CHAPTER II

REVIEW OF THE LITERATURE

Historical Overview

Learning Models

In order to place the brain-based research in perspective, it is necessary to develop the background and events that have contributed to our current knowledge of how the brain works. Interestingly, John Dewey is quoted in the literature as one of the first to be connected to the brain-based theory of learning. In the 1930s he pointed out that thinking can be done well or badly, and good thinking, like good manners, can be taught. Thinking takes place when beliefs are formed, when decision making occurs, and in solving problems. If good thinking can be taught, it can have far-reaching applications well beyond the classroom (Bucko, 1997). Many of Dewey's ideas, after a period of rejection and decline, have quietly found their way into our schools, contributing to today's educational model. Sylwester (1998) sees a parallel in how the brain-based research may come to prominence in future years after the intense scrutiny that usually surrounds new ideas has abated.

Before the landmark contributions of Dewey and others, the educational model that dominated our efforts to learn something was uncomplicated. If you wished to acquire a new skill or learn a trade the established path was to apprentice yourself to someone who knew more than you and learn from them. This model worked for anyone within the societal boundaries, rich or poor.

The Industrial Revolution made sweeping changes to this traditional path. A new model soon emerged with the notion that you could bring everyone together in a single place and offer a standardized curriculum. This paradigm was transferred from the workplace to schooling institutions in the 1800s and popularized throughout most of the 20th century (Jensen, 1998). This model, referred to as the "factory model," was a combination of influences from the fields of sociology, business, and religion. Emphasizing useful skills like obedience, orderliness, unity, and respect for authority, the model fit the times and enabled our country to prosper and grow into a world power and educational leader (Daggett, 1991).

We have followed this model with few variations because it served us well. During the 1950s and 1960s the model was altered by the influences of psychologists who developed the behaviorist theory to explain why humans behaved in the manner they observed. Their behaviorist theories lead to an infatuation with observing and measuring student behaviors, modifying those behaviors in students and either rewarding or punishing them (Jensen, 1998). At the time, these ideas seemed to make sense. Today, Kohn (1993) focuses on what he calls the damage to the educational system that the ideas the behaviorists have instilled within the teaching profession have created. Kohn maintains that rewards and punishments are not productive in assisting students in developing the appropriate attitude and mind-set to be receptive to learning. He asserts that students who work for rewards or to avoid punishments will not reach the level of self-awareness needed to instill a genuine desire to learn for the sake of learning.

<div align="center">Brain Models</div>

The brain itself has been the subject of centuries of study. Primitive models on the workings of the brain date back two-thousand years ago. The Greco-Roman model referred to the brain as a hydraulic system, while during the Renaissance it was likened to a fluid system. The advent of the Industrial Revolution ushered in an appropriate comparison, an enchanted loom. The early 1900s with the accompanying urbanization, saw the brain as a city's switchboard which led directly to the more recent comparison to a computer (Restak,1984).

Early brain theory during this century advocated the need for more right brain learning and educators developed programs to enhance that hemisphere's influence in students' activities (Jensen, 1998). Later, the triune brain theory emerged and gained much popularity, although based on a three-part evolutionary schema that ordered parts of the brain from low to high functioning (MacLean, 1990).

Jensen (1998) believes that history will record that a new paradigm began emerging in the final two decades of the 20th century. Just as the triune brain theory is now outdated, new ideas on how the brain works continue to unfold. Educators today are encouraged to embrace a whole-systems approach to understanding the brain. Jensen (1998) states:

> Technology paved the way for this paradigm shift: it changed the way we think, live, and learn. In the 1970s, 1980s, and 1990s phrases like "super learning" and "accelerated learning" became mainstream as the Information Age blossomed. "Brain scanners" like

Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET) gave us new ways to understand and see inside the brain. For the first time in history, we could analyze the brain while its owner was still alive. A new breed of "inner science" developed: neuroscience, which is an exciting interdisciplinary approach to questions about the brain. (p. 2)

This is where the tide of history has taken us. But before we can discuss the implications of neuroscience, other important factors and influences which impact our understanding of learning must be explored.

Frameworks for Learning

Other models and frameworks for learning were concurrent in time with the behaviorists' ideology. One of the fundamental frameworks for teachers to teach thinking skills in the classroom is Bloom's (1956) Taxonomy of Educational Objectives. Educators at all levels use this well-organized structure for the teaching of thinking. Since it was published in 1956, the basis for the work is not grounded in the current brain research. Recent studies have questioned this notable effort and point out that the last few decades of research on cognitive processes have not borne out such clear cut definitive boundaries in the learning process (Hart, 1986).

