The Theoretical and Empirical Basis for Graphic Organizer Instruction

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For over three decades, researchers have examined the effectiveness of graphic organizers for aiding the comprehension of students in content classrooms. The purpose of this study is to evaluate the effects of the type and specificity of embedded graphic organizer prompts on the achievement of relational knowledge of typical students and students with learning disabilities and how these embedded graphic organizer prompts influence the memory processing strategies used by teachers during instruction.

This review of literature will include an overview of information relating to the use of graphic organizers in content classrooms. Attention is focused on the learning theories that support the use of graphic organizers, a review of studies determining the effectiveness of graphic organizers, and studies relating to teacher implementation of graphic organizers. Also included is an overview of studies relating to the effectiveness of cognitive and metacognitive prompting during instruction as well as cognitive processing as it relates to student memory and classroom instruction.

The review will also include literature relating to the dependent variables of the study. The review will include studies relating to the validity and reliability of utilizing concept mapping procedures and content essays as a measure of student achievement and relational knowledge.

Cognitive Theories Relating to Graphic Organizers

Knowledge gained about how the brain processes information has been instrumental in the development of teaching techniques and learning strategies. Several cognitive theories in particular lend support to the use of graphic organizers in helping students process and retain information. Schema theory, dual coding theory, and cognitive load theory provide the basis for explaining the characteristics of graphic organizers that support the learning process.

Schema Theory

According to schema theory, memory is composed of a network of schemas. A schema is a knowledge structure that accompanies or facilitates a mental process. According to Winn and Snider (1996), all of the definitions of schema theory contain the following characteristics:

1. A schema is an organized structure that exists in memory and combined with other schemas, contains the sum of an individual's knowledge.
2. Schema consists of nodes and links that describe relationships between node pairs.
3. Schema is formed through generalities, not specific information.
4. Schemas are dynamic. As new information is learned, it is assimilated into existing schemas or causes the formation of new schemas.
5. Schema provides contexts for how new experiences are interpreted. How information is interpreted is based on existing schemas (Winn & Snider, 1996).

According to Dye (2000), "the graphic organizer has its roots in schema theory" (pg.72). When students learn something new, they must be able to retain the information for later use. Our knowledge is stored in a scaffolded hierarchy as a way of organizing information. According to Slavin (1991), people encode, store, and retrieve learned information based on this hierarchy. Information that fits into a student's existing schema is more easily understood learned and retained than information that does not. The teacher's task is to ensure that the student has prior knowledge related to the concept and to provide a means for helping the students make connections between prior knowledge and new concepts. Graphic organizers make it easier to link new information to existing knowledge and help students build the schema they need to understand new concepts (Guastello, Beasley, & Sinatra, 2000). If prior knowledge is activated, the schema will be able to provide a framework to which new information can be attached and learning and comprehension will be improved.

Dual Coding Theory

Paivio (1986) published a dual coding that assumes that memory consists of two separate but interrelated systems for processing information. One system is specialized in processing non-verbal imagery and the other is specialized in dealing with language. While each system can be activated independently, there are connections between the systems that allow for the dual coding of information. The visual system specializes in processing and storing images. The processed and stored images are termed imagens (Paivio, 1986). The verbal system processes linguistic information. The resulting stored linguistic information are termed logogens (Paivio,1986). Paivio describes both imagens and logogens as meaningful units of memory similar to "chunks" described by Miller (1956). According to Saavedra (1999), dual coded information is easier to retrieve and retain because of the availability of two mental representations, verbal and visual, instead of one. The more students use both forms, the better they are able to think about and recall information (Marzano, Pickering, & Pollock, 2001).

The theoretical foundations of dual coding theory have definite implications on the value and use of graphic organizers. Marzano, Pickering and Pollock (2001) state that graphic organizers "enhance the development of non-linguistic representations in students and therefore, enhance the development of that content" (p.73). The use of graphic organizers also helps students generate linguistic representations. As a visual tool, graphic organizers help students process and remember content by facilitating the development of imagens. As a linguistic tool, text based graphic organizers also facilitate the development of logogens thereby dual coding the information.

Cognitive Load Theory

Cognitive load is the amount of mental resources necessary for information processing (Adcock, 2000). Cognitive load theory maintains that working memory can deal with a limited amount of information and if its capacity is exceeded, the information is likely to be lost. According to Cooper (1998), working memory has a capacity of between four to ten elements depending on the student's existing schemas. Extraneous cognitive load refers to how much demand is placed on working memory to learn the new material. The level of extraneous cognitive load may be modified through different modes of instruction, thus facilitating student learning. Visual learning tools such as graphic organizers can reduce the cognitive load and as a result, allow more of the working memory to attend to learning new material (Adcock, 2000). As a result, content can be addressed at more sophisticated and complex levels through the use of graphic organizers.

The Effectiveness of Graphic Organizers

Graphic organizers have their roots in Ausebel's theories and research on advance organizers. Ausebel (1963) advanced the belief that a learner's existing knowledge, which he referred to as cognitive structure, greatly influences student learning. When the cognitive structure expands by incorporating new information, learning occurs. To facilitate this process, graphic organizers provide students with the framework for relating existing knowledge to the new information learned (Ausebel, 1963). Prior to 1969 advance organizers had been presented as prose passages. Baron (1969) changed them to tree diagrams that utilized vocabulary of the concepts to be learned. Baron called his modification of Ausubel's advance organizers "the structured overview". A structured overview is a "diagrammic representation of the basic vocabulary of a unit so as to show relationships among the concepts represented by those words" (Earle, 1969, p.4). Structured overviews are now referred to as graphic organizers (Hawk, 1986). The graphic organizer, like its predecessor the advance organizer, was originally intended as a readiness activity. Research and classroom practice, however, has shown that graphic organizers are equally useful as assimilation or follow-up activities (Dishner, Bean, & Readence, 1981; Simmons, Griffin & Kameenui , 1988).

