability to stand off and examine our own thoughts
6. Striving for Accuracy - Attaining the highest possible standards by pursing ongoing learning
7. Questioning and Posing Problems - Asking questions to fill in the gaps between what is known and unknown
8. Applying Past Knowledge to New Situations - When confronted with a new and perplexing problem you will draw forth experiences from your past

9. Thinking and Communication with Clarity and Precision - Supporting statements with explanations, comparisons, quantification, and evidence
10. Gathering Data Through All Senses - Taking in linguistic, cultural, and physical learning by observing or taking in through the senses
11. Creating, Imagining, Innovating - Conceiving solutions to problems differently and examining alternative possibilities from many angles
12. Responding with Wonderment and Awe - Having not only an "I can attitude", but also "I enjoy feeling"
13. Taking Responsible Risks - Is a responsible risk but does not behave impulsively
14. Finding Humor - Acquiring the habit of humor in a positive sense
15. Thinking Interdependently - Being able to work in groups, justify ideas, and to test the feasibility of solution strategies on others
16. Remaining Open to Continuous Learning - Being in a continuous learning mode (Costa, 2008, pp. 18-37)

Hyerle realized that it was important for teachers to coach their students in these 16 Habits of Mind skills in order to stimulate their thinking. Shortly after these seminars Hyerle was invited to be part of a group lead by Art Costa and Robert Garmston that would focus on mentoring and coaching. Participants needed to reflect on supervision, mentoring, and coaching through questions. It was then he realized that these reflections could be captured through the use of visual maps that facilitate metacognition.

Another experience that influenced Hyerle was his participation in Teacher Corps, a federally funded program focused on recruiting new teachers into urban education. While in Teachers Corps Hyerle piloted several programs. Working with eighth graders, he focused on three outcomes: content learning, basic skills in each area of content, and the explicit teaching of a model of fundamental cognitive skills in each area of content. One of the programs was the explicit teaching of fundamental cognitive skills developed by a relatively unknown semanticist and professor Albert Upton. Upton believes that there are six fundamental cognitive skills that work independently and interdependently. These skills are: defining "things" in context, describing, classifying, part-whole spatial reasoning, sequencing, and analogous thinking. Through Upton's work Hyerle learned that cognitive skills are required at all levels of complexity. These skills can be retained once learned from early childhood through adulthood. Hyerle implemented Upton's six fundamental cognitive skills together with key graphic representations with his inner city students who were scoring in the lower two quartiles in reading and mathematics. Within weeks he was able to see students' thinking through visual tools. Student's scores began to increase because of his newly discovered approach to thinking and learning (Hyerle, 2009).

Finally it was during his doctoral program at the University of California at Berkeley that George Lakoff's research on metaphors, mental models and framing helped Hyerle understand their impact on human cognition. Lakoff believes that cognitive skills such as categorization, comparison, sequencing, and causality are all framed by our experiences. Lakoff's research became a guiding principle for Hyerle on how cognitive processes and dynamic schemas work together to make sense of incoming stimuli to the learner's cognitive structure (Hyerle, 2009).

Hyerle drew from all this knowledge and created eight Thinking Maps® to facilitate thinking skills. These maps use the generative quality of brainstorming webs, the organizing structure of graphic organizers, and the deep cognitive processing found in concept maps (Hyerle, 2009).

Hyerle (2004) names the eight thinking-process maps he developed Thinking Maps®. Thinking Maps® can be described as eight fundamental cognitive skills defined and animated by maps, and introduced to teachers and students as a common visual language for thinking and learning across disciplines (Hyerle, 2004). Thinking Maps® are neither linear nor hierarchical. The eight Thinking Maps® include:

1. The Circle Map is used for seeking context. This tool enables students to generate relevant information about a topic as represented in the center of the circle. This map is often used for brainstorming.
2. The Bubble Map is designed for the process of describing attributes.
3. The Double Bubble Map is used for comparing and contrasting, such as characters in a story, historical figures, or social systems. It is also used for prioritizing which information is most important within a comparison. This map is used to identify character traits (language arts), cultural traits (social studies), properties (sciences), or attributes (mathematics).
4. The Tree Map enables students to do both inductive and deductive classification. Students learn to create general concepts, (main) ideas, or category headings at the top of the tree, and supporting ideas and specific details in the branches below.

5. The Brace Map is used for identifying the part-whole, physical relationships of an object. By representing whole-part and part-subpart relationships, this map supports students' spatial reasoning and for understanding how to determine physical boundaries.

6. The Flow Map is based on the use of flowcharts. It is used by students for showing sequences, order, timelines, cycles, actions, steps, and directions. This map also focuses students on identifying the relationships between stages and substages of events.

7. The Multi-Flow Map is a tool for seeking causes of events and the effects. The map expands when showing historical causes and for predicting future events and outcomes. In its most complex form, it expands to show the interrelationships of feedback effects in a dynamic system.

8. The Bridge Map provides a visual pathway for creating and interpreting analogies. Beyond the use of this map for solving analogies on standardized tests, this map is used for developing analogical reasoning and metaphorical concepts for deeper content learning.

9. The Frame "metacognitive" is not one of the eight Thinking Maps®. It may be drawn around any of the maps at any time as a "meta-tool" for identifying and sharing one's frame of reference for the information found within one of the Thinking Maps®. These frames include personal histories, culture, belief systems, and influences such as peer groups and the media (Hyerle, 2004, p. 6).

These maps or "non linguistic representations" (Marzano, Pickering & Pollack, 2001, pg. 73), represent eight cognitive processes that include: defining in context, describing attributes, comparing and contrasting, classification, part-whole spatial reasoning, sequencing, cause and effect reasoning, and reasoning by analogy. Hyerle (2009) believes that the key to understanding each of the eight cognitive processes illustrated by the maps is the essential interdependence among them. After students map out content using these non linguistic representations they may draw a rectangular “frame” of reference around the map and write within the frame any experience or information that may influence their point of view (Hyerle, 2009). This is called conceptual framing.

The eight maps have five characteristics. They are consistent, flexible, integrative, developmental, and reflective (Hyerle, 2004). Each map is consistent in symbolizing a visual cognitive skill. Thinking Maps® are flexible since there are many ways a map can grow and be configured. Learners of any age can draw these maps to show thinking. The learner and the content determine the complexity of the map created. Thinking Maps® can be integrated with one another. Learners may use a Flow Map to show the sequence of a story read and use a Double Bubble Map to compare and contrast characters in the same story. Thinking Maps® are reflective since a learner may look on the page and see what and how they are thinking. Teachers can also reflect on and informally assess the content learning and thinking processes of the learner. In addition, at any time and with every map, learners may draw a rectangular frame around a map. This represents the learner’s frame of reference, or metacognitive frame. When a student draws a frame around the map, the student may write down what influenced the references in the text.

Research on Thinking Maps®

Hyerle (1993) introduced the theoretical foundations for Thinking Maps® as student-centered tools for constructing personal, interpersonal, and social understanding and, as tools for the development of students' thinking and metacognitive abilities. In 1998 Marjann Kalehoff Ball conducted a study for two semesters that involved 92 junior college students from college reading classes. Instruction was identical for both the control group and the treatment group. The only difference was that Thinking Maps® were used as instructional tools with the treatment group and not with the control group. Ball (1999) found that there was a correlation between the use of Thinking Maps® and reading comprehension scores of college students as measured by the Stanford Diagnostic Reading Test. Leary (1999) studied the standardized test results of fourth grade students after 7 months of instruction on Thinking Maps® and found no significant student achievement difference between the treatment groups and the control group. Leary concluded that the program needed time to impact student achievement and seven months was not sufficient time. Hickie (2006) examined student performance in reading/language and mathematics after two years of Thinking Maps® implementation in three Tennessee schools. She found that a whole school approach appeared to improve student achievement in reading/language as tested on the Tennessee Comprehensive Assessment Program Achievement Tests (TCAP) but not in mathematics. National results on student achievement and Thinking Maps® can be found on Hyerle's *Design for Thinking* website, http://www.mapthemind.com (Hyerle, 2010). Robert J. Marzano in Hyerle's *Visual Tools for Transforming Information into Knowledge* (2009) states,

> David Hyerle has expanded the frontiers of strategies involving nonlinguistic representations far beyond what I and others have attempted to do. He provides not only a comprehensive theoretical basis for the efficacy of visual tools but expands their application to new and exciting arenas. (p. viii)

Title I Program

Title I is part of the Elementary and Secondary Education Act of 1965. Title I is intended to help ensure that all children have the opportunity to obtain a high-quality education and reach proficiency on challenging state academic standards and assessments. It is the largest federal program supporting elementary and secondary education. Schools that receive Title I dollars have the flexibility to use them to provide additional instructional staff, professional development, extended-time programs, and other strategies for raising student achievement in high poverty schools (USDOE, 2009).

The program focuses on promoting schoolwide reform in high poverty schools and ensuring students' access to scientifically based instructional strategies and challenging academic content. High poverty schools in Florida are defined by the percentage of the student population that come from low-income families. A school must have 40% or more of its student population from low-income families to qualify for Title I support. Title I provisions mandate states, school districts, and schools accountable for improving the academic achievement of all students. They require that students at low performing schools be provided alternatives to enable those students to receive a high-quality education (FLDOE, 2009).

Florida Comprehensive Assessment Test®

In 1976, the Florida Legislature approved assessments in Grades 3, 5, 8, and 11, including the nation’s first high school graduation test. Since then the Florida Legislature has continuously supported assessment and evaluation activities in the state’s public school system. The purpose and design of the statewide assessment program is articulated in Section 1008.22, F.S., and in the student progression plan in Section 1008.25, F.S.

Approximately 1.76 million public school students in grades 3-11 participated in the 2008 administration of The Florida Comprehensive Assessment Test® (FCAT). These students, including English language learners (ELLs) and students with disabilities, are all working toward a regular high school diploma. The Florida Comprehensive Assessment Test® (FCAT) is part of Florida's overall plan to increase student achievement by implementing higher standards. The FCAT consists of criterion-referenced tests (CRT) measuring content area strands, standards and benchmarks in mathematics, reading, science, and writing from the Sunshine State Standards (SSS). The skills and competencies outlined in the standards are to be embedded into core class materials.

Grade 3 students must earn an FCAT Reading score of level 2 or higher on a scale of 1 – 5 in order to be promoted to grade 4. Students in grade 10 must earn a developmental scale score of 1926 (Table 1) and a scale score of 300 (Table 2) or above to pass the FCAT Reading and a developmental scale score of 1889 (Table 3) and a scale score of 300 (Table 4) or above to pass the FCAT Mathematics.

Table 1: FCAT Reading Developmental Scale Scores

Grade	Level 1	Level 2	Level 3	Level 4	Level 5
3	86 – 1045	1046 - 1197	1198 - 1488	1489 - 1865	1866 – 2514
4	295 – 1314	1315 - 1455	1456 - 1689	1690 - 1964	1965 – 2638
5	474 – 1341	1342 - 1509	1510 - 1761	1762 - 2058	2059 – 2713
6	539 – 1449	1450 - 1621	1622 - 1859	1860 - 2125	2126 – 2758
7	671 – 1541	1542 - 1714	1715 - 1944	1945 - 2180	2181 – 2767
8	886 – 1695	1696 - 1881	1882 - 2072	2073 - 2281	2282 – 2790
9	772 – 1771	1772 - 1971	1972 - 2145	2146 - 2297	2298 – 2943
10	844 – 1851	1852 - 2067	2068 - 2218	2219 - 2310	2311 – 3008

Source: Florida Department of Education, Florida Comprehensive Assessment Test®, 2008

Table 2: FCAT Reading Scale Scores

Grade	Level 1	Level 2	Level 3	Level 4	Level 5
3	100 – 258	259 - 283	284 – 331	332 - 393	394 – 500
4	100 – 274	275 - 298	299 – 338	339 - 385	386 – 500
5	100 – 255	256 - 285	286 – 330	331 - 383	384 – 500
6	100 – 264	265 - 295	296 – 338	339 - 386	387 – 500
7	100 – 266	267 - 299	300 – 343	344 - 388	389 – 500
8	100 – 270	271 - 309	310 – 349	350 - 393	394 – 500
9	100 – 284	285 - 321	322 – 353	354 - 381	382 – 500
10	100 – 286	287 - 326	327 – 354	355 - 371	372 – 500

Source: Florida Department of Education, Florida Comprehensive Assessment Test®, 2008

Table 3: FCAT Mathematics Developmental Scale Scores

Grade	Level 1	Level 2	Level 3	Level 4	Level 5
3	375-1078	1079-1268	1269-1508	1509-1749	1750-2225
4	581-1276	1277-1443	1444-1657	1658-1862	1863-2330
5	569-1451	1452-1631	1632-1768	1769-1956	1957-2456
6	770-1553	1554-1691	1692-1859	1860-2018	2019-2492
7	958-1660	1661-1785	1786-1938	1939-2079	2080-2572
8	1025-1732	1733-1850	1851-1997	1998-2091	2092-2605
9	1238-1781	1782-1900	1901-2022	2023-2141	2142-2596
10	1068-1831	1832-1946	1947-2049	2050-2192	2193-2709

Source: Florida Department of Education, Florida Comprehensive Assessment Test®, 2008

Table 4: FCAT Mathematics Scale Scores

Grade	Level 1	Level 2	Level 3	Level 4	Level 5
3	100-252	253-293	294-345	346-397	398-500
4	100-259	260-297	298-346	347-393	394-500
5	100-287	288-325	326-354	355-394	395-500
6	100-282	283-314	315-353	354-390	391-500
7	100-274	275-305	306-343	344-378	379-500
8	100-279	280-309	310-346	347-370	371-500
9	100-260	261-295	296-331	332-366	367-500
10	100-286	287-314	315-339	340-374	375-500

Source: Florida Department of Education, Florida Comprehensive Assessment Test®, 2008

Graduating seniors must pass both the Reading and Mathematics sections of the Grade 10 Florida Comprehensive Achievement Test® (FCAT) to graduate from high school with a standard high school diploma. Requirements of FCAT scores for passing to the next grade level are set by school districts throughout Florida, as stated in each district's Student Progression Plan, as permitted in Section 1008.22(2)(c), F.S.