Others began to align themselves with the thinking skills movement in the 1980s and many traveled around the educational circuit expounding on their own particular brand of methodologies and strategies for increasing performance of students. Among those who rose to the top of the theorist guru status were Perkins (1986), Costa (1985), and Adler (1986).

Perkins (1986) concentrated on improving intelligence through teaching good thinking skills. He defined intelligence as the combination of power (natural ability), tactics (thinking strategy) and content combining to create an enlightened person. His analysis led to the idea that good thinking was not to be found in abundance in the student population, therefore students must be taught these skills in a variety of ways. Perkins described thinking frames or tactics/strategies that enhanced intelligence and prescribed methods for teachers to extract the full potential from students.

The culmination of the thinking strategy approach was a book published by the Association for Supervision and Curriculum Development in 1985 called Developing Minds.

Edited by Arthur Costa, the book presented useful ways to enhance thinking in such content areas as writing, reading, science, and math. Hundreds of other books, articles, and pamphlets added to the vast array of materials designed to teach thinking. But all of this activity transpired without any clear idea of how the mind actually received, processed, or produced information (Bucko, 1997).

Today, one does not hear the term thinking skills used in educational forums as it was during the apex of the movement. But in the 1980s, a few educators were presenting an alternative view about teaching thinking. One of this group, Adler (1986), supported a content-based instructional approach that involved reading, writing, measuring, testing, and trying to draw conclusions. He claimed that when practical thinking applications were applied to content instruction, meaningful thinking instruction occurred. Adler's ideas helped to lay the groundwork for the modern constructivist theory of educational practice. Constructivism is supported by cognitive research that tells us that making connections within the brain is the key to embedding information in the long-term memory and the ability to apply classroom learning in other contexts (Smilkstein, 1991).

Another immense influence that has assisted in the formation of conceptual frameworks for learning has been the contribution of Howard Gardner (1983) and his work with multiple intelligences (MI). Gardner documented the concept that the brain possesses many forms of intelligence in his landmark work. Most educators are familiar with this theory that describes how more than one type of knowing the world combine to define intelligence. Gardner's research has played a leading role in raising the consciousness of educators toward the importance of learning more about the brain. At present, Gardner has identified at least eight and possibly nine different types of intelligence. In a speech delivered at the annual conference of the Association for Supervision and Curriculum Development in March of 1997 he enumerated the list to include mathematical, musical, kinesthetic, linguistic, spatial, interpersonal, intra personal, naturalist, and perhaps existentialist intelligence.

Gardner based his theory on brain research, previous developmental work with young children, experiments with animals, psychological testing, cross-cultural studies and the works of Dewey, Bruner, Piaget, and Eisner (Reiff, 1997). A number of educators have incorporated

Gardner's work on multiple intelligences into practices within the classroom (Caine & Caine, 1994). These educators believe that each student possesses at least some potential in each of the eight or nine intelligences. In applying multiple intelligences, teachers can actively involve students in learning experiences, help develop particular intelligences those individual students may lack, and design culturally responsive approaches to reach students who have trouble learning in the school setting. Indeed, brain-compatible learning strategies and teaching to the multiple intelligences may be the most effective way to reach at-risk learners (Reiff, 1997).

Gardner's theory of multiple intelligences is not the first or only model that deals with intelligence or learning styles. Armstrong (1994) relates that there have been theories of intelligence since ancient times, when the mind was considered to reside somewhere in the heart, the liver, or the kidneys. He points out that other authors have identified an array of from one (Spearman's "g") to 150 (Guilford's Structure of the Intellect) types of intelligences. However, Armstrong asserts that Gardner's model is a true cognitive model, whereas seemingly related theories such as the sensory-based Visual-Auditory-Kinesthetic and personality-based Myers-Briggs can not be correlated with the theory of multiple intelligences because they are predicated on a different structural basis.

Recent Brain Literature

One of the basic realizations about the nature of learning comes from the unofficial name for the times in which we live. The Information Age is an apt phrase for the current epoch in which we strive to understand the world around us. In a recent talk, Dr. Pat Wolfe remarked that the amount of information available is doubling every six months. She predicts that at the current rate, it will soon elevate to double every 72 hours (Boyd, 1998). One area where such an astounding rate of new information is generated at this phenomenal pace is the field of brain research or brain-compatible learning.

Since the early 1980s, there have been a number of books on the bestseller lists that have used findings concerning the brain as fascinating subject matter for millions of readers. Some detail case studies of behavioral abnormalities caused by neurological damage to the brain. Many others are more mainstream and gravitate to the educational applications from the boom in cognitive science (Bucko, 1997). The recent technological revolution has enabled scientists to

study the cerebral cortex in a manner and depth never before imagined. New discoveries are surfacing every day. Researchers are locating areas of the brain that perform specific functions and speculation is that learning how these areas actually work is not far behind (Sylwester, 1995).