Ellis (2001) identifies three benefits of using graphic organizers. First, graphic organizers make content easier to understand and learn. Graphic organizers also help students separate important information from what might be interesting but not essential information. Second, according to Ellis (2001), graphic organizers decrease the necessary semantic information processing skills required to learn the material. By making the organization of content information easier to understand, graphic organizers allow material to be addressed at more sophisticated levels. Finally, students who use graphic organizers may become more strategic learners. An individual's approach to a task is called a strategy (Bulgren & Lenz, 1996). Strategies include how a person thinks and acts when planning, executing, and evaluating a task and its subsequent outcomes (Deshler & Lenz, 1989). When the organization of a topic becomes apparent, reading and writing skill, communication skills, analytical skills as well as creative skills are subject to improve with the use of graphic organizers (Ellis, 2002).

The use of graphic organizers has been shown to develop students' thinking and learning skills in a variety of content areas (Pruitt, 1993). To identify the empirical basis for using graphic organizers, Moore and Readence (1984) conducted a meta-analysis of graphic organizer research with non-disabled students. Twenty-three studies were included. Overall, 161 effect sizes were computed, and an average effect size of .22 was computed. However, the effect size varied depending on the treatment or the criterion variables examined. For example, a large effect size (.57) was found when graphic organizers were used after reading text, but a much smaller effect size was reported when graphic organizers were presented before the task. Similarly, an effect size of .68 was reported when the dependent measure was vocabulary in contrast, when the test measured comprehension, the effect size was .29. Moore and Readence also analyzed the 23 studies qualitatively. The results indicate that the teachers who used graphic organizers in the studies reported feeling more competent while leading students through content material.

The majority of the literature base assessing the effects of graphic organizers examined one or more of the following:

1. where the graphic organizer was used in the instructional sequence (Simmons, Griffin & Kameenui,1988;
2. whether the graphic organizer was teacher or student constructed (Armbruster, Anderson, & Meyer, 1991; Doyle, 1999; CiCecco & Greason (2002)
3. the effect on students with disabilities or varying ability levels (Guastello, Beasley, & Sinatra, 2000; Hawk, 1986)

Instructional Sequence

The placement of the graphic organizer activity in the instructional sequence of the lesson differs depending upon the study. A meta-analysis by Moore and Readence (1984) indicates a larger effect size for graphic organizers when the graphic organizers were introduced as a post organizer (.57) than as an advance organizer (.27). Simmons, Griffin and Kameenui (1988) specifically examined the differing effects of graphic organizers depending on whether the graphic organizers were used before or after the presentation of the content and concluded that graphic organizers as an advance organizer were significantly beneficial on delayed assessments. Simmons, Griffin and Kameenui (1988) compared the effectiveness of three instructional procedures for assisting sixth graders' comprehension and retention of science content. The first instructional procedure included teacher-constructed graphic organizers before textbook reading; the second procedure utilized teacher-constructed graphic organizers after textbook reading; and the third procedure utilized a more traditional form of instruction consisting of text-oriented discussion and questioning before, during, and after textbook reading. Forty-nine students from three homogeneously grouped general science classes in a middle income suburban school participated in the study. Subjects in all groups participated in six consecutive 30 minute daily lessons on atomic structures and properties. Three measures, short term probes, immediate and delayed posttests, were administered to assess students' comprehension and retention of science content. The probes were administered at the beginning of the third and fifth lesson and following the sixth lesson. The probes consisted of six short answer questions to assess students' comprehension of recently studied content-area text. The immediate posttest comprised of twelve short answer items and was administered the day following the completion of the instructional sessions. This immediate posttest assessed the range of information taught during the six instructional sessions. A delayed posttest of similar format as the immediate posttest was administered eleven days after completion of the instructional interventions. The results of the study indicated that the placement or timing of the graphic organizer in the text reading was a significant factor in determining student performance on a delayed posttest. The use of the graphic organizer before text reading appeared to be more effective in the recall of text material, as measured by the delayed posttest. The results of the analysis of variance (ANOVA) indicated a significant main effect for treatment on this measure ($p = .016$). However, results from the immediate posttest produced no significant differences in performance among the three instructional procedures.

Studies have shown graphic organizers have been shown to be useful as an advance organizer as well as a post organizer. (Simmons, Griffin, & Kameenui, 1988). According to Griffin and Tulbert (1995), outcomes of graphic organizer studies remain unclear because different types of graphic organizers are used in each study. Therefore, some graphic organizers may be more useful as an advance organizer and others as a post organizer. One purpose of this study is to examine the differing effects of different types of graphic organizers based upon the level of prompt embedded within the graphic organizer.