The FCAT meets the federal government's No Child Left Behind Act of 2001 (NCLB). The No Child Left Behind Act requires all states to report student achievement based on results of reading and mathematics statewide assessments and several other academic indicators for all schools, districts, and the state (USDOE, 2007). The Adequate Yearly Progress Report provides a breakdown of achievement test results for major racial groups, economically disadvantaged students, students with disabilities, and English language learners. All groups must reach the annual proficiency target for their schools to make Adequate Yearly Progress.

In addition to individual student accountability, schools also receive a letter grade that is based on the achievement of their students through a formula developed by the Florida Department of Education. Schools are provided financial incentives through the A+ School Accountability Program for improvements in student achievement (FLDOE, 2008).

Summary

Teachers use advance organizers, graphic organizers, and concept maps to assist their students in the learning process. Ausubel believed that it is by strengthening relevant aspects of cognitive structure that new learning and retention can be facilitated, and a learner's cognitive structure needs to be organized for learning to occur (Novak, 2002; Ivie, 1998). This literature review examined Subsumption Theory, meaningful learning, Subsumption Theory and instruction, the history of organizers to include, advance organizers, graphic organizers, and concept maps. Ausubel's Subsumption Theory laid the conceptual framework for the purpose of these organizers. The review of literature laid the context for the Thinking Maps® program. This review also included the history of Thinking Maps® and examined the eight maps that illustrate the eight cognitive concepts found in the Thinking Maps® program. Finally this review examined the Title I Program and the Florida Comprehensive Assessment Test®.

CHAPTER THREE: METHODS AND PROCEDURES

Introduction

This chapter describes the methodology and procedures that were used in this study to determine if students that were instructed for three years in the use of Thinking Maps® have higher academic achievement as measured by the Florida Comprehensive Assessment Test® (FCAT) than students that were not instructed for three years in the use of Thinking Maps®. This chapter is organized into the following sections: research design, population, profiles of schools in study, instrumentation, overview of FCAT test, reliability and validity of FCAT, data collection, null hypotheses, data analysis and summary.

Research Design

A nonrandomized control group, pretest-posttest design as described by Ary, Jacobs and Razavieh (2002) was used. There are over 300 trainers of Thinking Maps® in the urban school district selected for this study. Thinking Maps® has been widely used in the elementary schools with sporadic implementation at the secondary level. For this study the treatment middle school's principal (School A) reported to have implemented Thinking Maps® throughout all grade levels and core subjects for three years. The control middle school's principal (School B) reported that Thinking Maps® was not implemented throughout all grade levels and core subjects for three years.

At School A, treatment site, the initial training for Thinking Maps® was conducted by the school based trainer for all administrators and faculty members prior to the implementation of Thinking Maps®. An overview of the program was presented during an all day workshop. Administrators observed the use of Thinking Maps® during their classroom walkthroughs and observations. The control site, School B, did not receive instruction in the Thinking Maps® program.

This study was designed to investigate the effects of the Thinking Maps® program on student achievement as measured by the Florida Comprehensive Assessment Test (FCAT) after three years of Thinking Maps® instruction and implementation. The study examined if Thinking Maps® had an effect on student achievement in one middle school that had instructed and implemented Thinking Maps® throughout all grade levels and core subjects for three years as compared to student achievement in another middle school that did not instruct or implement the Thinking Maps® program throughout all grade levels and core subjects for three years. The question that the study sought to answer was:

1. Do students who have been instructed in the use of Thinking Maps® have higher academic achievement as measured by the Florida Comprehensive Assessment Test® (FCAT) than those who have not been instructed in the use of Thinking Maps®? Specific questions include:

1.1 Was there a difference between the 2008 FCAT Reading scores of 8th grade students who received Thinking Maps® instruction since 2006 and those who did not receive Thinking Maps® instruction since 2006?

1.2. Was there a difference between the 2008 FCAT Mathematics scores of 8th grade students who received Thinking Maps® instruction since 2006 and those who did not receive Thinking Maps® instruction since 2006?

1.3. Were there differences in student’s 2006, 2007, 2008 learning gains on FCAT Reading between schools (School A [treatment site] and School B [control site])?

1.4. Were there differences in student’s 2006, 2007, 2008 learning gains on FCAT Mathematics between schools (School A [treatment site] and School B [control site])?

1.5. Were there differences in student’s 2006, 2007, 2008 learning gains on FCAT Reading between subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students)?

1.6. Were there differences in student’s 2006, 2007, 2008 learning gains on FCAT Mathematics between subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students)?

1.7. Were there differences in student’s 2006, 2007, 2008 learning gains on FCAT Reading across subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students)?

1.8. Were there differences in student’s 2006, 2007, 2008 learning gains on FCAT Mathematics across subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students)?

Data for this study included school demographic data secured through the district office, training data collected by both the district and schools involved, and Florida Comprehensive Assessment Test® (FCAT) data found on the Florida Department of Education website. For this study it was necessary to have baseline data for FCAT achievement prior to Thinking Maps® instruction in School A and School B. FCAT scores of students that were in 6th grade in 2006, 7th grade in 2007, and 8th grade in 2008, and attended all three years provided a longitudinal comparison of scores for growth purposes. FCAT 2005 Scale Scores and Developmental Scale Scores were used as baseline data to establish comparability among students in this study.

The independent variable for this study was the Thinking Maps® program. The dependent variables were the 2006 sixth, 2007 seventh and 2008 eighth grade students FCAT Mathematics and Reading scores.

Population

At the time that this study was conducted the urban school district was ranked as one of the 10 largest school districts in the nation. The urban school district served approximately 175,363 students. There were 120 elementary schools, 3 K-8 schools, 34 middle schools, 19 high schools, and 4 special day schools for students with disabilities (OCPS, 2008). Schools selected for this study were designated Title I (USDOE, 2009) schools based on the high poverty level of the student population attending both schools. The poverty level at both schools exceeded 81% and the majority of the student populations were minority students. Both schools served English language learners, gifted students, and students with disabilities (Appendix B-G). The subjects for this study were students who attended one of the two Title I (USDOE, 2009) middle schools in this system for the 2005-2006 school year as sixth graders, the same school in the 2006-2007 school year as seventh graders, and the same school in the 2007-2008 school year as eighth graders. School A served as the treatment site where each student received instruction in Thinking Maps®. School B served as the control site, comparison group, where Thinking

Maps® instruction and implementation did not take place. This study was based on a population of approximately 300 students in sixth grade in 2006, the same 300 students in seventh grade in 2007 and the same 300 students in eighth grade in 2008.

School A Profile

School A began in 1965 as a junior high school. In 1966, School A served 900 students in grades 7-9. In 1987 the school district changed to the middle school model and began serving grades 6-8. School A's student population averaged 1042 students from 2005-2008 (Appendix B). At the time of this study the student population was diverse with the majority comprised of over 80% minority students (Appendix D). School A was a Title I school with over 80% of its student population economically disadvantaged (Appendix B). School A had partnerships with local city and community agencies. The city funded a free student tutoring and an on-site before and after school recreation program.

Students attending School A had access to before and after school mathematics programs. Science tutoring was offered, before school, for all 8th grade students. Another extended learning opportunity was provided through Prime Time, a city sponsored before and after school program that assisted students both academically and socially. State School Academic Improvement (SAI) funds provided tutoring programs for after school, course recovery classes during the school day, and summer school. Project Welcome, a neighborhood partnership funded through the city, was an additional after school program designed to support the needs of English language learners.

Math Club was provided after school for students who were preparing for Math competitions. The National Junior Honor Society provided for high achievers who served as ambassadors to the community. The Fellowship of Christian Athletes (FCA) met monthly to worship and serve in community service projects. Odyssey of the Mind, an afterschool club, encouraged team building and creativity to find solutions to a series of problems. Spanish Club was an after school club offered to all students to help students learn the Latino culture and language. It provided a social connection between Spanish speakers and non-Spanish speakers.

Instructional programs included STAR Reading, Accelerated Reader, and Success Maker. School A offered Advancement Via Individual Determination (AVID). AVID is an in-school academic program that prepares students for college eligibility and success. School A also offered the International Baccalaureate Middle Years Program (IBMYP). IBMYP is an internationally recognized program that is designed to help students develop the knowledge, understanding, attitudes, and skills necessary to participate actively and responsibly in a changing world. School A also offered Springboard which is a Web supported program designed to prepare all students for college success in mathematics and English/language arts. In addition School A offered Algebra and Geometry classes during the school day to enhance the math curriculum. All students participated in the Accelerated Reading Program and striving readers participated in Corrective Reading intervention classes.

A variety of on-site professional development opportunities were provided for teachers and administrators of School A, depending on experience and practice. Reading Endorsement classes were available through the district, at no cost, for all teachers to obtain certification in reading. College preparatory strategies were used to assist AVID classroom teachers with additional resources, as well as, Kagan's Cooperative Learning strategies, IB/Learners Profile and IB Areas of Interaction, Marzano's Building Academic Vocabulary, Thinking Maps®, Reading Competencies, Ruby Payne, and ESOL strategies for English language learners (ELLs).

Differentiation was considered when mentoring teachers. Novice teachers new to the school district were paired with a veteran teacher. An Instructional Coach met with beginning teachers monthly and visited classrooms on a weekly basis. Experienced teachers new to the school were paired with a returning teacher, and teachers new to the profession were paired with a master teacher. Master teachers were defined as those who had 4 or more years experience and had demonstrated effective teaching practices. Mentor teachers attended professional development to learn mentoring and coaching skills.

School A communicated with parents through the use of student planners, academic progress reports, academic report cards, parent teacher conferences, an English and Spanish school newsletter, and teacher phone and email contacts. School A also hosted a school website, an internet grade book, and an internet translation tool for parents that was funded by an IBM grant (School A SIP, 2005, 2006, 2007).

School B Profile

At the time of this study School B was over 30 years old. Originally School B was built for 860 students. From 2005-2008 School B's student population averaged 1000 students (Appendix B). The student population was diverse with the majority comprised of over 90% minority students (Appendix D). School B was a Title I school with greater than 87% of its student population economically disadvantaged (Appendix B). School B had a partnership through a 21st Century Community grant that provided students after school tutoring. Students were given opportunities to participate in Saturday Florida Comprehensive Assessment Test®

(FCAT) Reading tutoring. Identified upcoming 7th grade students participated in a summer program called Tapping Talent Early. Students identified participated in advanced level math and language arts coursework. These classes were co-taught by middle school teachers and high school teachers of Advanced Placement courses. A grant funded “Mad Science Camp” was offered during the summer. During the school year there was also a grant funded after school science tutoring program. Students participated in Battle of the Books and published a student newsletter. Students were rewarded for academic achievement and improvement through The Renaissance Rewards Program. School Academic Improvement (SAI) funds provided after school tutoring programs. Other local Supplemental Educational Services providers also provided after school tutoring.