We are learning about the brain at an unprecedented rate. Some researchers claim that anything you learned two years ago is already old information as the field of neuroscience is exploding (Kotulak, 1996). Because we have access to so many new and advanced technologies, scientists studying the brain are on the threshold of many exciting discoveries. Jensen (1998) offers three examples of how medical science has advanced through recent developments in neuroscience. Schizophrenia and Tourette's syndrome can be treated with medication. The causes of Parkinson's and Alzheimer's diseases are close to being revealed. A memory pill, Nimodipine, helps students better recall what they read. Sylwester (1997a) adds that we now know that the biological basis of impulsive and violent classroom behavior has its origins in the amount of the neurotransmitter serotonin present in the brain. All of these discoveries have resulted from our increased ability to study the brain's functions through technological and chemical advances. Before the Decade of the Brain ends, the 1990s may be remembered as the emergence of the chemical learner (Jensen, 1998).

Some researchers have used this new information along with previous research to formulate new theories. Sternberg's Triarchic Brain Theory of Intelligence is one such composite theory that has emerged from the explosion of brain compatible research. His work centers on three elements, creative intelligence, analytic intelligence, and practical intelligence. He believes that successful intelligence is the most effective when it balances all three of its creative, analytical, and practical aspects (Sternberg, 1996).

A new area of research that is gaining much attention is what Goleman (1995) refers to as Emotional Intelligence or EQ. This rapidly expanding field of study is a direct outgrowth of the new ways the brain can be studied and probed for sites that control functioning of our emotions. Studies on the brain have located the area where emotions are harbored, an almond sized structure called the amygdala, which controls the emission of the chemicals that regulate how we react to certain stimuli. Goleman believes that one's emotional intelligence may be more of a measure of success than one's IQ. This is another example of how the recent findings in brain

research are creating the need to re-examine how we perceive traditional views about how we learn and behave (Gibbs, 1995).

<div align="center">Unified Brain Theory</div>

Sylwester (1997a) of the University of Oregon says that without an emotional connection, no learning can take place. Reworking the studies of previous researchers he presents evidence that our brains function as a whole system, with all the parts working in unison, to complete the equation we know as intelligence. Sylwester is very interested in formulating a new theory, one that will bring together all aspects of what we know about the brain research and truly revolutionize how we conduct our pedagogy in the public schools.

The emergence of a Unified Brain Theory is still a few years away, and probably not until the next century. But the importance of such a theory will be the driving force that sparks the revolution in brain science analogous to the revolution in the physical sciences sparked by Albert Einstein's relativity theories. To translate the current biological theory into an educational theory will require the vision and foresight of an individual of the caliber of a John Dewey, a Jean Piaget, or a new B.F. Skinner. The theorist who develops this comprehensive theory will join the ranks of history's great scientists (Sylwester, 1997b).

While we await this leader's emergence, others in the field are advocating that educators take steps now to pave the way for cognitive science to explore ways to incorporate this new paradigm in the classroom. They see teachers and administrators conducting action research within their own educational universe to reap the benefits of the explosion of brain-compatible learning (Jensen, 1998). Comparing the development of this new research to current technology, they point out that brain-compatible learning is dynamic. The information changes daily like the influx of information in the technology industry. Waiting for all the knowledge to be assimilated is like waiting to buy the most up-to-date computer. There will always be updates (Jensen, 1998).

Change in education is notoriously slow. While we do need to exercise caution in jumping on the brain-compatible bandwagon and trying to apply every bit of research that is published before it proves to be sound, we need to be aware of how much evidence supports the power of understanding cognitive psychology. We are on the eve of a learning revolution that has the potential to change our schools for the better (Bucko, 1997).

<center>Graphic Organizers</center>

<center><u>History of Graphic Organizers</u></center>

One instructional strategy that bridges the gap between the brain-based research and the classroom is the graphic organizer. Graphic organizers are closely aligned with schema theory, one way to explain how the brain thinks (Monroe & Pendergrass, 1997). According to schema theory, when the brain encounters new information it either fits the new information into existing patterns of thinking or modifies its existing structures in order to make sense of the new information. A graphic organizer is a visual representation of how the brain organizes this information (Moore & Readence, 1984).