Teacher vs. Student Constructed

A second variable in graphic studies is the degree of teacher or student construction and completion of the graphic organizer. Armbruster, Anderson, and Meyer (1991) tested the effectiveness of organizational frames when teachers completed the graphic organizer, students completed the graphic organizer and when students filled in blanks in a teacher constructed graphic organizer. Armbruster, Anderson, and Meyer (1991) examined the effectiveness of graphic organizers on fourth and fifth grade students' ability to learn from reading their social studies textbooks during the course of an entire school year. The study involved four replications or rounds, in which instruction using frames to supplement the textbook was compared with instruction provided by the teacher's edition of the textbook. A total of 365 children from ten elementary schools participated in the study. There were two types of frames used in the study. One type of frame depicted a sequence with arrows connecting a series of boxes, the second depicted a matrix comparing characteristics and examples of concepts. In the first round of the study, there were three experimental conditions: a student framing condition in which students completed the frames independently, a teacher led framing condition, and a control condition using textbook resources. Each teacher was assigned to all conditions. In the subsequent rounds of the study, the student framing condition was conducted in groups instead of each student working independently. In each round, students in the framing conditions scored significantly higher on recognition and recall tests than did students in the control group. However, scores when students completed the frame, both independent and group completion, did not differ significantly from the scores when teachers assisted in completing the frames. The researchers concluded that frames help readers with selecting and organizing information from the text.

Doyle (1999) examined the effectiveness of student constructed graphic organizers versus teacher directed note-taking. The subjects in this study were eight high school students with learning disabilities and were conducted in a Resource United History II class. The study used two interventions for teaching information from the textbook. The first intervention entailed presenting different graphic organizers to students and having them fill in the graphic organizers. In the second intervention, the teacher presented the information through lecture and had the students copy notes that were written on the board. On completion of each of the chapters of text presented through the two interventions, the students participating in the study took a chapter textbook test. Students received higher scores on post instruction tests when graphic organizers were used compared to when the more traditional lecture and note taking method of information presentation was used ($p < .05$).

Studies have shown graphic organizers have been shown to be useful when teacher constructed and student constructed (Doyle, 1999). Across studies, researchers have varied the manner in which the graphic organizer is constructed. According to Rice (1994), many graphic organizer studies lack specificity of administration procedures making it unclear the amount of teacher input that is actually taking place during the graphic organizer activity and making replication impossible.

Varying Ability Levels

Many students, particularly students with LD, lack skills for processing and organizing written and oral information (Bos & Vaughn, 1994; Lenz, Alley, & Schumaker, 1987). These students experience difficulties with making inferences, understanding relationships and connections, distinguishing main ideas from insignificant details, and understanding the gist of a passage or lecture (Kameenui & Simmons, 1990). Students with LD and other students who struggle to understand relationships need instruction that explicitly demonstrates the connectedness of knowledge (Alexander, Schallert & Hare, 1991).

Graphic organizers have been shown to be effective in improving the understanding and application of content material for students of varying ability levels (Baxendell, 2003). For example, a study by Guastello, (2000) assessed the effects of concept mapping on a science unit with low-achieving seventh graders in urban Brooklyn, New York. Each participating student had demonstrated below average achievement in both science and reading on standardized assessments. Students were randomly assigned to either a concept mapping group or a read and discuss group. The concept mapping group constructed organizational maps of the unit material with the assistance of the teacher as the students read the chapter in the book. The read and discuss group read the chapter in sections and participated in discussion and questioning following each reading. The study was conducted over a period of eight school days during the students' regularly scheduled science classes. The results indicate the two groups scored similarly on pretests of the unit material and on science and reading achievement. Because the pretest was significantly correlated to posttest scores ($r = 0.18$, $p < .05$), an analysis of covariance (ANCOVA) with pretest scores as the covariate was conducted. The ANCOVA results showed a statistically significant main effect ($p < .0001$) favoring the graphic organizer group indicating that instructional techniques using graphic representations are more effective than traditional methods. The authors suggested that concept mapping, if used to teach textual material, might assist students to build schemas for understanding a lesson's concepts. Furthermore, the process of creating the semantic map may simply serve to focus students' attention on the relevant sections of the text.

A study by Hawk (1986) involved above average students in sixth and seventh grade life science classes, and examined the effectiveness of graphic organizers as an advance organizer on student achievement. A total of 455 students from 15 classes were in one of two groups: one group received graphic organizers at the beginning of a chapter; the other group did not receive graphic organizers. Each participating student in the study scored above the 60^{th} percentile on a standardized achievement test. The treatment variable was the use of graphic organizers throughout the first seven chapters of instruction in the life science class. The control students did not have graphic organizers during the instruction of the first seven chapters. The same Life Science text was used in all 15 classes. Identical pretests and posttests containing 50 items were used for evaluation purposes. Students in classes that used graphic organizers scored significantly higher on posttests than students in the control group. The one-way analysis of covariance showed a statistically significant main effect ($p < .001$) in favor of the students who received instruction using graphic organizers. The conclusion drawn from this study was that the graphic organizer is an effective and practical teaching strategy. Hawk's rationale was that graphic organizers provide an overview of material to be learned and a framework that in turn provides reference points to aid the learner in assimilating the new vocabulary and organizing the main concepts into a logical pattern.

CiCecco and Greason (2002) examined the effects of using graphic organizers with middle school students with LD on student attainment of relational knowledge. relational knowledge. The 24 students with LD participating in the study were chosen from three pullout resource room programs for students with mild disabilities and randomly assigned to two groups. One group received instruction using graphic organizers as a post reading activity led by the teacher. The other group received the same instruction except not in graphic organizer form. Pre-testing and achievement data indicated that the groups had equivalent ability and knowledge of the content to be covered. Participants received instruction for a period of four weeks during the regular reading periods in the special education resource room of two schools. The study counted the number of relational statements made in student written essays as a measure relational knowledge and a 20 item multiple choice tests to measure factual knowledge. The results indicated that instruction using graphic organizers did not significantly affect factual knowledge as measured by multiple choice tests ($p = .2641$). However results of the student written essays revealed that students in the graphic organizer group had significantly more relational knowledge statements ($p = .0007$) than students in the no graphic organizer group. The results indicate that graphic organizers aid students with LD in their recall of relational knowledge but did not seem to aid the students' recall of factual information.