Instructional Programs School B used were Accelerated Reader and Pearson’s SuccessMaker reading software program for all students’ in grades 6-8 and as a reading intervention for students reading below grade level. Corrective Reading was also used as a reading intervention. Math offerings included Intensive Mathematics, Math Coach, Pre-Algebra, 7th grade Algebra Honors, Enrichment Mathematics, FCAT Mathematics, Advanced Mathematics, and FCAT Explorer. Teachers incorporated writing across the curriculum through the use of Write…For The Future. The Language for Learning Program was provided for students that were beginners in English Speakers of Other Languages (ESOL). School B used the Saxon Mathematics program as the core mathematic curriculum for students performing two or more years below grade level in mathematics. Algebra I, Geometry, and Spanish for high school credit and Springboard curriculum were provided for students that had achieved Level 3-5 on the Florida Comprehensive Assessment Test® (FCAT). The Advancement Via Individual

Determination (AVID) elective was provided for identified students. Hands-on equations strategies were additional resources used to teach algebraic thinking. The instructional day included hands-on activities, small group instruction, cooperative learning groups, one on one individual teacher instruction, Socratic Seminars, and inquiry based instruction.

School B's teacher mentoring program was spearheaded by the principal, other administrators and instructional support personnel. A new teacher orientation program was provided for teachers the week before preplanning. School B paired experienced teachers with less experienced and together they trained using Performance Learning Systems' Conferencing Skills and Coaching techniques. Each department had instructional leaders that collaborated with school based Math and Reading Coaches to assist new teachers or teachers in need of assistance. Mentees were matched by content area. Mentees were required to meet twice a week with their mentors. Substitutes' were provided for mentee's to observe their mentors' class. The administration scheduled regular meetings with Mentors and Mentees to discuss and evaluate the effectiveness of Teacher Mentoring activities. Teachers participated in Differentiated Instruction and CRISS Strategies professional development. Individualized professional development activities were provided to teachers in the areas of math and reading. Data coaching and analysis sessions were provided for teachers. The school adopted the Small Learning Communities philosophy. Reading Endorsement classes were made available through the district, at no cost, for all teachers to obtain certification in reading. College Preparatory strategies were used to assist AVID classroom teachers with additional resources. Reading Competencies, Marzano's/Building Academic Vocabulary, Ruby Payne, Fish Philosophy Training, and ESOL strategies for English language learners (ELLs) were also provided to teachers.

School B invited parents to participate in Florida Comprehensive Assessment Test® (FCAT), Mathematics, Science, and Reading/Language Arts evening meetings aimed at providing parents with performance data and strategies. Quarterly student progress reports and report cards were sent home. Parents and families were invited to school orientations. The school published a monthly newsletter and hosted a website. Parents were provided written notification about school improvement status and accountability reports. School B conducted home visitations. Parents were involved in Additions (school volunteer) training and school recognition activities (School B SIP, 2005, 2006, 2007).

Instrumentation

Florida Comprehensive Assessment Test® (FCAT)

Data was collected using The Florida Comprehensive Assessment Test® (FCAT) instrument. Student scores were obtained through the school district and the Florida Department of Education. The Florida Comprehensive Assessment Test® (FCAT) measures student achievement on selected benchmarks in reading, mathematics, writing, and science that are defined by the Florida Sunshine State Standards (SSS). FCAT was first administered in 1998. Developed by Florida educators, the SSS contains challenging content students are expected to know and be able to demonstrate. All public schools are expected to teach students the content found in the SSS (FLDOE, 2008).

Achievement Levels

Achievement levels describe the success a student has achieved on the Sunshine State Standards (SSS) tested on the Florida Comprehensive Assessment Test® (FCAT) Reading, Mathematics, Science, and Writing+ assessments. Achievement levels were first established for

Reading and Mathematics and later for Science and Writing+. Achievement levels based on both scale scores and developmental scale scores range from 1 (lowest) to 5 (highest). Achievement level definitions apply to all FCAT subtests.

Level 5 - This student has success with the most challenging content of the Sunshine State Standards. A student scoring in Level 5 answers most of the test questions correctly, including the most challenging questions.

Level 4 - This student has success with the most challenging content of the Sunshine State Standards. A student scoring in Level 4 answers most of the test questions correctly, including the most challenging questions.

Level 3 - This student has partial success with the challenging content of the Sunshine State Standards, but performance is inconsistent. A student scoring in Level 3 answers many of the test questions correctly but is generally less successful with questions that are the most challenging.

Level 2 -This student has limited success with the challenging content of the Sunshine State Standards.

Level 1 -This student has little success with the challenging content of the Sunshine State Standards (FLDOE, 2008).

Scale scores are reported for all Florida Comprehensive Assessment Test® (FCAT) Sunshine State Standards (SSS) subjects and range from 100 (lowest) to 500 (highest) whereas Developmental Scale Scores (DSS) are only reported for FCAT SSS Reading and Mathematics and range from 0 to about 3000 across grades 3 through 10. Developmental Scale Scores (DSS) link two years of student FCAT data that track student progress over time. Students should receive higher scores as they move from grade-to-grade according to their increased achievement. DSS cannot be determined for FCAT Science and Writing+ because students are not tested in these subjects at each grade level. Learning Gains are part of the school grading system. Annual learning gains can be shown by improvement in an achievement level, e.g., from Achievement Level 1 to Achievement Level 2, maintaining an Achievement Level 3, 4, or 5, or showing adequate DSS change if a student remains in Achievement Level 1 or 2 (FLDOE, 2008).

Reliability and Validity

The FCAT reliability indices at grades 4, 5, 8, and 10 are above 0.90. According to the Florida Department of Education website, http://fcat.fldoe.org, the FCAT test has content validity. The FCAT has a very precise set of definitions and controlling specifications. It was developed by the Department of Education with the assistance of commercial testing companies and validated by committees of practicing Florida classroom teachers and curriculum specialists. The combination of these elements assures that the FCAT has content validity.

Information is readily available to reveal “concurrent validity” of the FCAT and can be found on the FLDOE website. This concept conveys the idea that the FCAT is correlated with some other test score that measures students in the same content area.

Since the Florida Comprehensive Assessment Test® (FCAT) administration includes both a criterion-referenced component and a norm-referenced test (the SAT-9), the correlation between the scores for all students who were tested has been studied. These correlations for grades 4, 5, 8, and 10 are between 0.70 and 0.81 which is strong for tests that are measuring slightly different content.

Data Collection

Exempt status was secured from the University of Central Florida Institutional Review Board prior to the initiation of this study (Appendix H). A letter was written to request permission to conduct the study to the Senior Director of Accountability/Research and Assessment from the school system where the study was conducted (Appendix I) and permission was granted (Appendix J). Copyright permission was also secured from Thinking Maps®, Inc. in order to use (Appendix K) the term Thinking Maps® and the eight visual tools associated with that term.

The FCAT scores were secured from the Florida Department of Education website. Data was also secured using district generated reports. These reports included attendance data for students attending the 2005-2006, 2006-2007 and 2007-2008 school years during the FTE periods designated by the state of Florida for the months of October and February. Demographic reports were gathered to analyze subgroup data for students involved in this study. FCAT 5^{th} grade 2005 scale scores and developmental scale scores were used to establish comparability and to calculate FCAT Reading and Mathematics learning gains.

Data Analysis

The Statistical Program for the Social Sciences (SPSS) was used to analyze the data. MANOVA tests were run to determine the difference in FCAT scale scores between students who received ThinkingMaps® instruction (treatment school) since 2006 and those who did not receive Thinking Maps® instruction (control school) since 2006. Chi-square tests of independence were run to determine a relationship between two dichotomous variables: FCAT learning gain (yes or no) and instruction received (ThinkingMaps® instruction and no

ThinkingMaps® instruction) and among specific demographic subgroups (Ary, Jacobs & Razavieh, 2002; Lomax, 2001). These analyses were used to test the following hypotheses:

Hypotheses

Ho1: Students who have been instructed in the use of Thinking Maps® do not have higher academic achievement as measured by the Florida Comprehensive Assessment Test® (FCAT) than those who have not been instructed in the use of Thinking Maps®.

- $Ho1_1$: There was no difference between the 2008 FCAT Reading scores of 8th grade students who received Thinking Maps® instruction since 2006 and those who did not receive Thinking Maps® instruction since 2006.

- $Ho1_2$: There was no difference between the 2008 FCAT Mathematics scores of 8th grade students who received Thinking Maps® instruction since 2006 and those who did not receive Thinking Maps® instruction since 2006.

- $Ho1_3$: There was no difference between the 2006, 2007, and 2008 learning gains on FCAT Reading between schools (School A [treatment site] and School B [control site]).

- $Ho1_4$: There was no difference between the 2006, 2007, and 2008 learning gains on FCAT Mathematics between schools (School A [treatment site] and School B [control site]).

- $Ho1_5$: There was no difference between the 2006, 2007, and 2008 learning gains on FCAT Reading between subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students).

- $Ho1_6$: There was no difference between the 2006, 2007, and 2008 learning gains on FCAT Mathematics between subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students).

- $Ho1_7$: There was no difference among the 2006, 2007, and 2008 learning gains on FCAT Reading across subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students)?

- $Ho1_8$: There was no difference among the 2006, 2007, and 2008 learning gains on FCAT Mathematics across subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students).

Summary

Chapter three consists of the research design, population, profiles of schools in study, instrumentation, overview of Florida Comprehensive Assessment Test® (FCAT), reliability and validity of FCAT, and data collection. Null hypotheses based on research questions were listed. Quantitative data was used, with a nonrandomized control group, pretest-posttest design. Data was collected from student FCAT scores for sixth, seventh, and eighth grade students. FCAT 5th grade 2005 scale scores and developmental scale scores were used to establish comparability and to calculate FCAT Reading and Mathematic learning gains. The results from the analyses will be presented in Chapter four.

CHAPTER FOUR: ANALYSIS OF DATA

Introduction

The purpose of this study was to determine what differences, if any, exists between the implementation and use of Thinking Maps® and students' academic achievement in Reading and Mathematics as measured over time by the Florida Comprehensive Assessment Test® (FCAT). This longitudinal study examined 6^{th}, 7^{th} and 8^{th} grade FCAT Reading and Mathematics scores for students who received three years of Thinking Maps® instruction while attending a middle school that implemented Thinking Maps® throughout all grade levels and core subjects during the 2005-2006, 2006-2007, and 2007-2008 school years as compared to students who attended a middle school for three years that did not implement Thinking Maps® throughout all grade levels and core subjects during the 2005-2006, 2006-2007, and 2007-2008 school years. FCAT 5^{th} grade 2005 scale scores and developmental scale scores were used to establish comparability and to calculate FCAT Reading and Mathematics learning gains. This chapter contains the results of the data analyses as they relate to the questions proposed in Chapters 1 and 3.

Analysis of Research Questions

Research Question 1

Do students who have been instructed in the use of Thinking Maps® have higher academic achievement as measured by the Florida Comprehensive Assessment Test® (FCAT) than those who have not been instructed in the use of Thinking Maps®? Specific questions include:

Research Question 1.1

Was there a difference between the 2008 FCAT Reading scores of 8th grade students who received Thinking Maps® instruction since 2006 and those who did not receive Thinking Maps® instruction since 2006?

The analysis of data for this research question involved 2005 FCAT Reading scores as baseline data to establish comparability among students and 2006, 2007 and 2008 FCAT Reading scores of 8th grade students who received Thinking Maps® instruction since 2006 (School A [treatment site]) and those who did not receive Thinking Maps® instruction since 2006 (School B [control site]).

The null hypothesis was:

$Ho1_{1:}$ There was no difference between the 2008 FCAT Reading scores of 8th grade students who received Thinking Maps® instruction since 2006 and those who did not receive Thinking Maps® instruction since 2006.

Research Question 1.2.

Was there a difference between the 2008 FCAT Mathematics scores of 8th grade students who received Thinking Maps® instruction since 2006 and those who did not receive Thinking Maps® instruction since 2006?

The analysis of data for this research question involved 2005 FCAT Mathematics scores as baseline data to establish comparability among students and 2006, 2007 and 2008 FCAT Mathematics scores of 8th grade students who received Thinking Maps® instruction since 2006 (School A [treatment site]) and those who did not receive Thinking Maps® instruction since 2006 (School B [control site]).

The null hypothesis was:

$Ho1_{2:}$ There was no difference between the 2008 FCAT Mathematics scores of 8^{th} grade students who received Thinking Maps® instruction since 2006 and those who did not receive Thinking Maps® instruction since 2006.

For Research Questions 1.1 and 1.2, two separate MANOVA tests were run to determine the difference in FCAT scale score between students who received Thinking Maps® instruction (treatment school) since 2006 and those who did not receive Thinking Maps® instruction (control school) since 2006 and students who did not. The analysis associated with Research Question 1.1 addressed FCAT Reading, while the analysis associated with Research Question 1.2 addressed FCAT Mathematics.