Many of the sources in the literature agree that the graphic organizer has its roots in Ausubel's (1967) advance organizer (AO). As a cognitive psychologist, Ausubel developed the advance organizer as an attempt to translate his cognitive theory of meaningful reception learning into practice. The advance organizer was an introductory prose passage that the student read prior to reading a longer passage containing new material. It was designed to include content important to the structure of the passage. His rationale for the use of AOs was to assist students in learning new material by providing a framework to link previous knowledge to the material to be learned. Ausubel claimed:

> One of the strategies that can be employed for deliberately enhancing the positive effects of cognitive structure variables generally in meaningful reception learning, and hence for promoting integrative reconciliation, involves the use of appropriately relevant introductory materials or organizers which, in their own right, are maximally clear and stable. These organizers are introduced in advance of the learning material itself, and are also presented at a higher level of abstraction, generality, and inclusiveness; and since the substantive content of a given organizer or series of organizers is selected on the basis of its appropriateness for explaining and integrating the material it precedes, this strategy satisfies the substantive as well as the programming criteria for enhancing the positive transfer value of existing cognitive structure on new meaningful reception learning (p.26)

Ausubel based a good deal of his theory on four studies he and his colleagues conducted over a period of years. McEneany (1990) conducted a review of the four studies to demonstrate what he considered serious flaws in the research. While some studies which had been conducted in the intervening years had indicated minimal support for Ausubel's theory, McEneany found that a meta-analysis of 135 studies on AOs only had a small facilitative effect. With this many studies, a number of inconsistencies can occur in the definition and construction of advance organizers. McEneany critiqued Ausubel's four original studies and concluded (1) there was no consistent evidence across the four studies in support of the efficacy of advance organizers, (2) the theoretical construct of how the advance organizer operates was not supported and (3) Ausubel himself could not construct an advance organizer that met all of his specifications. More research on Ausubel's theory and advance organizers will be necessary to resolve the questions raised in this review.

Since the AO is in the format of written prose, researchers called attention to the fact that students had difficulty in drawing inferences from so much written material. Robinson (1998) gives an account in his review of how other educators proposed that a graphic display of words showing a hierarchical organization of important concepts would improve students' understanding more than a written paragraph. The "structured overview" (SO) was derived from this idea. It differed from the AO in its ability to illustrate relations among key concepts found in the text. The SO was used to represent the key vocabulary of a learning task.

At this time the debate in the research centered on the placement of the organizer to maximize the students' learning potential. Moore and Readence (1984) conducted an exhaustive meta-analysis in order to review the research on all types of graphic organizers. They addressed the placement of the organizer in their work and explained how the literature found that the structured overview (overview denotes a pre-activity) had experienced little success in the pre-reading position and thus the term was changed to "graphic organizer" or GO. Indeed, they found that GOs enjoyed their greatest success as post reading activities.

Moore and Readence's qualitative review revealed three themes that an earlier quantitative review process had passed over. They identified the role of the teacher in the process and described how classroom teachers who engaged students in GOs tended to feel more

confident and competent while leading students through the content. Second, they saw GOs changing from a means to link prior learning to new material (Ausubel's original format) to the GO becoming a learning strategy to facilitate comprehension. And third, in studies that reported statistically non-significant findings, students viewed GOs as an isolated learning activity that did not fit the ongoing instructional program. We will revisit these themes in conjunction with the section on Thinking Maps® .

<center>Graphic Organizer Studies</center>

A number of studies illustrate how research has been conducted in the area of graphic organizers in the last few years. The first study described in this review was a collaborative effort by Wiegmann, Dansereau, McCagg, Rewey and Pitre (1992). Their study focused on how to construct graphic displays to make them more effective for students. Acknowledging that under certain conditions, visual maps can be a more performance-effective alternative than traditional text, they set up an experiment to examine the effects of variations in map configuration on the performance of students with different spatial and verbal abilities. Their premise was that students would perform better using maps that were configured in a manner congruent with the processing priorities of the perception system (e.g., configurations that use gestalt organizational principles of symmetry, proximity, and good continuation).

They chose 37 students from a university as the sample for the study. These students were presented with two map configurations, one which adhered to the gestalt principles of organization and one which was just a web without symmetry. Two memory tests were used in order to assess students' memories of the information presented, one a fill-in-the-blank and the other a multiple-choice measure. In addition, two commercially produced tests used to measure individual differences in spatial and verbal ability were used to correlate the students results with the memory tests on the material. The Group Embedded Figures Test (GEFT) and the Delta Reading Vocabulary (Delta) are two reliable and commonly used tests of spatial and verbal ability.