Finally, Horton, Lovitt, and Bergerud (1990) investigated the effectiveness of graphic organizers for students with LD, low achieving remedial students, and students in regular education. The study also investigated the effects of different forms of instruction utilizing graphic organizers. The study compared teacher directed graphic organizer instruction, student directed instruction with text reference, and student directed instruction with clues to student self study of content material. Three classes of middle school science, three classes of middle school social studies and three classes or high school social studies participated in the study. In each subject area, two classes were randomly selected to serve as experimental groups and a third class served as a "neutral group". The experimental classes included eight students with learning disabilities. The nine students identified as "remedial" were all in the same high school social studies class. The graphic organizers in the study were hierarchical in format. The outcome measures were the content of the students' versions of the graphic organizers compared to a criterion graphic organizer. Within a subject area, two passages were selected from the same chapter of text. The neutral group read one passage and independently completed the corresponding graphic organizer, followed immediately by reading the second passage and completing the accompanying student graphic organizer. According to the authors, the purpose of the neutral classes was to evaluate the difficulty of the two reading passages. The most difficult passage was assigned the graphic organizer treatments while the easiest passage was assigned a self-study condition. The results of three separate experiments indicated that teacher directed, student directed with text references, and student directed with clues produced significantly higher performance than self-study for students with LD, remedial students, and students in regular education ($p < .01$).

Not all studies indicated significant gains when using graphic organizers over other forms of instruction. In one example, Griffin, Simmons, and Kammenui, (1991) examined the effect of graphic organizers on the acquisition and recall of science content by fifth and sixth grade students with learning disabilities. Students were randomly assigned to a graphic-organizer condition or a no graphic organizer condition. Students in the graphic organizer condition did not perform significantly better on immdeiate oral free retell, production task, or choice response task immediate posttesting or production task and choice response task delayed posttesting. Similar results were obtained by Bean, Singer, Sorter, and Frazee (1986). In this study, the authors concluded that graphic organizer instruction was no more effective than outlining instruction for tenth grade honors world history students.

Text Variables and Transfer of Skills

Other variables examined less frequently in graphic organizer studies are the type of text presented to the student and the students' ability to transfer skills gained from using graphic organizers to other readings. In a critique of graphic organizer research, Rice (1994) concluded that graphic organizer researchers have neglected to analyze the correspondence between graphic organizers and the texts used in research. One example of research taking into account the difficulty of the text was Alvermann and Boothby (1983). Alvermann and Boothby (1983) investigated differences in students' retention of "inconsiderate" social studies text of fourth grade students considered to be above average in ability. "Inconsiderate" text is defined as containing irrelevant information and lacks unity. Thirty-three fourth graders from two classes in the same school comprised the sample. The experimental group used of a graphic organizer during the text reading, whereas those in the control group did not. Results of a free recall measure found graphic organizers to be effective in reducing the amount of irrelevant information retained ($p < .05$) and increasing the amount of relevant information retained from the text ($p < .001$).

Another variable less frequently studied is the transfer effects of training and use of graphic organizers. In one example, Alvermann and Boothby (1986) examined the transfer effects of graphic organizer instruction on 24 fourth-grade students' ability to comprehend and retain social studies content from brief chapters in tradebooks written for elementary age students. Participants were randomly assigned to one of three conditions. Those in the two experimental conditions received instruction in the use of partially completed hierarchical graphic organizers for 14 class periods and 7 class periods respectively while reading their social studies text. However, no graphic organizer was provided for the tradebook readings since the purpose of this passage was to test for transfer of learning. Control group subjects were taught by the reading recitation method commonly used by the participating teachers. The criterion measures consisted of both recall and recognition type tasks. Written free recalls and an 18 item multiple choice test were used to measure student comprehension and retention of the tradebook passages. Students in the experimental group, who received 14 days of graphic organizer instruction, comprehended and recalled significantly more information than those who received no graphic organizer instruction, as measured by a criterion-free recall assessment. However, scores from the multiple choice test were not significantly different across the three conditions.

Graphic Organizers with Generative Cognitive Prompts

In addition to organizing information, graphic organizers can be used also to promote a more thorough understanding of information (Bulgren & Lenz, 1996). The process of understanding difficult but important concepts and relationships has to involve higher order processing strategies. The aim of the understanding process is to acquire new information by integrating the new information with prior knowledge. The types of demands related to promoting understanding of content area information include: (a) learning concepts, (b) applying or generalizing learned concepts to novel situations, (c) retrieving knowledge already known that is related to the new content, (d) deciding the relevance of prior knowledge, (e) translating the content into networks of prior knowledge, (f) making conclusion on the integration of prior knowledge with new information (Bulgren & Lenz, 1996). The graphic organizers presented below are devices used as a part of concept enhancement routines. Each of the graphic organizers used contain generative embedded cognitive prompts that promote concept learning.