A Multiple Analysis of Variance, MANOVA, was utilized to analyze the difference in means in a set of dependent variables among the groups defined by one or more independent variables. FCAT Reading and Mathematics scale scores, which range from 100 to 500 in each grade, served as the dependent variables, with each grade from 5^{th} through 8^{th} contributing a separate dependent variable. Although all scale scores range from 100 to 500, a score of 300 in one grade does not necessarily represent the same level of proficiency in the next grade if a student were to once again attain a score of 300. Therefore, while these scores have some relationship, they are not suitable for a matched-pairs setup. The independent variable was the dichotomous factor of instruction, where students either received Thinking Maps® instruction or did not.

Prior to running the MANOVA tests, assumptions were checked, including normality, homogeneity of variances, and homogeneity of covariance. Skewness and kurtosis values fell between -2 and 2 for each of the dependent variables among all grades for both reading and math, which provided evidence of normality. Levene's Test was utilized to measure homogeneity of variances; all tests were non-significant at $\alpha = .05$ and therefore provided evidence of equal variances for all subgroups within each of the dependent variables.

Finally, homogeneity of covariance, which is essentially an expansion of a test for homogeneity of variances across multiple variables considered simultaneously, was tested as well using Box's M test. For the FCAT Reading analysis, this result was non-significant, suggesting homogeneity; however, for the FCAT Mathematics analysis, the *p*-value of $< .001$ provided evidence of heterogeneity of covariances. This violation was not used as a reason to alter the methodology due to the homogeneity of the individual variances as well as the facts that there were only two levels of the independent factor and that Box's M test is often an extremely sensitive statistical test.

The MANOVA test was conducted for the FCAT Reading dependent variables. Descriptive statistics, including means and standard deviations, are contained within Table 5. The multivariate test, which checks for significance among all of the dependent variables for the independent factor, did not indicate that there was a statistically significant difference at any of the grade levels in FCAT Reading scale score between the students who received Thinking Maps® instruction and those who did not: $F(4, 273) = 1.68$, $p = .16$. The η^2 value of .02, a measure of effect size, was small. Although this omnibus test indicated a lack of significance, individual *F*-tests were examined as well to ensure that no particular single dependent variable was ignored by the multivariate analysis. No individual *F*-test was significant which was consistent with the overall result.

Therefore, null hypothesis $Ho1_1$ was retained.

Table 5: *Summary Statistics for FCAT Reading Scale Score (N = 278)*

	Treatment (n = 142)		Control (n = 136)	
Grade	M	SD	M	SD
6th	304.06	55.74	300.18	51.54
7th	309.80	49.17	307.29	52.66
8th	304.87	46.13	300.94	40.11

A MANOVA test was then conducted for the FCAT Mathematics dependent variables. Descriptive statistics, including means and standard deviations, are contained within Table 6. The multivariate test, which checks for significance among all of the dependent variables for the independent factor, did not indicate that there was a statistically significant difference at any of the grade levels in FCAT Mathematics scale score between the students who received Thinking Maps® instruction and those who did not: $F(4, 271) = 0.98$, $p = .41$. The η^2 value of .01, a measure of effect size, was small. Although this omnibus test indicated a lack of significance, individual *F*-tests were examined as well to ensure that no particular single dependent variable was ignored by the multivariate analysis. No individual *F*-test was significant which was consistent with the overall result.

Therefore, null hypothesis $Ho1_2$ was retained.

Table 6: *Summary Statistics for FCAT Mathematics Scale Score (N = 276)*

	Treatment (n = 140)		Control (n = 136)	
Grade	M	SD	M	SD
6th	301.34	62.59	293.13	62.50
7th	305.64	50.43	301.16	55.51
8th	318.10	40.50	314.13	44.66

Research Question 1.3.

Were there differences in student's 2006, 2007, 2008 learning gains on FCAT Reading between schools (School A [treatment site] and School B [control site])? The analysis of data for this research question involved 2006, 2007 and 2008 FCAT Reading learning gains of School A (treatment site) and School B (control site) students.

The null hypothesis was:

$Ho1_{3:}$ There were no differences between the 2006, 2007 and 2008 learning gains on FCAT Reading between schools (School A [treatment site] and School B [control site]).

Research Question 1.4.

Were there differences in student's 2006, 2007, 2008 learning gains on FCAT Mathematics between schools (School A [treatment site] and School B [control site])? The analysis of data for this research question involved 2006, 2007 and 2008 FCAT Mathematics learning gains School A (treatment site) and School B (control site) students.

The null hypothesis was:

$Ho1_{4:}$ There were no differences between the 2006, 2007 and 2008 learning gains on FCAT Mathematics between schools (School A [treatment site] and School B [control site]).

For Research Questions 1.3 and 1.4, chi-square tests of independence were run to determine a relationship between two dichotomous variables: FCAT learning gain (yes or no) and instruction received (Thinking Maps® instruction and no Thinking Maps® instruction). The analysis associated with Research Question 1.3 addressed FCAT Reading, while the analysis associated with Research Question 1.4 addressed FCAT Mathematics.

The results for Research Question 1.3 are located in Table 7. Results from three separate chi-square tests are contained within, reflecting learning gains among the population for grades 6, 7, and 8, respectively. The implementation of Thinking Maps® instruction was not associated with a difference in incurrence of FCAT Reading learning gains at any of the three grade levels, as all of the *p*-values were greater than the $\alpha = .05$ threshold. Likewise, effect sizes, represented by Φ, were small, all below .10. Crosstabulation of overall FCAT Reading learning gains are found in Appendix L.

Therefore, null hypothesis $Ho1_3$ was retained.

Table 7: *Chi-Square Results, Overall FCAT Reading Learning Gains (N = 300)*

Year	χ^2	p	Φ
Grade 6 (2006)	0.75	.39	.05
Grade 7 (2007)	0.04	.85	.01
Grade 8 (2008)	0.97	.32	.06

Note. df = 1. Treatment site n = 144; Control site n = 156.
*p < .05. ** p < .01.

The same set of chi-square analyses was conducted for FCAT Mathematics learning gains, as located in Table 8, to determine whether there was a relationship between this variable and the use of the Thinking Maps® instruction. The implementation of Thinking Maps® instruction was not associated with a difference in incurrence of math learning gains at any of the three grade levels, as all of the *p*-values were greater than the $\alpha = .05$ threshold. Likewise, effect sizes, represented by Φ, were small, all below .10. Crosstabulation of overall FCAT Mathematics learning gains are found in Appendix M.

Therefore, null hypothesis $Ho1_4$ was retained.

Table 8: *Chi-Square Results, Overall FCAT Mathematics Learning Gains (N = 300)*

Year	χ^2	p	Φ
Grade 6 (2006)	0.51	.48	.04
Grade 7 (2007)	0.86	.36	.05
Grade 8 (2008)	0.40	.53	.04

Note. df = 1. Treatment site n = 144; Control site n = 156.
*p < .05. ** p < .01.

Research Question 1.5.

Were there differences in student's 2006, 2007, 2008 learning gains on FCAT Reading between subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students)? The analysis of data for this research question involved 2006, 2007 and 2008 learning gains on FCAT Reading between subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students) of School A (treatment site) and School B (control site).

The null hypothesis was:

$Ho1_5$: There were no differences between the 2006, 2007 and 2008 learning gains on FCAT Reading between subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students).

Research Question 1.6.

Were there differences in student's 2006, 2007, 2008 learning gains on FCAT Mathematics between subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students)? The analysis of data for this research question involved 2006, 2007 and 2008 learning gains on FCAT Mathematics between subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students) of School A (treatment site) and School B (control site).

The null hypothesis was:

$Ho1_6$: There were no differences between the 2006, 2007 and 2008 learning gains on FCAT Mathematics between subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students).

For Research Questions 1.5 and 1.6, chi-square tests of independence were run to determine a relationship between two dichotomous variables: FCAT learning gain (yes or no) and instruction received (Thinking Maps® instruction and no Thinking Maps® instruction), among specific demographic subgroups: white students, black students, Hispanic students, economically disadvantage students, English language learners, and students with disabilities. The analyses associated with Research Question 1.5 addressed FCAT Reading, while the analysis associated with Research Question 1.6 addressed FCAT Mathematics.

The results for Research Question 1.5 are located in Table 9 through Table 14. Results from three separate chi-square tests are contained within each table, reflecting FCAT Reading learning gains among the specified subgroups for grades 6, 7, and 8, respectively. Among all grades and subgroups, the implementation of Thinking Maps® instruction was not associated with a difference in incurrence of FCAT Reading learning gains, as all of the *p*-values were greater than the $\alpha = .05$ threshold. Likewise, effect sizes, represented by Φ, were small, all below .10. Crosstabulation of FCAT Reading learning gains by subgroup are found in Appendices N.

Therefore, null hypothesis $Ho1_5$ was retained.

Table 9: *Chi-Square Results, White Student FCAT Reading Learning Gains (N = 33)*

Year	χ^2	p	Φ
Grade 6 (2006)	0.08	.77	.05
Grade 7 (2007)	3.12	.08	.31
Grade 8 (2008)	0.03	.87	.03

Note. df = 1. Treatment site n = 25; Control site n = 8.
*p < .05. ** p < .01.

Table 10: *Chi-Square Results, Black Student FCAT Reading Learning Gains (N = 79)*

Year	χ^2	p	Φ
Grade 6 (2006)	0.02	.89	.02
Grade 7 (2007)	0.34	.56	.07
Grade 8 (2008)	0.06	.80	.03

Note. df = 1. Treatment site n = 13; Control site n = 66.
*p < .05. ** p < .01.

Table 11: *Chi-Square Results, Hispanic Student FCAT Reading Learning Gains (N = 173)*

Year	χ^2	p	Φ
Grade 6 (2006)	0.84	.36	.07
Grade 7 (2007)	0.50	.48	.05
Grade 8 (2008)	2.76	.10	.13

Note. df = 1. Treatment site n = 99; Control site n = 74.
*p < .05. ** p < .01.

Table 12: *Chi-Square Results, Economically Disadvantaged Student FCAT Reading Learning Gains (N = 262)*

Year	χ^2	p	Φ
Grade 6 (2006)	0.30	.59	.03
Grade 7 (2007)	0.01	.94	-
Grade 8 (2008)	0.86	.35	.06

Note. df = 1. Treatment site n = 125; Control site n = 137.
*p < .05. ** p < .01.

Table 13: *Chi-Square Results, English Language Learner FCAT Reading Learning Gains (N = 84)*

Year	χ^2	p	Φ
Grade 6 (2006)	0.14	.71	.04
Grade 7 (2007)	0.00	.98	-
Grade 8 (2008)	3.15	.08	.19

Note. df = 1. Treatment site n = 32; Control site n = 52.
*p < .05. ** p < .01.

Table 14: *Chi-Square Results, Students with Disabilities FCAT Reading Learning Gains (N = 25)*

Year	χ^2	p	Φ
Grade 6 (2006)	0.24	.62	.10
Grade 7 (2007)	0.05	.82	.05
Grade 8 (2008)	0.11	.74	.07

Note. df = 1. Treatment site n = 14; Control site n = 11.
*p < .05. ** p < .01.

The results for Research Question 1.6 are located in Table 15 through Table 20. Results from three separate chi-square tests are contained within each table, reflecting FCAT Mathematics learning gains among the specified subgroups for grades 6, 7, and 8, respectively. Among all grades and subgroups, the implementation of Thinking Maps® instruction was not associated with a difference in FCAT Mathematics learning gains, as all of the *p*-values were greater than the $\alpha = .05$ threshold. Likewise, effect sizes, represented by Φ, were small, all below .10. Crosstabulation of FCAT Mathematics learning gains by subgroup are found in Appendices O.

Therefore, null hypothesis $Ho1_6$ was retained.

Table 15: *Chi-Square Results, White Student FCAT Mathematics Learning Gains (N = 33)*

Year	χ^2	p	Φ
Grade 6 (2006)	0.51	.48	.12
Grade 7 (2007)	0.68	.41	.14
Grade 8 (2008)	2.65	.10	.28

Note. df = 1. Treatment site n = 25; Control site n = 8.
*p < .05. ** p < .01.

Table 16: *Chi-Square Results, Black Student FCAT Mathematics Learning Gains (N = 79)*

Year	χ^2	p	Φ
Grade 6 (2006)	0.03	.87	.02
Grade 7 (2007)	0.23	.63	.05
Grade 8 (2008)	0.35	.56	.07

Note. df = 1. Treatment site n = 13; Control site n = 66.
*p < .05. ** p < .01.