The means and standard deviations of the findings are depicted in Table 1. Pearson product-moment correlations were computed to examine the relationship between scores on the two individual measures and the scores on the two memory tests. The results of the analyses revealed that scores on the GEFT and the Delta correlated positively and consistently with

performance of students across both map groups (correlations ranged from r=.24 to r=.32). The alpha levels on all significant effects reported in this study are .05.

Table 1.

Means and Standard Deviations for Percentage Correct on Tests As A Function of Map Group.

Map Group	Fill-in-the-blank	Multiple-choice
Gestalt map (n=20)		
M	73.56	80.30
SD	19.61	19.48
Web map (n=17)		
M	54.12	66.27
SD	18.28	17.41

In order to determine the reliability of the observations from Table 1, a multi-variate analysis of covariance (MANCOVA) was performed on the memory test scores. Map group (gestalt vs web) was the between group factor. GEFT and Delta scores were used as the covariate. The results of the analysis revealed a significant multi-variate effect for the map group,[$F(2,32) = 5.48$, p< .05]. Uni-variate post hoc tests indicated that students in the gestalt-map group reliably outperformed students in the web-map group on both the fill-in-the-blank, [F $(1,33) = 11.25$, p < .05, $w^2 = .23$] and the multiple-choice tests, [F $(1,33) = 5.76$, p < .05, $w^2 = .11$]. (w^2 is the strength of association measure)

Wiegmann and his colleagues have postulated from these results that a map configured using gestalt organizational principles is congruent with certain processing priorities of the reader's spatial/perceptual systems. They further speculate that the congruency may have facilitated the acquisition of the test information by providing an organizational scaffold and by allowing students to navigate more effectively through the display. Finally, they report that since the effect magnitude revealed that map configuration had a greater impact on students' fill-in-the-blank test performance ($w^2 = .23$) than on their multiple-choice test performance ($w^2 = .11$), the gestalt map may have enhanced retrieval as well as encoding. This result may have profound implications for Thinking Map application. Since Thinking Maps® were designed to access specific brain thought processing functions, such research may collaborate the creators' claims.

A second study that directly relates to the research on Thinking Maps® was conducted by

Griffin, Malone and Kameenui (1995). Briefly, they sought to answer two questions from the literature on graphic organizers that they believed needed more investigation. The areas of concern involved the teachers' role in the instructional process and program efficacy. The two questions were :

> (1) To what degree is explicit instruction necessary for independent generation and use of graphic organizers by students?

> (2) Does graphic organizer instruction facilitate comprehension, recall, and transfer of information contained in a expository textbook?

This study tried to answer these questions through a research design that involved using five intact classrooms of fifth-grade students from homogeneously grouped classes (n = 99) divided into five treatment categories. One class served as the control receiving the traditional basal instruction while the others received either explicit instruction with GOs or explicit instruction without GOs or implicit instruction with GOs or implicit instruction without GOs. The rationale for employing this design was to assist the researchers in trying to determine what effects on classroom instruction made a difference in student performance. Video taping of the experiment was conducted to ensure comparability of the teaching presentations given by the investigators.

Additionally, over the course of this ten day long study, the students were administered a series of measures (i.e., immediate and delayed post tests, immediate and delayed recall measures, and a transfer test) to assess their comprehension, retention, and transfer of the social studies content taught to all students. A technique called Johnson's pausal unit analysis procedure was employed to determine the structurally most important units (SMIUs) from the material to be covered. This consisted of having 141 undergraduate students enrolled in education courses to parse the experimental passages into individual units and determine the salient points of the experimental passages.

Statistical analysis consisted of a one-way, between groups multi variate analysis of variance (MANOVA) to evaluate the effects of the treatment conditions on study participants' immediate and delayed comprehension, recall, and transfer of social studies content. The effect of treatment on the combined comprehension, recall, and the transfer variables was statistically

significant, $[F(20, 372) = 3.366, p < .001]$.

The bottom line concerning this study is that the researchers concluded from the results that without explicit instruction in a procedure such as graphic organizer instruction, students may not perform any better than expected from traditional methods. While a few problems surfaced in the design of this study, such as the traditional group doing better than expected, the consensus that emerged was that an instructional strategy that is explicitly taught will improve student performance. The design flaw in this study occurred when extra study time was allotted to the control group to compensate for the time used to instruct the other groups in the use of the graphic organizer. This may have accounted for their unexpected performance.

Interestingly, a similar study conducted by Simmons, Griffin, and Kameenui (1988), with sixth-grade subjects studying science earlier had found no significant differences among the groups. In that study too, the traditionally instructed group outperformed the groups receiving graphic organizer instruction.