One example of a concept enhancement routine that utilizes graphic organizers with generative embedded cognitive prompts is the *concept teaching routine* (Bulgren, Deshler, & Schumaker, 1988). The concept teaching routine is built around a graphic organizer called the concept diagram. The concept diagram displays information about: (a) the name of the targeted concept, (b) the definition of the concept (c) characteristics that are always, sometimes, and never associated with the concept, and (d) examples and non-examples of the concept. In a study to evaluate the effectiveness of concept diagrams and the concept teaching routine, Bulgren, Deshler, and Schumaker (1988) found that students with and without disabilities using the concept teaching routine scored significantly higher on concept acquisition scores ($p < .0001$ for both LD and nonLD), and regular classroom test scores ($p < .0001$ for both LD and nonLD) than during baseline conditions.

Later, the same researchers tested another routine, the Concept Anchoring Routine (Bulgren, Deshler, Schumaker, & Lenz, 2000) designed to help students learn new, difficult, concepts through analogies. The concept anchoring routine is built around a graphic organizer called an anchoring table that allows teachers to display information about a difficult new concept by developing an analogy to a familiar concept that shares critrical characteristics with the targeted new concept. The graphic organizer of the concept anchoring routine displays information about: (a) the name of the new concept, (b) the name of the known concept, (c) information that the student knows about the known concept, (d) characteristics of the known concept, (e) characteristics of the new concept, (f) characteristics shared by the known and new concept, (g) space for students to convey their understanding of the new concept. The study assessed the impact of the concept anchoring routine on students with LD, low achieving students, normal achieving students, and high achieving students on two concept lessons in a laboratory setting and a classroom setting. Although differences were not significant for all subgroups in every case, teacher use of the routine led to an overall increase in student retention and expression of information for each subgroup over a traditional lecture-discussion format.

Most recently, Bulgren, Lenz, Schumaker, Deshler, and Marquis (2002) investigated the effectiveness of a concept comparison routine built around a visual device called the concept comparison table that allows a teacher to display information about two or more concepts or topics through an analysis of the characteristics the concepts share. The concept comparison table displays information about: (a) the names of two or more concepts, (b) the name of the larger concept group into which the concepts fit, (c) characteristics of each of the concepts, (d) identification of the characteristics and categories of characteristics in each that are alike, (e) identification of the characteristics and categories of characteristics in each that are different, (f) a summary statement of how the concepts are alike and different (g) space provided for extensions that go beyond the basic characterictics. Specific procedures for the comparison routine guide the teacher how to use the comparison table to compare concepts. Use of the routine led to significantly better retention and expression of information by students in the experimental condition compared with students participating in a traditional lecture-discussion format. A multivariate analysis revealed that the experimental students with LD performed significantly better than the control students with LD ($p = .027$), experimental low achieving students performed significantly better than low achieving students under the experimental condition ($p = .012$), the experimental normal achieving students performed significantly better than the normal achieving control students ($p = .017$), and the experimental normal achieving students performed significantly better than the normal achieving control students ($p = .017$). However, recognition scores were not statistically significant for normal achieving students. In addition, there were no statistically significant differences between the high achieving experimental and control groups on any of the outcome measures.

Graphic Organizers with Content Specific Cognitive Prompts

Although some studies have examined the effectiveness of graphic organizers with cognitive prompting to promote elaboration, each of the graphic organizers used were generative and applicable to a variety of topics in a variety of content classes. Presently no studies have been conducted examining the effect of content specific or topic specific graphic organizers.

Complexity and Type of Graphic Organizer

According to Griffin and Tulbert (1995), studies examining the effectiveness of graphic organizers vary in the complexity of the graphic organizers used. Furthermore, Griffin and Tulbert (1995) conclude that this variability in graphic organizer complexity is a contributing factor to the lack of clarity of graphic organizer researcher. However, no research has been conducted comparing the type and complexity of graphic organizer. It is the purpose of this study to evaluate the effects of the type and specificity of embedded graphic organizer prompts on the achievement of typical students and students with learning disabilities and how these embedded graphic organizer prompts influence the types and cognitive level of student elaborations elicited during instruction.

Summary of Effectiveness

To summarize, the literature demonstrates that the use of graphic organizers is an effective learning strategy for typical students and students with learning disabilities. Students demonstrated higher levels of comprehension and ability to recall information when they had used a graphic organizer in content area instruction. The literature found the use of graphic organizers to be an effective strategy for helping such students comprehend content area material, organize information, and retain and recall content, as measured by posttests. Although some impressive effects have been achieved in many of the studies, few of the studies focused solely on the live instruction of comparative information in general education classes at the secondary level. Moreover, few of the studies have focused on the higher order thinking skills involved in analyzing and explicitly identifying relationships among concepts in a unit of study. Although some studies examined the effects of graphic organizers with organizational and generative cognitive prompting, no study in the literature have examined the effects of topic specific cognitive prompting or compared the effects of types of prompts embedded in graphic organizers.

Explicit Instruction in the Use of Graphic Organizers

Secondary content teachers feel increasingly pressured to cover large amounts of content in a limited time frame. Ellis (2001) uses the term “instructional economy” to describe how must make difficult choices in their attempts to efficiently cover essential material with limited instructional time. Often, in order to cover large amounts of information in a short time, secondary content teachers turn to lecture as the primary vehicle of instruction (Putnam, Deshler & Schumaker, 1992). While lecture is an effective means for quickly presenting large amounts of material, the speed of delivery is often at the expense of meaningful learning (Bulgren & Lenz, 1996). Various instructional approaches have been investigated in an attempt to respond to the challenges associated with the demands of content classrooms. One instructional device that the literature has suggested is effective in assisting teachers and students in the differentiation of key aspects of the curriculum while improving students’ understanding and application of content is graphic organizers (Guastello, Beasley & Sinatra. 2000). The literature also indicates that students as well as teachers require direct instruction on the strategies associated with instructional devices such as graphic organizers (Lenz, Alley & Schumaker, 1987).