Table 17: *Chi-Square Results, Hispanic Student FCAT Mathematics Learning Gains (N = 173)*

Year	χ^2	p	Φ
Grade 6 (2006)	0.73	.39	.07
Grade 7 (2007)	2.06	.15	.11
Grade 8 (2008)	0.00	.97	-

Note. df = 1. Treatment site n = 99; Control site n = 74.
*p < .05. ** p < .01.

Table 18: *Chi-Square Results, Economically Disadvantaged Student FCAT Mathematics Learning Gains (N = 262)*

Year	χ^2	p	Φ
Grade 6 (2006)	1.04	.31	.06
Grade 7 (2007)	1.70	.19	.08
Grade 8 (2008)	0.14	.71	.02

Note. df = 1. Treatment site n = 125; Control site n = 137.
*p < .05. ** p < .01.

Table 19: *Chi-Square Results, English Language Learner FCAT Mathematics Learning Gains (N = 84)*

Year	χ^2	p	Φ
Grade 6 (2006)	2.18	.14	.16
Grade 7 (2007)	2.73	.10	.18
Grade 8 (2008)	0.16	.68	.05

Note. df = 1. Treatment site n = 32; Control site n = 52.
*p < .05. ** p < .01.

Table 20: *Chi-Square Results, Students with Disabilities FCAT Mathematics Learning Gains (N = 25)*

Year	χ^2	p	Φ
Grade 6 (2006)	0.11	.74	.07
Grade 7 (2007)	0.71	.40	.17
Grade 8 (2008)	0.17	.68	.08

Note. df = 1. Treatment site n = 14; Control site n = 11.
*p < .05. ** p < .01.

Research Question 1.7

Were there differences in student's 2006, 2007, 2008 learning gains on FCAT Reading across subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students)?

The null hypothesis was:

$Ho1_7$: There were no differences in 2006, 2007 and 2008 learning gains on FCAT Reading across subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students).

Research Question 1.8

Were there differences in student's 2006, 2007, 2008 learning gains on FCAT Mathematics across subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students)?

The null hypothesis was:

$Ho1_8$: There were no differences in 2006, 2007 and 2008 learning gains on FCAT Mathematics across subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students).

An analysis of the data for Research Question 1.7 and 1.8 could not be conducted because the possibility of internal validity issues and the lack of sufficient power to either reject or retain the null hypotheses. Heterogeneity of subjects with reference to the dependent variable of learning gain could be a problem since students could belong to several subgroups and be counted more than once. Since students can belong to multiple groups, the reliability of results could be questionable, as well as the calculation of effect size. Even if these data were to be analyzed using a method such as hierarchical linear modeling, the relatively small sample size and large number of independent variable groups makes the process difficult because of the extremely small sub-group sizes that would result.

Therefore, null hypothesis $Ho1_7$ and $Ho1_8$ could neither be rejected nor retained.

CHAPTER FIVE: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Purpose and Methodology

The purpose of this study was to determine what difference, if any, exists between the implementation and use of Thinking Maps® and students' academic achievement in reading and mathematics as measured over time by the Florida Comprehensive Assessment Test® (FCAT). A nonrandomized control group, pretest-posttest design as described by Ary, Jacobs and Razavieh (2002) was used. The two middle schools selected for this study were designated Title I (USDOE, 2009) schools based on the high poverty level of the student population attending both schools. The majority of the 300 students in this study were minorities. Both schools served English language learners, gifted students and students with disabilities. This longitudinal study examined 6th, 7th, and 8th grade FCAT Reading and Mathematics scores for students who received three years of Thinking Maps® instruction while attending a middle school that implemented Thinking Maps® (treatment school) throughout all grade levels and core subjects during the 2005-2006, 2006-2007, and 2007-2008 school years as compared to students who attended a middle school for three years that did not implement Thinking Maps® (control school) throughout all grade levels and core subjects during the 2005-2006, 2006-2007, and 2007-2008 school years. FCAT 5th grade 2005 scale scores and developmental scale scores were used to establish comparability and to calculate FCAT Reading and Mathematics learning gains.

This study focused around the central question, "Do students who have been instructed in the use of Thinking Maps® have higher academic achievement as measured by the Florida Comprehensive Assessment Test® (FCAT) than those who have not been instructed in the use of Thinking Maps®?" From this central question additional questions were generated. The independent variable was Thinking Maps®. Dependent variables included 6^{th}, 7^{th}, and 8^{th} grade FCAT Reading and Mathematics scores for students who received three years of Thinking Maps® instruction while attending a middle school that implemented Thinking Maps® throughout all grade levels and core subjects during the 2005-2006, 2006-2007, and 2007-2008 school years (School A [treatment site]) as compared to students who attended a middle school for three years that did not implement Thinking Maps® throughout all grade levels and core subjects during the 2005-2006, 2006-2007, and 2007-2008 school years (School B [control site]). Specific dependent variables included: 2006 6^{th}, 2007 7^{th}, and 2008 8^{th} grade FCAT Reading scores, 2006 6^{th}, 2007 7^{th}, and 2008, 8^{th} grade Mathematics scores, 2006, 6^{th} grade, 2007, 7^{th} grade, and 2008, 8^{th} grade FCAT Reading learning gains, 2006, 6^{th} grade, 2007, 7^{th} grade, 2008, 8^{th} grade FCAT Mathematics learning gains, school type and subgroup (black students, white students, Hispanic students, English language learners, students with disabilities and economically disadvantaged students). MANOVA tests were run to determine the difference in FCAT scale score between students who received Thinking Maps ®instruction (treatment school) since 2006 and those who did not receive Thinking Maps® instruction (control school) since 2006. Chi-square tests of independence were run to determine a relationship between two dichotomous variables: FCAT learning gain (yes or no) and instruction received (Thinking Maps® instruction and no Thinking Maps® instruction) and among specific subgroups (Ary, Jacobs & Razavieh, 2002; Lomax, 2001).

Research Questions

Research Question 1

From the central question, "Do students who have been instructed in the use of Thinking Maps® have higher academic achievement as measured by the Florida Comprehensive Assessment Test® (FCAT) than those who have not been instructed in the use of Thinking Maps®?" specific questions were generated. These questions and results are included in this section.

Research Question 1.1

Was there a difference between the 2008 FCAT Reading scores of 8th grade students who received Thinking Maps® instruction since 2006 and those who did not receive Thinking Maps® instruction since 2006? Results from the multivariate test indicated that there was not a statistically significant difference at any of the grade levels in FCAT Reading scores between the students who received Thinking Maps® instruction and those who did not receive Thinking Maps® instruction.

Research Question 1.2.

Was there a difference between the 2008 FCAT Mathematics scores of 8th grade students who received Thinking Maps® instruction since 2006 and those who did not receive Thinking Maps® instruction since 2006? Results from the multivariate test indicated that there was not a statistically significant difference at any of the grade levels in FCAT Mathematics scores between the students who received Thinking Maps® instruction and those who did not receive Thinking Maps® instruction.

Research Question 1.3.

Were there differences in student's 2006, 2007, and 2008 learning gains on FCAT Reading between schools (School A [treatment site] and School B [control site])? Results from three separate chi-square tests reflecting learning gains among the population for grades 6, 7, and 8 indicated that the use of Thinking Maps® was not associated with a statistical significant difference in FCAT Reading learning gains at any of the three grade levels.

Research Question 1.4.

Were there differences in student's 2006, 2007, 2008 learning gains on FCAT Mathematics between schools (School A [treatment site] and School B [control site])? Results from three separate chi-square tests reflecting learning gains among the population for grades 6, 7, and 8 indicated that the use of Thinking Maps® was not associated with a statistical significant difference in FCAT Mathematics learning gains at any of the three grade levels.

Research Question 1.5.

Were there differences in student's 2006, 2007, 2008 learning gains on FCAT Reading between subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students)? Results from three separate chi-square tests reflecting learning gains on FCAT Reading among subgroups for grades 6, 7, and 8 indicated no statistically significant difference among all grades and subgroups in the use of Thinking Maps®.

Research Question 1.6.

Were there differences in student's 2006, 2007, 2008 learning gains on FCAT Mathematics between subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students)? Results from three separate chi-square tests reflecting learning gains on FCAT Mathematics among subgroups for grades 6, 7, and 8 indicated no statistically significant difference among all grades and subgroups in the use of Thinking Maps®.

Research Question 1.7

Were there differences in student's 2006, 2007, 2008 learning gains on FCAT Reading across subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged)? A data analysis for this question could not be conducted because of the possibility of internal validity issues and the lack of sufficient power to either reject or retain the null hypotheses:

$Ho1_7$: There were no differences in 2006, 2007, and 2008 learning gains on FCAT Reading across subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students).

Heterogeneity of subjects with reference to the dependent variable of FCAT Reading learning gains across subgroups could be a problem since students could belong to several subgroups and be counted more than once. For example, a white student can also be a student with a disability and economically disadvantaged. This one student can be classified under three different subgroups. Since students can belong to multiple groups, the reliability of results could be questionable, as well as the calculation of effect size. Even if data were to be analyzed using a method such as hierarchical linear modeling, the relatively small sample size and large number of independent variable groups would make the process difficult because of the extremely small sub-group sizes that would result.

Research Question 1.8

Were there differences in student's 2006, 2007, 2008 learning gains on FCAT Mathematics across subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged)? Data analysis for this question could not be conducted because of the possibility of internal validity issues and the lack of sufficient power to either reject or retain the null hypotheses:

$Ho1_8$: There were no differences in 2006, 2007, and 2008 learning gains on FCAT Mathematics across subgroups (black students, white students, Hispanic students, English language learners, students with disabilities, and economically disadvantaged students).

Heterogeneity of subjects with reference to the dependent variable of FCAT Mathematics learning gains across subgroups could be a problem since students could belong to several subgroups and be counted more than once. For example, a Hispanic student can also be an English language learner, a student with a disability and economically disadvantaged. This one student can be classified under four different subgroups. Since students can belong to multiple groups, the reliability of results could be questionable, as well as the calculation of effect size. Even if data were to be analyzed using a method such as hierarchical linear modeling, the relatively small sample size and large number of independent variable groups would make the process difficult because of the extremely small sub-group sizes that would result.

Discussion

The theoretical framework for this study was Ausubel's Subsumption Theory. Ausubel believed that a learner's cognitive structure must be organized, stable, and clear to facilitate the learning and retention of new concepts (Ausubel, 1960, 1963, 2000). It is through an organized cognitive structure that subsumption or assimilation of new concepts can occur (Ausubel, 1960, 1963, 2000; Mayer, 1979; Ivie, 1998). Classroom teachers need instructional visual tools, such as Thinking Maps®, to ascertain what concepts students already possess in their cognitive structure. The use of these instructional visual tools can assist students in constructing and reconstructing their individual conceptual frameworks (Mayer 1979;Novak, 2002;Hyerle, 2004; Stull & Mayer, 2007) thereby increasing cognitive competence (Hyerle, 2004) that results in conceptual understanding (Novak, 2002; Bransford, Brown, & Cocking, 1999). This study focused on one instructional program called Thinking Maps®. Thinking Maps® are eight fundamental thinking skills defined and animated by maps, and are introduced to teachers and students as a common visual language for thinking and learning. These eight visual tools enable learners to communicate what and how they are thinking (Hyerle, 2004).

The eight Thinking Maps® are based on connective thinking for understanding. These maps enable students to generate relevant information about a topic, describe attributes, compare and contrast, or prioritize information within a comparison. These instructional visual tools can also be used for inductive and deductive classification where students learn to create general concepts and support their ideas with specific details. Sequences, relationships, order, timelines, causes, effects, cycles, actions, steps, directions, and even analogical reasoning and metaphorical concepts for deeper content can be demonstrated by students through the use of these maps

(Hyerle, 1993; Hyerle, 2000; Hyerle & Yeager, 2000; Hyerle, 2004; Hyerle, 2009; Hyerle, 2010). Studies have demonstrated that students attain, retain, and transfer knowledge across content disciplines through learner generated conceptual maps (Bascone & Novak, 1985; Berkowitz, 1986; Nesbit and Adescope, 2006) such as Thinking Maps®.

The data in this study indicate that there is no statistically significant difference between the 6th, 7th, and 8th grade FCAT Reading and Mathematics scores for students who received three years of Thinking Maps® instruction while attending a middle school that implemented Thinking Maps® throughout all grade levels and core subjects during the 2005-2006, 2006-2007, and 2007-2008 school years as compared to students who attended a middle school for three years that did not implement Thinking Maps® throughout all grade levels and core subjects during the 2005-2006, 2006-2007, and 2007-2008 school years. Results from this study do not support results on student achievement and Thinking Maps® as cited by Hyerle (2000;2010) and Hickie (2006).