How Graphic Organizers Affect Race, Gender and Previous Achievement

While many studies involving graphic organizers have been done since Barron and Stone conducted the first study on graphic organizers in 1974, relatively few have contributed information on the three independent variables addressed in this investigation. Griffin and Tulbert (1995) report that over 45 studies have been conducted during this twenty-year span, with many providing contradictory results and recommendations. Reviewing the studies, they point out that there is no constant in graphic organizer research. For example, studies of graphic organizers that are teacher made are not separated from studies of graphic organizers that are student constructed in the meta-analysis research that has attempted to determine facilitative effects. Thus, due to a lack of consistency in study design, the effect sizes obtained in the meta-analysis can be misleading

Griffin and Tulbert propose that graphic organizer research should be conducted in studies where a similar set of visual features and teaching procedures are employed, with the presence of a control group, to increase the likelihood of complementary rather than contradictory study results. Further, they maintain that the independent variables studied should be limited. A study of Thinking Maps® , a graphic organizer program with set parameters, with limited

independent variables, provides the opportunity to examine graphic organizer usage in the context prescribed by Griffin and Tulbert.

Studies involving graphic organizers that report the affect of race or ethnic composition in using visual tools have not been reported in the literature. The researcher included race as a variable because little is known about the effects of graphic organizer usage in the classroom on student achievement among the races. Thinking Maps® are used by teachers in the classroom with all students. The researcher is interested in discovering how the program affects every student the teacher may encounter in a real classroom, in regard to improving achievement.

In reviewing the literature on achievement and race, the researcher focused on those studies that were central to how graphic organizers impacted upon students. Tate (1997) reviewed mathematics achievement among the races and reported that the achievement gap between whites and Afro-Americans has not narrowed appreciably. He cites as the reason for the discrepancy in mathematics achievement scores between the two groups a deficiency in language proficiency of Afro-Americans. Graphic organizers have been demonstrated to assist students of lower ability in a number of studies (Alvermann, 1981a; Dickens, 1988; Bernard, 1990; Lehman, 1992; Herbst, 1995). Regardless of the students's race, lower ability students are characterized by poor reading achievement. Following this line of reasoning, graphic organizers may have a positive effect in improving lower ability Afro-Americans' achievement scores in reading, mathematics, and language. Any other effects observed from the study with regard to achievement and race will be reported.

No studies reviewed in the literature are able to pronounce that graphic organizers are more suited to males or females as an instructional advantage. Foxworthy (1995) studied 87 fourth and sixth grade students in two elementary schools. Her study design incorporated a pretest and posttest constructed to assess the effects of the modified graphic organizers on the knowledge acquisition of key science concepts and science skills. Gender was included in the independent variables she addressed. Using an ANOVA to compare the interaction between the treatment (graphic organizers) and gender, she found no significant differences for gender.

Stone (1983) analyzed 112 investigations of the graphic advanced organizer, with Glass's meta-analysis technique, and compared the results with predictions from Ausubel's model

of assimilative learning. While he found that overall, advance organizers were shown to be associated with improved learning and retention of the material to be learned, the resulting effect size attained for gender in this study was not reliable. He stated that the number of effect sizes available were too small for any inference to be made.

Manning's (1998) research on the achievement differences between the genders reveals that at least in one subject area, "as girls and boys progress through the mathematics curriculum, they show little difference in ability, effort or interest until the adolescent years"(p. 168). Hancock, Stock, and Kulhavy (1996) used a 40-item study behavior questionnaire with 793 elementary students to determine how males and females in the fourth and sixth grades differed in study strategies. They found that both fourth-grade boys and girls emphasize overt study activities, but girls are more occupied with text, their thinking appears to be deeper, and their study behavior more deliberate. In sixth-grade, however, the girls are attuned to conscious, planful review for tests, whereas the boys are more concerned with independent study behaviors and deep processing of oral classroom interaction. These researchers believe that these gender differences in study strategies account for gender differences in academic achievement identified in various research studies.

More studies have reported results in regard to the ability of the learner and the impact of graphic organizers than the other two independent variables combined. However, the findings of the studies are not consistent across the research base. Researchers have reported that graphic organizers assist high ability students more than those of lower ability (Boothby & Alvermann, 1984; Bernard, 1990; Foxworthy, 1995; Luiten, Wilbur, & Ackerson, 1980). Luiten, et al., conducted a meta-analysis of 135 studies to determine the facilitative effect of advance organizers on learning and retention. While they assumed that graphic organizers would be most effective with individuals of low ability, the data they collected indicated the opposite held true. In fact, according to their findings, participants defined as high ability have an average effect size of almost twice that of low-ability participants. Although the researchers cautioned against relying on their results because of problems in the consistency of the studies examined in regard to the operational definition of high, middle, and low ability, they recommended that graphic organizers be used in conjunction with high ability students.