However, given the pressure to cover large amounts or content in content classrooms, questions remain about the efficacy of spending instructional time teaching learning strategies. Griffin, Malone, and Kameenui (1995) examined the degree to which explicit instruction is necessary for independent generation and use of graphic organizers by students. In the study, five intact classes of students were randomly assigned to one of five treatment groups: explicit graphic organizer instruction condition (Ex GO), explicit instruction no graphic organizer condition (Ex No-GO), implicit instruction graphic organizer condition (Im GO), implicit instruction no graphic organizer condition (Im No-GO), and traditional basal instruction (traditional). Results of immediate posttests and an immediate recall measure suggest that the performance of treatment and control groups showed no significant variation. However, an examination of descriptive data reveals that students receiving Ex GO instruction had the highest mean scores on both the immediate posttest and the immediate recall measure. According to the authors, this outcome is important to examine in light of the fact that these students were required to learn not only content knowledge but knowledge in the procedures for constructing graphic organizers. When students were asked to read and recall new content from another chapter of the text, students participating in the Ex GO, Ex No-GO, and the Im GO conditions recalled more ideas than students in the traditional instruction condition did. The authors conclude that the explicitness of instruction and the graphic organizer played important roles in students’ ability to generalize the instruction to new textual material.

A study by Lenz, Alley and Schumaker (1987) revealed that not only is explicit student instruction necessary for enhanced learning with graphic organizers, explicit teacher training in the use of graphic organizers is also a significant factor in effective graphic organizer use. This study affirmed that graphic organizers presented in content classrooms could significantly increase adolescents with learning disabilities’ level of retention of content information. The study also demonstrated through a multiple baseline research design that these effects are not obtained until the students are taught specifically to use the graphic organizers being utilized.

Further, the study showed that content teachers who occasionally use graphic organizers could be trained in less than one hour to use graphic organizers effectively at the mastery level. The multiple baseline study also revealed significantly increased use of graphic organizers after training and increased student achievement. The authors of the study concluded that teachers and students must learn to use graphic organizers in order for the benefits of graphic organizer instruction to be fully reached.

Unfortunately, content teachers are largely unwilling to use instructional time teaching learning strategies when faced with pressure of extensive content coverage (Bulgren & Lenz, 1996). Recently published graphic organizers (eg. Ellis, 2005) contain prompts that enable students and teachers to make connections and applications of content material with little or no direct instructional time devoted to teaching graphic organizer use.

Teaching Thinking Skills and Relational Knowledge

Infusion of Thinking Skills

What is taught in content classrooms should be more than a set of isolated pieces of information. Classroom content should be consistant with the material that people use to engage much of their thinking (Swartz, 2000). For example, the nutritional content taught in Biology class should influence the dietary choices and habits that people make. Likewise, understanding of political history should influence should affect student's choices of candidates and positions on political issues. The information teachers give students should serve as the raw materials for the natural thinking tasks that guide us through our lives. Yet, too often what students learn is learned to pass a classroom test or standardized assessment (Swartz, 2000). In order to encourage the teaching of thinking skills in content classrooms, Melville Jones and Haynes (1999) propose infusing thinking skills into content curricula. They advocate that teachers should provide explicit structure for students' thinking. Swartz (2000) claims that the infusion of higher level thinking skills involves more that asking more challenging higher-level questions? According to Swartz, questioning of this sort does not teach students who are generally unaware of how they think to modify any bad habits they have in thinking. Swartz (2000) recommends the use of explicit "thinking strategies" to help guide students through the process of skillful thought processes. Swartz specifically recommends the use of graphic organizers to provide students with places to "download" their ideas for further reflection in a format that can be organized in such a way as to cue students to focus their attention on certain patterns of thought. Swartz also recommends the use of meta-cognitive prompts to cue students to think about their thought processes. Students need to be engaged in their own thinking so they can reflect on their thought processes and enable themselves to monitor and direct their own thought instead of relying upon the teacher to do so. Some examples of teaching strategies that can be used to promote metacognition range from directive strategies such as giving students a graphic organizer to guide their thinking in a lesson to techniques like "Think-Pair-Share" in which students "think out loud" so that other students can help them directly while they are doing their thinking.

Relational Knowledge

Explicit representations of relations plays some role in virtually all higher cognitive processes. Classification, deductive reasoning, comparing, and contrasting information all entail the processing of relations (Halford, 1996). The intent of instruction in content classrooms should be the formation of concepts or principles in a system of learning as opposed to the memorization of factual information (DiCecco & Gleason, 2002). However, the inordinate amount of factual information in textbooks interferes with this goal. Too many facts and not enough explicit conceptual linkages appear to comprimise the understanding of complex concepts and principles in content area curricula. Students with LD and other students who struggle to understand relationships need instruction that explicitly demonstrates the connectedness of content knowledge (Alexander, Schallbert, & Hare, 1991). Logically, if the source of relational knowledge is structured and organized, it will be more accessible to the learner (Ausebel, 1968). The use of graphic organizers in instruction are one way of providing illustrations that depict relationships among key concepts.