Hyerle's book *A field guide to using visual tools* (Hyerle, 2000) and his website *Design for Thinking*, http://www.mapthemind.com (Hyerle, 2010) include national results for the Texas Assessment of Academic Skills, Georgia State Test of Basic Skills, the Maryland School Performance Assessment Program, Florida Writes! and the North Carolina State End-of-Year Tests. Results included were for schools or school systems in which all teachers received comprehensive, cross-discipline training, and classroom follow-up coaching for a minimum of one school year in the use and implementation of Thinking Maps®.

The results cited were reported by administrators representing the schools or school systems in which the Thinking Maps® were implemented. These results were submitted because they showed significant gains on the different test instruments used by the respective institutions. In all cases, the administrators have evidence that the results were directly related to the use of Thinking Maps® by students. The scores are comparisons of results using state tests from year to year (Hyerle, 2000, pg. 134; http://www.mapthemind.com/research/research.html, pg.1, Hyerle, 2010).

It is important to note that test data presented by Hyerle's were reported in terms of percentage increases and not in terms of statistical significance as in this study. The fifth grade reading results portion of Hickie's 2006 study found statistical significant differences in the implementation of Thinking Maps®. However, Hickie's (2006) population and instruments used to measure student outcomes were comparable to those found in this study.

Results of this study contradict Hickie's (2006) reading findings but support Hickie's (2006) mathematics findings. Hickie (2006) found that after two years of Thinking Maps® implementation there was a statistically significant difference in the achievement of fifth grade students in reading as measured by the criterion referenced reading/language portion of the Tennessee Comprehensive Assessment Program Achievement Tests (TCAP) but not in the mathematics portion of the Tennessee Comprehensive Assessment Program Achievement Tests (TCAP). This study examined 6^{th}, 7^{th}, and 8^{th} grade Florida Comprehensive Assessment Test® (FCAT) Reading and Mathematics scores for students who received three years of Thinking Maps® instruction while attending a middle school that implemented Thinking Maps® (treatment school) throughout all grade levels and core subjects as compared to students who attended a middle school for three years that did not implement Thinking Maps® (control school) throughout all grade levels and core subjects. While Hickie's (2006) study examined results on the Tennessee Comprehensive Assessment Program Achievement Tests (TCAP) of two (treatment schools) elementary schools that implemented Thinking Maps® instruction for two years throughout various areas of curriculum and one (control school) that did not implement Thinking Maps® instruction for two years.

States develop their own content standards and performance tests to measure these content standards. Although the TCAP is similar to the Florida Comprehensive Assessment Test® (FCAT) in that it is a criterion-referenced test that measures student's performance according to specific content standards it differs from the FCAT in that content standards tested on TCAP include reading, language arts, mathematics, science and social studies (Hickie, 2006). FCAT only tests reading, mathematics, writing, and science (FLDOE, 2008). Another major difference in the TCAP and FCAT are the number of proficiency categories. TCAP student achievement scores are categorized in three areas: advanced, proficient, and below proficient compared to FCAT that reports student achievement scores according to Achievement Levels 1-5. FCAT Achievement Levels 1 and 2 are below proficient, Achievement Level 3 is proficient, and Achievement Levels 4 and 5 are above proficiency. It is important to point out while results of this study contradict reading and support mathematics results reported by Hickie (2006), that criterion-referenced instruments used in both Hickie's (2006) and this study differed in specific content standards tested and number of proficiency categories.

The findings of this study do support Leary's (1999) findings. Leary's 1999 study found no statistically significant differences between the treatment group and control group as measured on the norm referenced Stanford Achievement Test (SAT) (Ninth Edition). There were several differences in Leary's study as compared to this study. Leary (1999) examined reading, mathematics, and language arts test results as measured on the norm referenced Stanford Achievement Test (SAT) (Ninth Edition) for fourth grade students that received only 7 months of Thinking Maps® instruction (treatment group) as compared to fourth grade students that did not receive Thinking Maps® instruction (control group) during the same 7 months. While this study examined 6th, 7th, and 8th grade criterion-referenced Florida Comprehensive Assessment Test® (FCAT) Reading and Mathematics scores for students who received three years of Thinking Maps® instruction while attending a middle school that implemented Thinking Maps® (treatment school) throughout all grade levels and core subjects as compared to students who attended a middle school for three years that did not implement Thinking Maps® (control school) throughout all grade levels and core subjects. This study and Leary's (1999) study are similar in that the researchers had no control over the implementation of Thinking Maps® instruction.

Implications for Practice

This study adds to the research on the implementation of Thinking Maps® instruction at the middle school level. In the large urban school district where the study was conducted there were over 300 Thinking Maps® trainers throughout 180 schools. District and school dollars have been used to purchase Thinking Maps® training and materials since 2002. In the large urban school district where the study was conducted there had not been a study to determine what difference, if any, exists between the implementation and use of Thinking Maps® and students' academic achievement as measured by the Florida Comprehensive Assessment Test® (FCAT). Results of this study may be used to guide future decisions that impact schools and their budgets. Results of this study indicate that students who have been instructed in the use of

Thinking Maps® do not have higher academic achievement as measured by FCAT than those who have not been instructed in the use of Thinking Maps®. Statistical analysis did not result in significant differences in the use of Thinking Maps® as measured by FCAT but there were percentage differences that may indicate educational significance for Hispanic, economically disadvantaged and English language learners in FCAT Reading and for white, black and students with disabilities in FCAT Mathematics. Results of this study should not discourage the implementation of Thinking Maps® instruction as visual tools for learning. FCAT may not be an appropriate instrument to measure if an instructional visual tool such as Thinking Maps® makes a difference in student achievement. A better measurement tool would be for teachers to develop rubrics that can be used to assess student generated Thinking Maps® or use rubrics provided in the *Thinking Maps ®: A Language for Learning* (Hyerle & Yeager, 2007) training manual.

Florida Comprehensive Assessment Test® (FCAT) consists of criterion-referenced tests that measure selected mathematics, reading, science and writing achievement from the Florida Sunshine State Standards. These standards include content area strands, standards and benchmarks. FCAT Achievement Levels are based on both scales scores and developmental scale scores that range from 1 (lowest) to 5 (highest). FCAT Achievement Levels 1 and 2 are below proficiency, Achievement Level 3 is proficient and Achievement Levels 4 and 5 are above proficiency. Scale scores are reported for all sunshine state subjects and range from 100 (lowest) to 500 (highest), where as reading and mathematics developmental scale scores range from 539 to about 2790 across grades 6 through 8. Developmental scale scores link two years of student FCAT data that track student progress over time. Annual learning gains can be shown by improvement in an academic level, e.g. from Achievement Level 1 to Achievement Level 2, maintaining an Achievement Level 3,4, or 5 or showing adequate developmental scale score change if a student remains in Academic Level 1 or 2 (FLDOE, 2008). Performance tasks include short and extended responses. Students are required to demonstrate knowledge learned by describing a character in a story writing a mathematical equation after reading a word problem explaining a scientific concept comparing and/or contrasting two passages, creating a graph or describing the steps in an experiment. While FCAT measures the knowledge students possess as it relates to the Sunshine State Standards, it may not be an appropriate instrument to measure if the implementation of Thinking Maps® instruction makes a difference in student achievement. The goal of increasing student achievement related to the SSS guides instruction. Therefore Thinking Maps® serve as an instructional visual tool for learning to meet this goal.

Although this study did not find statistical significant difference on FCAT Reading and Mathematics scores of students who received instruction in the use of Thinking Maps®, teachers still need instructional tools and strategies that teach students to construct and reconstruct their conceptual frameworks that will lead to increased cognitive competence. Ausubel's Subsumption Theory viewed thinking as an orderly activity where knowledge is arranged in a hierarchical structure or pattern. In this hierarchical structure retention of knowledge occurs when the learner is able to anchor new knowledge with the learner's prior knowledge (Ausubel, 1960, 1963, 1968, 2000; Ivie 1998). Ausubel believed that the most important single factor influencing learning is what the learner already knows and that teachers need to find ways of ascertaining this knowledge in order to teach students (Ausubel, 1968). Thinking Maps® move beyond Ausubel's concept of organizers that are introduced prior to a lesson to promote new learning and retention (Ivie, 1998). Thinking Maps® are learner generated and provide teachers and students with a view of their own thinking. The use of Thinking Maps® could continue to be used as a supplemental tool of instruction that move learners from simply subsuming new concepts to possibly becoming experts and experiencing superordinate learning (Novak, 2002).

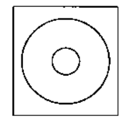
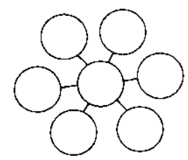
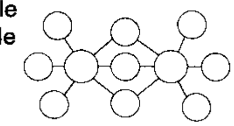
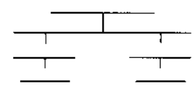
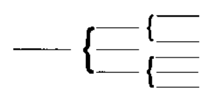
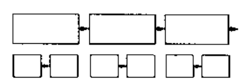
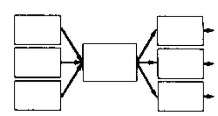
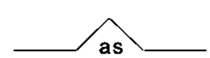
Other methods of evaluating the implementation of Thinking Maps® instruction and student achievement should be explored. Recommendations to determine what difference, if any, exists between the implementation and use of Thinking Maps® and students' academic achievement may include teacher lesson studies conducted by teachers trained in Thinking Maps® to determine the existing conceptual framework that exists in the minds of students. Formative evaluations of learning through the use of teacher developed rubrics that are based on concepts in a lesson may provide evidence of student achievement related to the use of Thinking Maps®. Student led presentations called conceptual conversations in the presence of experts (teachers and field/community members) conducted by students who are adept in the use of Thinking Maps® are a final recommendation. Through the use of conceptual conversations in the presence of experts, students that are adept in the use of Thinking Maps® select a concept of interest from required curricula and develop knowledge of this concept throughout a school year in collaboration with a teacher and field/community expert. During the presentation the student walks the expert teacher and field/community expert through the conceptual development process that they had a part in creating, evidenced by learner generated Thinking Maps®.

Recommendations for Future Research

The researcher offers the following areas as recommendations for further research:

1. A longitudinal study where the researcher can control the training and implementation of Thinking Maps® over the course of three years at a middle school.
2. Qualitative study at the treatment middle school that evaluates student achievement and Thinking Maps® through lesson studies.
3. Qualitative study at the treatment middle school that evaluates student's conceptual development through conceptual conversations in the presence of experts.
4. Qualitative study at the treatment middle school that evaluates teacher, student, administrators and parents perceptions of the use of Thinking Maps® and its impact, if any, on student achievement.
5. Qualitative study at the treatment middle school that evaluates fidelity of implementation of Thinking Maps® and its impact, if any, on student achievement.
6. Qualitative study at the treatment middle school that evaluates teacher and student mastery in the use of Thinking Maps®.
7. A quantitative study using a researcher developed tool that measures visual tools and their impact on student achievement.
8. Qualitative longitudinal study at the treatment middle school that uses researcher conducted student interviews coupled with the use of Thinking Maps® to identify the concept and propositional frameworks that students use to create these graphic representations.