Boothby and Alvermann (1984) studied children in two fourth-grade classrooms (N=38) over a three month period to test the effectiveness of the graphic organizer strategy for facilitating comprehension and retention of information in a social studies text. When the students in the treatment and control groups were given the posttest, students in the graphic organizer group (treatment) recalled significantly more of the total number of idea units (used to score recall) than the students in the control group. The researchers postulated that their findings validated the meta-analysis results of Moore and Readence (1984); graphic organizers benefit high ability students. They reached this conclusion based on the fact that the fourth graders involved in the study were all of average or above average in their verbal ability.

Foxworthy (1995) also indicated in her conclusions regarding her study of fourth and sixth graders that low ability students (in this case students in federally funded programs) scored significantly lower on the adjusted posttest in both grades. The sample involved students in federally funded programs (Title I) whose poor performance in basic reading contributed to their performance. The researcher recommended that visual testing be conducted in the posttest phase of future experiments to reduce this study limitation.

Three studies reviewed by the researcher found that both groups, low and high ability students, benefitted from graphic organizer usage. Alvermann (1981b) tested tenth-grade students on immediate and delayed recall measures and found that all students, regardless of reading level (a measure of ability) improved in achievement from the use of graphic organizers. Likewise, Lafeur (1992), working with older students at a community college, revealed in a study to improve thinking through using graphic organizers, that no significant differences existed between students of low ability and high ability on the cognitive measure employed to test the hypotheses. However, this study, employing a four group Solomon design, was conducted on a sample total of 29 students.

Stone (1983) using the meta-analysis technique, found that graphic organizers assisted the middle ability group the most. He remarked that Ausubel's predictions were not confirmed by the results he obtained. Ausubel (1967) had predicted in his model that students having low ability or low prior knowledge of the material to be learned should be helped more by graphic organizers than other students.

Five studies reviewed by the researcher found that graphic organizers facilitate the learning of low ability students better than high ability students (Alvermann, 1981a; Dickens, 1988; Lehman, 1992; Griffin & Tulbert, 1995; Herbst, 1995). Alvermann studied "lookback behaviors" (p. 326) in sixty-four tenth graders. When a student looked back in the text to find an answer, this action was labeled as lookback behavior. She found that lookback behavior, induced by using a graphic organizer as a road map, differentiated between students who perceived themselves as low-ability comprehenders but not between students who perceived themselves as high-ability comprehenders. This result confirmed her hypothesis that an achievement-treatment interaction would be found between the treatment and the low ability group.

Herbst (1995) investigated 427 ninth graders in her study involving graphic organizer usage in social studies. She concurred with earlier researchers that graphic organizers provided frames for the low ability students to learn material in a clear, logical format.   Lehman (1992) adds that graphic organizers allow students to relate information to personal experience, assisting in the need to provide structure and organization for the low ability student.

While both Lehman and Herbst found that students of low ability can benefit from using graphic organizers, Griffin and Tulbert (1995),who conducted a recent review of the literature on graphic organizers, recommend that further examination of the use of graphic organizers with populations of poor readers is needed, given the conflicting results of studies in which reading ability was a variable of interest.

<u>Themes in Graphic Organizer Research</u>

Three themes have evolved from graphic organizer research; teacher preparation, graphic organizer dynamics, and the instructional context of graphic organizer interventions (Moore & Readence, 1984).   These three themes represent the dominant explanations in the literature for how the graphic organizer works.

The first theme Moore and Readence identified, teacher preparation, revealed that teachers who engaged students in graphic organizers reported that they felt more competent and confident with the content while using this instructional strategy. They perceived themselves as better organized, more in control of the learning activity, and more sensitive to the learner's needs in understanding the learning task.

The second theme, graphic organizer dynamics, focuses on the student learner. Explanations from the research which center on how the student learns through graphic organizer instruction include such strategies as creating an effort at comprehension, processing information at different levels, and rehearsing information.

The third theme relates to the instructional context in which the graphic organizer was used. Moore and Readence recount that in graphic organizer research reporting statistically non-significant findings, students viewed graphic organizers as an isolated learning activity not connected to the material to be learned.

From this overview of the research, it is apparent that some areas of further study in the realm of graphic organizers is needed. But before discussing that topic, a quick introduction to Thinking Maps® is in order.