Cognitive and Metacognitive Prompting

Goals, Format and Delivery of Prompts

The goal of some classroom prompts is to help students gain understanding as they complete a task. For example, Tein, Rickey, and Stacy (1999) demonstrated the effectiveness of cognitive prompts in helping students gain conceptual understanding when performing laboratory experiments in chemistry. Other prompts explicitly call for students to elaborate on a concept. For example, Brown and Palinscar (1989) tested the effectiveness of reciprocal teaching. In reciprocal teaching, students are prompted to explain and summarize concepts with peers. Some prompts are explicitly metacognitive and assist students as they monitor and regulate their own cognitive processes. For example, White and Fredericksen (1998) found that students who routinely answered reflective prompts not only developed greater understanding of content, but also gained greater understanding of the scientific inquiry process.

Regardless of their goals, prompts can be formatted and delivered in various ways. For example, they can take the form of sentence starters or questions to be responded to verbally or in writing. Researchers can prompt students for verbal explanations (Chi, 2000; Chi, deLeeuw, Chiu, & LaVancher, 1994); teachers can prompt students to elaborate on their ideas verbally in class (Van Zee & Minstrell, 1997); and peers can prompt each other to explain and summarize (Brown & Palinscar, 1989; Palinscar & Brown, 1984) or think aloud together (Hogan, 1999). Written prompts can be used to highlight important features (Rothkopf, 1966) or promote self-assessment (White & Fredrickson, 1998). Computer software can also prompt students. For example, Brown (2003) used sentence starters as prompts as part of computerized instruction to promote reflection and foster metacognition and sense-making in complex science projects. Regardless of the delivery mechanism or format, all the prompts reviewed have been shown to be effective in promoting understanding.

As far as timing, prompts are typically provided to students while they are engaged in the learning activity. For example, in research conducted by Chi (2000), students are asked for a self-explanation while reading a passage of text. On the other hand, White and Fredericksen's (1998) self-assessment prompts were introduced after each learning activity, while Flower and Hayes (1980) prompted planning in writing before the learning activity began. In some cases, students were given the option of whether or not to utilize or respond to embedded prompts (Kolodner & Nagel, 1999). These "voluntary supports" place metacognitive demands on students but allow for scaffolding and fading of the prompts. Though there is little empirical evidence of the relative value of prompting before, during or after the learning activity, empirical evidence indicates the usefulness of prompting at each time frame as well as voluntary prompting.

Specificity of Prompts

Most of the research reviewed points to the effectiveness of specific, contextualized prompts over abstract prompts (eg., Bell & Tien, 1995; Clark, 1996; Linn & Clancy, 1992). A specific prompt directs students toward performing a specific desired action and a contextualized prompt is specific to a particular learning activity (Davis, 2003). For example, in reciprocal teaching, students internalize an appropriate and specific program of prompts for a particular activity (Brown & Palinscar, 1989). However, a study by Davis (2003) compared generic with directed prompts on student performance and understanding of concepts on a science project and concluded that students in the generic prompt condition developed more coherent understandings as they work on a science project. Davis, (2003) concluded that students reflect unproductively more often with directed prompts when compared to generic prompts. Thus, specific and conceptualized prompts may have drawbacks as well. These prompts may not be appropriate to some students' level of understanding. In conclusion, specific and contextualized prompts must be carefully designed so they do not confuse students.

Currently, the literature contains no studies that assess the effects of imbedded prompts as an aid to graphic organizer instruction and training. Further, it is the purpose of this study to determine if teachers and students feel that cognitive prompts embedded within graphic organizers lead to greater student achievement.

Depth of Processing and Elaboration

Beginning in the late 1960s theories of memory expanded from discrete memory stores, such as short term term, long term and working memory stores, to memory being seen as a function of active encoding, storage and retrieval processes (Craik, 2002). The earliest studies investigating the influence of processing were connected with repetition effects. These studies concluded that repeated presentation of an item provides more occasions for processing the item and thereby a greater chance for deeper or greater processing (Craik, 202). However, the possibility of deeper processing of repeated items was not assessed by the early researchers of repeated presentation until Craik and Lockhart (1972) developed the "levels of learning theory". The major proposition of of this theory is that learners utilize different levels of elaboration as they process information. This is done on a continuum from perception, through attention, to labeling and finally meaning. The key point is that all stimuli are stored in memory, but different levels of processing contribute to the ability to retrieve that memory (Huitt, 2003). Researchers have found that individuals remember information better when they process it at a deeper level (Craik, 2002; Hunt & Ellis, 1999).

Students with LD seem to have problems with memory (Swanson, Cochran, & Ewers, 1990; Torgeson & Kail, 1980) and these problems do not seem to stem from a limited memory capacity (Wong, 1980, 1982). Rather the problems seem to be caused by inefficient processing or encoding (Hughes, 1996). Students with LD frequently do use rehearsal strategies, but the strategies are shallow and therefore ineffecient in making the information permament and accessible in long term memory. Researchers in this area characterize students with LD as lacking spontaneous use of elaborative memmory strategies (Hughes, 1996; Swanson et al. , 1990).

Rehearsal

A shallow form of processing information commonly used in school settings involves rehearsal (Dye, 2000). Rehearsal is the conscious repetition of information over time to increase the length of time information stays in memory. Rereading text, and the repeated answering of factual questions about material already covered are common examples of rehearsal tasks commonly used in schools. Rehearsal works best when individuals need to remember a list of items for a brief period of time. When individuals need to retain information over long periods of time other strategies usually work better than rehearsal.

Elaboration

Cognitive psychologists generally agree that for information to be retained in the long term memory, it is imperitive that students elaborate on the new material (Anderson, 1990; Gagne, 1985). Levin (1988) defines elaboration as "meaning-enhancing additions, constructions or generations that improve ones memory" (p. 191). For example, requiring students to explain the causes of a war would most likely result in greater long term memory of the material than having students recall a list of reasons.