APPENDIX A: EIGHT THINKING MAPS®

Questions from Texts, Teachers and Tests →	Thinking Processes →	Thinking Maps as Tools	
How are you defining this thing or idea? What is the context? What is your frame of reference?	**DEFINING IN CONTEXT**	Circle Map	
How are you describing this thing? Which adjectives would best describe this thing?	**DESCRIBING QUALITIES**	Bubble Map	
What are the similar and different qualities of these things? Which qualities do you value most? Why?	**COMPARING and CONTRASTING**	Double Bubble Map	
What are the main ideas, supporting ideas, and details in this information?	**CLASSIFYING**	Tree Map	
What are the component parts and subparts of this whole physical object?	**PART-WHOLE**	Brace Map	
What happened? What is the sequence of events? What are the substages?	**SEQUENCING**	Flow Map	
What are the causes and effects of this event? What might happen next?	**CAUSE and EFFECT**	Multi-Flow Map	
What is the analogy being used? What is the guiding metaphor?	**SEEING ANALOGIES**	Bridge Map	

1-9

Source: Thinking Maps ® (Printed with permission from Thinking Maps®)

APPENDIX B: STUDENT ENROLLMENT

Student Enrollment

School	2005-2006	2006-2007	2007-2008
A	1071	954	1102
B	1077	1011	911

Source: District Information Technology Online Data Access for School Years 2005-2008

Percentage of Economically Disadvantaged Students

School	2005-2006	2006-2007	2007-2008
A	85.2	83.3	81.1
B	85.7	87.7	88.7

Source: District Information Technology Online Data Access for School Years 2005-2008

APPENDIX C: RACE BY STUDENT ENROLLMENT AND YEAR

Race by Student Enrollment and Year

School	2005-2006 White	2005-2006 Black	2005-2006 Hispanic	2005-2006 Other
A	173	113	748	37
B	51	482	492	52

School	2006-2007 White	2006-2007 Black	2006-2007 Hispanic	2006-2007 Other
A	142	107	661	44
B	43	481	433	54

School	2007-2008 White	2007-2008 Black	2007-2008 Hispanic	2007-2008 Other
A	151	99	787	65
B	37	441	391	42

Source: District Information Technology Online Data Access for School Years 2005-2008

APPENDIX D: RACE BY PERCENTAGE OF STUDENT ENROLLMENT AND YEAR

Race by Percentage of Student Enrollment and Year

School	2005-2006 White	2005-2006 Black	2005-2006 Hispanic	2005-2006 Other
A	16.2	10.6	69.8	3.4
B	4.7	44.8	45.7	4.8

School	2006-2007 White	2006-2007 Black	2006-2007 Hispanic	2006-2007 Other
A	14.9	11.2	69.3	4.6
B	4.3	47.6	42.8	5.3

School	2007-2008 White	2007-2008 Black	2007-2008 Hispanic	2007-2008 Other
A	13.7	9	71.4	5.9
B	4.1	48.4	42.9	4.6

*S*ource: District Information Technology Online Data Access for School Years 2005-2008

APPENDIX E: ENROLLMENT OF ENGLISH LANGUAGE LEARNERS BY YEAR

Enrollment of English Language Learners by Year

School	2005-2006	2006-2007	2007-2008
A	424	347	458
B	428	416	383

Source: District Information Technology Online Data Access for School Years 2005-2008

Percentage of English Language Learners by Year

School	2005-2006	2006-2007	2007-2008
A	39.6	36.4	41.6
B	39.7	41.1	42

Source: District Information Technology Online Data Access for School Years 2005-2008

APPENDIX F: ENROLLMENT OF STUDENTS WITH DISABILITIES BY YEAR

Enrollment of Students With Disabilities by Year

School	2005-2006	2006-2007	2007-2008
A	178	162	182
B	136	124	99

Source: District Information Technology Online Data Access for School Years 2005-2008

Percentage of Students With Disabilities by Year

School	2005-2006	2006-2007	2007-2008
A	16.6	17	16.5
B	12.6	12.3	10.9

Source: District Information Technology Online Data Access for School Years 2005-2008

APPENDIX G: ENROLLMENT OF GIFTED STUDENTS BY YEAR

Enrollment of Gifted Students by Year

School	2005-2006	2006-2007	2007-2008
A	26	31	55
B	10	12	16

Source: District Information Technology Online Data Access for School Years 2005-2008

Percentage of Gifted Students by Year

School	2005-2006	2006-2007	2007-2008
A	2.4	3.2	5
B	0.9	1.2	1.8

Source: District Information Technology Online Data Access for School Years 2005-2008

APPENDIX H: UCF NOTICE OF EXEMPT REVIEW STATUS

University of Central Florida

Notice of Exempt Review Status

From: **UCF Institutional Review Board**
FWA00000351, Exp. 10/8/11, IRB00001138

To: **Anna Diaz**

Date: **June 15, 2009**

IRB Number: **SBE-09-06248**

Study Title: **THE RELATIONSHIP BETWEEN THINKING MAPS® AND FLORIDA COMPREHENSIVE ASSESSMENT TEST® READING AND MATHEMATICS SCORES IN TWO URBAN MIDDLE SCHOOLS**

Dear Researcher:

Your research protocol was reviewed by the IRB Chair on 6/15/2009. Per federal regulations, 45 CFR 46.101, your study has been determined to be **minimal risk for human subjects and exempt** from 45 CFR 46 federal regulations and further IRB review or renewal unless you later wish to add the use of identifiers or change the protocol procedures in a way that might increase risk to participants. Before making any changes to your study, call the IRB office to discuss the changes. **A change which incorporates the use of identifiers may mean the study is no longer exempt, thus requiring the submission of a new application to change the classification to expedited if the risk is still minimal.** Please submit the Termination/Final Report form when the study has been completed. All forms may be completed and submitted online at https://iris.research.ucf.edu.

The category for which exempt status has been determined for this protocol is as follows:

1. Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as:

(i) research on regular and special education instructional strategies, **or**
(ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

4. Research involving the collection or study of existing data, documents, records, pathological specimens or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. ("***Existing***" means already collected and/or stored before your study starts, not that collection will occur as part of routine care.)

All data, which may include signed consent form documents, must be retained in a locked file cabinet for a minimum of three years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained on a password-protected computer if electronic information is used. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

On behalf of Tracy Dietz, Ph.D., UCF IRB Chair, this letter is signed by:
Signature applied by Janice Turchin on 06/15/2009 02:10:00 PM EDT

Janice mTurchin

IRB Coordinator
University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901, 407-882-2012 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

APPENDIX I: LETTER TO SENIOR DIRECTOR OF ACCOUNTABILITY/RESEARCH AND ASSESSMENT

6529 Hidden Beach Circle
Orlando, FL 32819
January 19, 2009

Lee Baldwin
445 West Amelia Street
Orlando, FL 32801

Dear Dr. Baldwin:

I am a doctoral candidate in the Curriculum and Instruction program at the University of Central Florida. My dissertation is a study on Thinking Maps® and Two Middle School's Student Academic Achievement on the Reading and Mathematics Florida Comprehensive Assessment Test®. The purpose of this study is to determine what, if any, association exists between the implementation and use of Thinking Maps® and students' academic achievement in Reading and Mathematics as measured over time by the Florida Comprehensive Assessment Test® (FCAT). The association will be examined after three years of Thinking Maps® implementation and instruction at two OCPS Title I middle schools.

I would like your permission to access and utilize student data that will include FCAT scores for the 2005-2006, 2006-2007, and 2007-2008 school years, school and student demographic data along with attendance data.

I anticipate that the results of this study will result in valuable information that may be used by OCPS when making decisions on instruction and implementation of the Thinking Maps® program.

I will be contacting your office next week to discuss next steps. If you would like you may contact me at 407-406-0468.

Sincerely,

Anna D. Diaz

APPENDIX J: SCHOOL DISTRICT RESEARCH REQUEST FORM

Submit this form and a copy of your proposal to:
Accountability, Research, and Assessment
P.O. Box 271
Orlando, FL 32802-0271

Orange County Public Schools

RESEARCH REQUEST FORM

Your research proposal should include:
- Project Title
- Purpose and Research Problem
- Instruments
- Procedures and Proposed Data Analysis

Requester's Name: Anna D. Diaz — Date: March 18, 2009

Address: 6912 Hidden Beach Circle (Street), Orlando, Florida (City, State), 32819 (Zip) — Phone: 407-406-0468

Institutional Affiliation: University of Central Florida

Project Director or Advisor: Dr. Suzanne Martin — Phone: 407- 823- 4260

Address: College of Education, UCF, Orlando, Florida 32817

Degree Sought (check one): ☐ Associate ☒ Doctorate ☐ Bachelor's ☐ Not Applicable ☐ Master's ☐ Specialist

Project Title: THE RELATIONSHIP BETWEEN THINKING MAPS® AND FLORIDA COMPREHENSIVE ASSESSMENT TEST® READING AND MATHEMATICS SCORES IN TWO URBAN MIDDLE SCHOOLS

ESTIMATED INVOLVEMENT

PERSONNEL/CENTERS	NUMBER	AMOUNT OF TIME (DAYS, HOURS, ETC.)	SPECIFY/DESCRIBE GRADES, SCHOOLS, SPECIAL NEEDS, ETC.
Students			
Teachers			
Administrators			
Schools/Centers			
Others (specify)			Instructional Technology Department, Accountability, Research and Assessment Department

Specify possible benefits to students/school system: The results of this study will assist the urban school district with data that may be used to further evaluate the effectiveness of Thinking Maps® as a districtwide initiative. This study will add to the research on the instruction and implementation of Thinking Maps® at the middle school level.

ASSURANCE

Using the proposed procedures and instrument, I hereby agree to conduct research in accordance with the policies of the Orange County Public Schools. Deviations from the approved procedures shall be cleared through the Senior Director of Accountability, Research, and Assessment. Reports and materials shall be supplied as specified.

Requester's Signature: Anna D. Diaz

Approval Granted: ☒ Yes ☐ No — Date: 4-3-09

Signature of the Senior Director for Accountability, Research, and Assessment: Lee Baldwin

APPENDIX K: PERMISSION FROM THINKING MAPS® GENERAL MANAGER

From: Geoff Suddreth [mailto:geoff@thinkingmaps.com]
Sent: Monday, January 26, 2009 11:49 AM
To: Diaz, Anna D.
Cc: James Dean
Subject: RE: Dissertation and the Use of Thinking Maps
Ms. Diaz,

Thank you for forwarding the proposal to me. I have reviewed it and am very excited about the possibilities of your research. You are authorized to use the term "Thinking Maps®" and the eight "primitive graphics" for purposes of your study. Please include the following statement in your work: "Thinking Maps® is a registered trademark of Thinking Maps, Inc."

Thank you again and please let me know if you have any questions. We would love to hear about the results of your research and would be happy to see your work once it is completed.

Sincerely,

Geoff
Geoffrey P. Suddreth
General Manager
Thinking Maps,
Inc.

From: Diaz, Anna D. [mailto:anna.diaz@ocps.net]
Sent: Friday, January 23, 2009 3:32 PM
To: Geoff Suddreth
Cc: James Dean
Subject: Dissertation and the Use of Thinking Maps
Importance: High
Dear Mr. Suddreth,
I emailed you earlier in December with a draft proposal of my dissertation. I made several changes to it and I have met with my committee. They have given me the green light. Attach are draft copies of Chapter 1, 2 and 3. We are excited about the research since it is founded on Learning Theory. Can you please send me a letter via email giving me permission to use the term Thinking Maps® and the eight "primitive graphs" for this study? I need this as soon as possible so I may proceed.

APPENDIX L: RESEARCH QUESTION 1.3

Research Question 1.3

Crosstabulation Overall FCAT Reading Learning Gains (N = 300)

	Treatment (n = 144)		Control (n = 156)	
Grade	Freq. Gains	% w/Gains	Freq. Gains	% w/Gains
6th	91	63.2	106	67.9
7th	92	63.9	98	62.8
8th	92	63.9	91	58.3

APPENDIX M: RESEARCH QUESTION 1.4

Research Question 1.4

Crosstabulation for Overall FCAT Mathematics Learning Gains (N = 300)

	Treatment (n = 144)		Control (n = 156)	
Grade	Freq. Gains	% w/Gains	Freq. Gains	% w/Gains
6th	67	46.5	79	50.6
7th	114	79.2	130	83.3
8th	116	80.6	121	77.6

APPENDIX N: RESEARCH QUESTION 1.5

Research Question 1.5

Crosstabulation for White Student FCAT Reading Learning Gains (N = 33)

	Treatment (n = 25)		Control (n = 8)	
Grade	Freq. Gains	% w/Gains	Freq. Gains	% w/Gains
6th	17	68.0	5	62.5
7th	18	72.0	3	37.5
8th	18	72.0	6	75.0

Crosstabulation for Black Student FCAT Reading Learning Gains (N = 79)

	Treatment (n = 13)		Control (n = 66)	
Grade	Freq. Gains	% w/Gains	Freq. Gains	% w/Gains
6th	8	61.5	42	63.6
7th	9	69.2	40	60.6
8th	8	61.5	43	65.2

Research Question 1.5

Crosstabulation for Hispanic Student FCAT Reading Learning Gains (N = 173)

	Treatment (n = 99)		Control (n = 74)	
Grade	Freq. Gains	% w/Gains	Freq. Gains	% w/Gains
6th	63	63.6	52	70.3
7th	59	55.1	48	44.9
8th	62	62.6	37	50.0

Crosstabulation for Economically Disadvantaged Student FCAT Reading Learning Gains (N = 262)

	Treatment (n = 125)		Control (n = 137)	
Grade	Freq. Gains	% w/Gains	Freq. Gains	% w/Gains
6th	79	63.2	91	66.4
7th	79	63.2	86	62.8
8th	80	64.0	80	58.4

Research Question 1.5

Crosstabulation for English Language Learner FCAT Reading Learning Gains (N = 84)