<div align="center">Thinking Maps®</div>

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

The idea of creating a program of Thinking Maps® was first incubated by David Hyerle when he was teaching in an inner-city middle school in Oakland, California in the 1980s. His experiences and frustrations in helping his students make connections to the content resulted in his reliance on strategies such as visual mapping to gain an understanding of how they were processing ideas. When his school piloted a thinking skills program that included diagrams based on several thinking processes, he wondered "What would happen if teachers and students had basic maps for applying different, fundamental thinking processes?" (Hyerle, 1996b, p. 2). He began to formulate the series of graphic organizers that became the basis for Thinking Maps®.

Since that time he has helped to package the program now copyrighted and being sold to schools around the country. As part of the introduction teachers receive during the Thinking Maps® training, extensive brain-based research is made an integral part of the foundation for the program (Implementation and Assessment Guide, 1997).   Each map is connected to one thought process, that is, each map is used to depict how the brain thinks about a concept. Figures 2-9 are the eight Thinking Maps® as developed by Hyerle (Hyerle, 1996a).

<div align="center">Thinking Maps® as Graphic Organizers</div>

From the review of the research on graphic organizers a number of issues of interest

regarding Thinking Maps® can be developed. Griffin and Tulbert (1995) in their review found only one study that addressed the conditions under which graphic organizers are effective for learning from expository passages. This line of research, examining the conditions where GOs are effective, applies to the problem of implementing Thinking Maps® . What are the optimal conditions to introduce instructional strategies such as Thinking Maps® ? How should the training of teachers be conducted to ensure the best practice? Moore and Readence (1984) call for more studies that concentrate on the length of teacher training and the instructional focus as variables.

Another area where the researchers are questioning the use of graphic organizers is described by Dunston (1992) in her critical review of GOs. She points out that educators no longer question if they work, but want to know how and why they work. Here the path crosses the brain-based research in its quest for understanding of how the brain makes sense of these strategies. Dunston further reports that some studies show that elementary students benefit from GOs more than secondary students in comprehension and free recall. How can these results be explained? Many of the reviewers (Moore & Readence, 1984; Robinson, 1998) found discrepancies in the studies that were difficult to decipher.

The result of these discrepancies have kept the meta-analysis effect size minimal (Glass, 1981). The small differences between effect sizes in the levels of testing in posttest conditions indicate that GOs equally affect short and long-term learning. This implies that GOs may not be particularly effective as a strategy in affecting long-term memory. Robinson and Schraw (1994) found there does seem to be a paradox in using graphic organizers to embed information in the long-term memory. They observed that the advantages of a GO disappear when testing is delayed. Speculation is that because the student can communicate information so effectively that he does not have to "untangle" (p. 400) the necessary information, it is never encoded in the long-term memory process. Graphic organizers were intended to organize information for understanding. Should they be viewed through so broad a spectrum as to demand that they improve student performance?

To conclude, the final area for investigative research fits like a glove with the study of Thinking Maps®. Robinson (1998) in his review quotes Tukey who presents an incredible

challenge for researchers to construct GOs in a manner that takes full advantage of the power of visual argument. Visual argument involves transmitting ideas through a spatial arrangement of words rather than through written language. By seeing ideas, students are relieved of the burden of untangling complex relations from the linear structure of text. We would know when we have accomplished this because it would be impossible for students to view them without discovering knowledge of concept relations. The discovery of this knowledge should make an immediate and powerful impact on the students.

<div style="text-align:center">Summary of the Literature Review</div>

Brain-based research has emerged as a new frontier in education. Medical science is unlocking the secrets of how the brain functions. Educators are exploring this new information and searching for innovative ways to implement the findings within the classroom. One instructional strategy that is linked to the revelations about how the brain learns is the graphic organizer. Studies on the various types of graphic organizers have been conducted and reported in the literature for thirty years, beginning with Ausubel. While numerous studies have documented that graphic organizers can improve students' abilities in a variety of areas from comprehending vocabulary to remembering text passages, and meta-analyses have reported facilitative effects for graphic organizer use, few studies have focused on how they improve achievement.

This study examined the Thinking Maps® program, a series of graphic organizers that the authors claim will increase student achievement. Administrators, charged with finding ways to increase student achievement in light of the standards movement, need programs that will impact positively on student performance. Thinking Maps® are promoted as a toolkit for students to improve the basics of reading, writing, and mathematics as well as for problem-solving and the development of higher-order thinking abilities (Hyerle, 1996a). This study will add information to the research knowledge base on the use of graphic organizers.

AOs

Schema Theory

GOs

Visual Argument

MI Theory

Thinking Skills

EQ

Conceptual Maps

Visual Tools

Mind Mapping

Brain-based Research

Thinking Maps® Conceptual Model

Thinking Maps®