Often elaboration strategies require summarization (Huitt, 2003). Summarization involves having the students identify key aspects of the concepts being learned in language that is meaningful to the student. Summarization goes beyond simple rehearsal because the student decides what information is meaningful and encodes the information in an individual way that adds personal meaning to the student. Elaboration strategies also often require students to draw conclusions or make inferences related to the concepts that has been covered. The process of making inferences and drawing conclusions requires students to synthesize and evaluate informtion to be learned and generalize concepts into novel situations; all of which require deeper processing (Slavin, 1990).

Elaboration strategies often require students to construct memory links between new information to be learned and some related information already held in long term memory (Richie & Karge, 1996). In order to accomplish this, students must go through what Richie and Karge

(1996) describe as a thoughtful pause during which new memories are created and linked to existing structures. This link could be anything that serves to connect the new information to information already in long term memory, such as inferences, continuations, examples, or details (Gagne, 1985). In classrooms, students could elaborate on a new concept by linking the new concept to concepts that have already been learned in a previous lesson or the new concept could be linked to an experience from the student's past. If the students background experiences lack direct examples of the new concept, elaboration could be achieved through the construction of analogies that compare the new concept to one in the students background that may have similar characteristics (Richie & Karge, 1996). For example, Ellis (2002) describes a learning situation where the difficult concept of photosynthesis is compared to baking. Therefore, there are still opportunities for elaboration for students with limited background experiences and when teaching difficult concepts.

A third form of elaboration is transformational elaboration. Students sometimes lack the basic knowledge structures of a concept to which new information can be related. In these cases, elaborations can be made through a transformation of the new material (Pressley, Johnson, & Symons, 1987). This transformation is accomplished by associating the new material with a word that is acoustically similar or by rearranging the pieces of information into a new presentation (Richie & Karge, 1996). In other words, the new material is coded by introducing relationships that are neither naturally or semantically inherent in it. For example, a new vocabulary word could be compared to an acoustically similar key word already in the student's vocabulary. The vocabulary word "treaty" could be associated with the word "treat" and similar attributes to the two words could be identified to create an elaboration. Another example would be the use of a first letter mnemonics strategy by using the acronym HOMES to remember the names of the great lakes. and visual cues are other examples of transformational elaborations.

This study will assess the effect of instruction utilizing graphic organizers with organizational prompts, generative cognitive prompts, and topic specific cognitive prompts on the types of encoding strategies and elaborations used during instruction. The study may also assess whether significant differences in elaboration strategies result in significantly increased achievement.

Concept Mapping

In this study, a dependent variable for the measurement of student achievement is the construction of a concept map of the core ideas of the content unit. Based on Ausebel's (1968) hierarchical memory theory and Deese's associationist memory theory, Novak and Gowin (1984) coined the term *concept map.* A concept map is a visual illustration displaying the organization of concepts and outlining the relationship among or between the concepts. According to Novak and Gowin, concept maps should be: (a) hierarchical with subordinate concepts at the apex; (b) labeled with precise linking words; and (c) crosslinked such that the relations between sub-branches of the hierarchy are identified. Moreover, the hierarchy expands according to the principle of progressive differentiation: new concepts and new links are added to the hierarchy, either by creating new branches or by differentiating existing ones even further. Finally meaning increases for students as they recognize new links between sets of concepts or propositions at the same level of hierarchy. These crosslinks represent the connections among different subdomains of the structure (Ruiz-Primo & Shavelson, 1996).

According to Novak and Gowin, concept maps include two key elements: concepts and propositions. A *concept* is " a perceived regularity in events or objects designated by an arbitrary label" (Novack, Gowin, & Johansen, 1983, p. 625). For example, rain is the label used for the concept of water falling out of the sky. A *proposition* is formed by connecting two concepts with a rational link (Lambiotte, Dansereau, Cross, & Reynolds, 1989). In a concept map, the proposition "rain is a type of precipitation" would be visually linked using an arrow pointing from the concept "rain" to the concept "precipitation". Novak and colleagues (1983) contend that networks of propositions are how concept meanings are linked.

Concept Maps as an Assessment Tool

Although concept maps are far more frequently used as instructional tools (e.g. Briscoe & Lemaster, 1991; Willerman & MacHarg, 1991) than as an assessment tool, the validity of several concept mapping techniques has been well established in the literature (e.g. Ruiz-Primo, Shavelson, & Schultz, 2001; Ruiz-Primo, Shultz, Li, & Shavelson, 1998). In one test of validity, Markham, Mintzes, and Jones (1994), a sample of college students were used to compare concept mapping scores with scores obtained on a card sorting task of key terms. The results indicated that the concept maps of biology majors in comparison with non-majors included more branching and more hierarchies, indicating greater concept differentiation. The cross links, indicative of conceptual integration, and examples in maps of the biology majors far surpassed those of non-majors. Comparable results were found with the card sorting assessment, thus establishing the concurrent validity of the concept mapping. When constructing the maps, students were given a list of key terms and concepts and told to construct a concept map using those terms.

As an assessment tool, concept maps can be thought of as a procedure to measure a student's declarative knowledge (Ruiz-Primo, Shultz, Li, & Shavelson, 1998). Any assessment can be conceived as a combination of a task, a response format, and a scoring system. Based on this framework, a concept map used as an assessment tool can be characterized as: (a) a task that invites students to provide evidence of their knowledge structure, (b) a format for student response, and (c) a scoring system by which students' concept maps can be can be evaluated accurately and consistently.

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