	Treatment (n = 32)		Control (n = 52)	
Grade	Freq. Gains	% w/Gains	Freq. Gains	% w/Gains
6th	21	65.6	32	61.5
7th	19	59.4	31	59.6
8th	24	75.0	29	55.8

Crosstabulation for Students with Disabilities FCAT Reading Learning Gains (N = 25)

	Treatment (n = 14)		Control (n = 11)	
Grade	Freq. Gains	% w/Gains	Freq. Gains	% w/Gains
6th	9	64.3	6	54.5
7th	7	50.0	6	54.5
8th	8	57.1	7	63.6

APPENDIX O: RESEARCH QUESTION 1.6

Research Question 1.6

Crosstabulation for White Student FCAT Mathematics Learning Gains (N = 33)

	Treatment (n = 25)		Control (n = 8)	
Grade	Freq. Gains	% w/Gains	Freq. Gains	% w/Gains
6th	12	48.0	5	62.5
7th	23	92.0	8	100.0
8th	22	88.0	5	62.5

Crosstabulation for Black Student FCAT Mathematics Learning Gains (N = 79)

	Treatment (n = 13)		Control (n = 66)	
Grade	Freq. Gains	% w/Gains	Freq. Gains	% w/Gains
6th	5	38.5	27	40.9
7th	11	84.6	52	78.8
8th	11	84.6	51	77.3

Research Question 1.6

Crosstabulation for Hispanic Student FCAT Mathematics Learning Gains (N = 173)

	Treatment (n = 99)		Control (n = 74)	
Grade	Freq. Gains	% w/Gains	Freq. Gains	% w/Gains
6th	47	47.5	40	54.1
7th	74	74.7	62	83.8
8th	76	76.8	57	77.0

Crosstabulation for Economically Disadvantaged Student FCAT Mathematics Learning Gains (N = 262)

	Treatment (n = 125)		Control (n = 137)	
Grade	Freq. Gains	% w/Gains	Freq. Gains	% w/Gains
6th	56	44.8	70	51.1
7th	95	77.6	115	83.9
8th	100	80.0	107	78.1

Research Question 1.6

Crosstabulation for English Language Learner FCAT Mathematics Learning Gains (N = 84)

	Treatment (n = 32)		Control (n = 52)	
Grade	Freq. Gains	% w/Gains	Freq. Gains	% w/Gains
6th	9	28.1	23	44.2
7th	30	93.8	42	80.8
8th	24	75.0	41	78.8

Crosstabulation for Students with Disabilities FCAT Mathematics Learning Gains (N = 25)

	Treatment (n = 14)		Control (n = 11)	
Grade	Freq. Gains	% w/Gains	Freq. Gains	% w/Gains
6th	6	42.9	4	36.4
7th	13	92.9	9	81.8
8th	10	71.4	7	63.6

LIST OF REFERENCES

Alvermann, D. (1981). The compensatory effect of graphic organizers on descriptive texts. *Journal of Educational Research,* 75, 44-48.

Anderson, T.H., & Armbruster, B.B. (1982). Reader and text studying strategies. In W. Otto & S. White (Eds.) *Reading expository material.* New York: Academic Press. 235-239.

Ary, D., Jacobs, L. C. & Razavieh, A. 2002). *Introduction to research in education. Be*lmont, CA: Wadsworth/Thomson Learning.

Ausubel, D.P. (1960). The use of advance organizers in the learning and retention of meaningful learning. *Journal of Educational Psychology.* 51(5), 267-262.

Ausubel, D.P. (1963). *The psychology of verbal meaningful learning.* New York: Grune & Stratton, Inc.

Ausubel, D.P. (1968). *Educational psychology: A cognitive view.* New York: Holt, Rinehart & Winston.

Ausubel, D.P. (2000). *The acquisition and retention of knowledge: A cognitive view.* Dordrecht: Kluwer Academic Publishers.

Ausubel, D.P. (2008). David P. Ausubel, MD Ph. D. Retrieved December 15, 2008, from http://www.davidausubel.org.

Ball, M.K. (1999). *The effects of thinking maps on reading scores of traditional and nontraditional college students.* Unpublished doctoral dissertation, University of Southern Mississippi, Hattiesburg.

Bascones, J., & Novak, J.D. (1985). Alternative instructional systems and the development of problem-solving skills in physics. *European Journal of Scicence Education,* 7(3), 253-261.

Berkowitz, S.J., (1986). Effects of instruction in text organization on sixth-grade students' memory for expository reading. *Reading Research Quarterly,* 21, 161-178.

Bransford, J.D., Brown, A.L., & Cocking, R.R. (Eds.) (1999). *How people learn: Brain, mind, experience, and school.* Washington, D.C: National Academy Press. P.20.

Chang, K., Sung, Y., & Chen, I. (2002). The effect of concept mapping to enhance text comprehension and summarization. *The Journal of Experimental Education, 71*(1) 5-23.

Costa, A. L. (2008). Describing the habits of mind. In A.L. Costa & B. Kallick (Eds.), *Learning and leading with habits of mind.* Alexandria, VA: Association for Supervision and Curriculum Development.

Driscoll, M. P. (2005). *Psychology of learning for instruction*. Boston: Pearson.

Florida Department of Education, (2008). Florida Comprehensive Assessment Test®. Retrieved December 15, 2008, http://fcat.fldoe.org.

Florida Department of Education, (2009). Title I Programs. Retrieved December 15, 2008, http://www.fldoe.org/bsa/title1/parta.asp.

Florida Department of Education, (2009). Highly Qualified Teacher Status. Retrieved September 20, 2009, http://www.fldoe.org/eias/dataweb/database_0708/st170_1.pdf.

Guastello, E. F., Beasley, T.M., & Sinatra, R.C. (2000). Concept mapping effects on science content comprehension of low-achieving inner-city seventh graders. *Remedial and Special Education, 21*(6), 356-365.

Guri-Rosenblit, S. (1989). Effects of a tree diagram on students' comprehension of main ideas in an expository text with multiple themes. *Reading Research Quarterly,* 24, 236-247.

Hickie, K. (2006). An examination of student performance in reading/language and mathematics after two years of Thinking Maps® implementation in three Tennessee schools (Doctoral dissertation, East State Tennessee University, 2006). Retrieved December 15, 2008, from, http://www.thinkingfoundation.org/research/graduatestudies/pdf/HickieKstudy.pdf.

Hilbert, T.S., & Renkl, A. (2007). Concept mapping as a follow-up strategy to learning from texts: What characterizes good and poor mappers? *Instructional Science, 36,* 53-73.

Horton, P.B., McConney, A.A., Gallo, M., Woods, A.L., Senn, G.J., & Hamelin, D. (1993). An investigation of the effectiveness of concept mapping as an instructional tool. *Science Education*, 77, 95-111.

Horton, S.V., Lovitt, T.C., & Bergerud, D. (1990). The effectiveness of graphic organizers for three classifications of secondary students in content area classes. *Journal of Learning Disabilities, 23*(1), 12-29.

Hossein, N. (2007). Schema theory and knowledge-based processes in second-language reading comprehension: A need for alternative perspective. *Language Learning, 57,* 79-113.

Hyerle, D. (1993). Thinking maps as tools for multiple modes of understanding (Doctoral dissertation, University of California, Berkeley, 1993). *Dissertation Abstracts International*, 55/07, 1810.

Hyerle, D. (2000). *A field guide to using visual tools. A*lexandria, VA: Association for Supervision and Curriculum Development.

Hyerle, D. & Yeager, C. (2000). *Thinking maps® training of trainers guide resource manual* (Rev.ed.) Raleigh, NC: Innovative Services.

Hyerle, D. (2004). *Student successes with thinking maps®: School-based research, results, and models for achievement using visual tools.* Thousand Oaks, CA: Corwin Press.

Hyerle, D. & Yeager, C. (2007). *Thinking maps®: A language for learning.* Cary, NC: Thinking Maps, Inc.

Hyerle, D. (2009). *Visual tools for transforming information into knowledge.* Thousand Oaks, CA: Corwin Press.

Hyerle, D. (2010). *Design for thinking.* Retrieved February 23, 2010, from http://www.mapthemind.com.

Ivie, S. (1998). Ausubel's learning theory: An approach to teaching higher order thinking skills. *High School Journal*, *82*(1), 35. Retrieved December 15, 2008 from http://ezproxy.lib.ucf.edu/login?URL=http://search.ebscohost.com. ezproxy.lib.ucf.edu/login.aspx?direct=true&db=aph&AN=1572210&site=ehost-live.

Leary, S.F. (1999). The effect of Thinking Maps® instruction on the achievement of fourth- grade students (Doctoral dissertation, Virginia Polytechnic Institute and State University, 1999). *Dissertation Abstracts International*, 62/07, 2303.

Lomax, R.G. (2001). *An introduction to statistical concepts for education and behavioral sciences.* Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Marzano, R.J., Pickering, & D.J., Pollock, J.E. (2001). *A handbook for* c*lassroom instruction that works.* Alexandria, VA: Association for Supervision and Curriculum Development.

Mayer, R.E. (1979). Twenty years of research on advance organizers: Assimilation theory is still the best predictor of results. *Instructional Science, 8,* 133-167.

Mayer, R.E. & Wittrock, M.C. (2006). Problem solving. In M. Gregoire Gill (Ph. D.), *Analysis of learning theories in instruction.* Orlando: University of Central Florida.

Nesbit, J.C., & Adesope, O.O. (2006). Learning with concept and knowledge maps: A meta-analysis. *Review of Educational Research, 76,* 413-448.

Novak, J.D., & Musonda, D. (1991). A twelve –year longitudinal study of science concept learning. *American Educational Research Journal*, 28(1), 117-153.

Novak, A.D. (1994). The effects of cooperative learning with concept mapping in a preservice teacher education course. (Doctoral dissertation, Indiana University, 1994). AAT 9518517.

Novak, J.D. (2002). Meaningful learning: The essential factor for conceptual change in limited or inappropriate propositional hierarchies of learners. *Science Education, 86*, 548-571. Retrieved November 30, 2008 from http://www.interscience.wiley.com.

O'Donnell, A.M., Dansereau, D.F., & Hall, R.H. (2002). Knowledge maps as scaffolds for cognitive processing. *Educational Psychology Review*, 14, 71-86.

Orange County Public Schools, (2008). *Pocket Facts.* [Brochure]. Community Relations: Author.

Robinson, D.H., & Kiewra, K.A. (1995). Visual argument: Graphic organizers are superior to outlines improving learning from text. *Journal of Educational Psychology, 87*(3), 455-467.

School A. (2005). *School improvement plan.* Orlando, FL: Author

School A. (2006). *School improvement plan.* Orlando, FL: Author

School A. (2007). *School improvement plan.* Orlando, FL: Author

School B. (2005). *School improvement plan.* Orlando, FL: Author

School B. (2006). *School improvement plan.* Orlando, FL: Author

School B. (2007). *School improvement plan.* Orlando, FL: Author

Shiffrin, R.M., & Schneider, W. (1977). Controlled and automatic human information processing. II. Perceptual learning, automatic attending, and a general theory. *Psychological Review, 84*, 127-190.

Shneider, C. I. & Ohadi, M.M. (1998). Unraveling students's misconceptions about earth's shape and gravity. *Science Education 82* (2), 265-284.

Simmons, D.C., Griffin, C.C., & Kameenui, E.J. (1988). Effects of teacher-constructed pre- and post-graphic organizer instruction on sixth-grade science students' comprehension and recall. *Journal of Educational Research*, 82, 15-21.

Stull, A.T. & Mayer, R.E. (2007). Learning by doing versus learning by viewing: Three experimental comparisons of learner-generated versus author-provided graphic organizers. *Journal of Educational Psychology, 99*(4), 808-820.

Tasar. M. (2008). Editorial. *Eurasia Journal of Mathematics, Science & Technology Education,* 4(3), 195. Retrieved December 15, 2008, from http://www.ejmste.com/V4N3/Eurasia_4n3_editorial.pdf .

United States Department of Education. (2007). *No Child Left Behind Act*. Retrieved November 1, 2007, from http://www.ed.gov/nclb/overview/intro.

United States Department of Education (2009). Title I – Improving The Academic Achievement of The Disadvantaged. Retrieved September 20, 2009, from http://www.ed.gov/policy/elsec/leg/esea02/pg1.html.

Wallace, D.S., West, S.C., Ware, A.M., & Dansereau, D.F. (1998). The effect of knowledge maps that incorporate gestalt principles on learning. *Journal of Experimental Education,* 67, 5-16.

Winn, W. (1991). Learning from maps and diagrams. *Educational Psychology Review,* 3, 211-247.