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CONCEPT MAPPING: AN EFFECTIVE INSTRUCTIONAL STRATEGY
IN SCIENCE WITH KINDERGARTEN STUDENTS

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF THE
UNIVERSITY OF HAWAI'I IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF EDUCATION
IN
CURRICULUM AND INSTRUCTION
MAY 1996

By
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S. Arthur Reed
Donald B. Young
DEDICATION

This dissertation is dedicated to my Mother, Mary L. Reich, and my Father, William A. Reich. You got me started on this road by instilling such high value for learning, but who would have thought it would go this far. Thank you Mom for being there through the final edit. I miss you Daddy, I only wish you were here to see this. “Anything you set your mind to do, you can accomplish.” I love you both.
ACKNOWLEDGEMENTS

A dissertation cannot be done in isolation. It is the result of the unending help and support of friends, family, colleagues, and mentors. The list is long and the debt is great.

The teachers and students who participated in the case studies were wonderful. Without your enthusiasm and cooperation, this study could not have been done at all. Thank you, Brooke, Jim, Sandy, and Tony.

My committee members were exceptional. To have helped me to persevere to the end was in itself a monumental task. Dr. Fred Bail helped me so much in the beginning to understand learning theory and to form a workable idea. In the end, he helped me find the light at the end of the tunnel. Dr. Morris Lai taught me much about the study design, data collection and analysis during our many late night sessions. Dr. Tom Jackson knows how young children think and caused me to reflect in this context. Dr. Art Reed threw out a life line to keep me from sinking on two occasions. Dr. Don Young is responsible for getting me into this and for making me believe I could do it. He is both a mentor and a very special friend. Dr. Tom Speitel, my chair, has been supportive throughout the entire process. Without his help I would have been overwhelmed by the sheer amount of data to say nothing of the writing. Tom, we did it! A heartfelt thank you to each one of you for giving so much of your time and expertise.

Dr. Frank Pottenger deserves a tremendous amount of gratitude. He made it possible for me to do this. His encouragement and support are very much appreciated. My colleagues have had incredible patience and gone out of their way to see that this study came to fruition. To Gayle Hamasaki, Jeff
Fujimoto, Val Hashimoto, and Corinne Morisako, thank you, I owe you all so much.

Friends, what would I have done without you? Donna Therrien, whose study is often cited in this work, has been there for me through the entire endeavor. Mary Gullickson, Jim Hope, and John Kuducky, thank you for listening and for your unfailing encouragement for so very long.

Last but by no means least, to my family, Bob, Wendy, and Kevin, without your love, support and never-ending patience, this dissertation would never have been completed! Bob, the den is yours at last. I love you all.
This study investigated the claim made by kindergarten teachers that concept mapping, as described in the Developmental Approaches in Science, Health, and Technology (DASH) Program, is an effective instructional strategy to use with their students. Classroom evidence was sought to verify this claim. A questionnaire designed to determine the reasons for this claim was sent to all DASH trained kindergarten teachers. The most common reasons and ideas among the 160 teachers who responded were identified. A list of research areas on the effectiveness of concept mapping and potential evidence for each was compiled from the responses.

A review of the literature supported many of the reasons suggested by the teachers. Six case studies were conducted at three geographically diverse locations. The video tapes, field notes, photographs, and interviews from the case studies were then analyzed for supporting evidence of the teachers' reasons for the effectiveness of this strategy.

All the most often mentioned reasons identified from the questionnaire were validated in the case study data. This study found that kindergarten students did organize information and make connections between ideas on concept maps. Both class concept maps and individual student interviews, exhibited several levels of categorization and showed connections between ideas. Kindergarten students did supply the teacher with information about their prior knowledge and their on-going learning on concept maps. Video tapes, field notes, and class concept maps provided evidence of students sharing their prior knowledge and experiences and teachers recording them. Concept mapping...
mapping did support multiple modes of learning and had a high rate of student participation. Concept mapping can give teachers a context to build students' self esteem and cooperative learning skills. Video tapes, field notes, photographs, and student interviews provided evidence for these claims. Data concerning knowledge acquisition were inconclusive.

This study presents strong evidence for the effectiveness of using concept mapping as a teaching strategy with young children. This finding leads to implications for pre-service training, professional staff development, assessment, and curriculum development.
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CHAPTER ONE
INTRODUCTION AND OVERVIEW OF THE STUDY

INTRODUCTION

The introduction to this dissertation on concept mapping with young learners provides a brief description of a concept map and of the program, Developmental Approaches to Science, Health, and Technology (DASH) of which it is a part.

A concept map is usually a visual representation of what is known about a particular concept or idea. Ideas describing the concept’s form and function are arranged on a map composed of linked and progressively subordinate or hierarchically arranged structures. The physical characteristics of a concept comprise its form. The function of a concept describes what it does or how it is used. The relationships to the major concept and between the subordinate ideas are represented by connecting lines and linking words. Figure 1 describes insects and illustrates a portion of a typical concept map. Chapter 2 contains a complete description of concept mapping as reported in the literature.

The steps used with elementary students to develop the skill to create concept maps are described in the DASH program. These steps along with the forms for and functions of a concept map as described by DASH make up the DASH concept mapping process studied in this dissertation. This process is described in Chapter 3, Study Description and Methodology.
DASH is a comprehensive program which integrates science, health, and technology for K-6 students. It was developed by the Curriculum Research...
and Development Group at the University of Hawai'i. DASH incorporates a constructivist view of learning and teaching. It is designed to develop and nurture the cognitive and social skills of students. "It assumes that these skills can be taught most effectively in contexts of authentic technologies and scientific exploration, invention, and explanation, which provide models for thinking and problem solving. Individual and group activities focus on making sense of new information, making connections between new information and what children know, and then using new knowledge to enhance understanding of the world around them" (Young, 1992).

A HISTORY OF KINDERGARTEN CONCEPT MAPPING IN DASH

The very first concept map attempted in the context of the DASH program was done with a group of second graders by the researcher on September 1, 1989 before a group of science educators. They were members of the DASH Steering Committee gathered in Hawai'i to give guidance to the development team. The researcher, at the time a classroom teacher, had been asked to provide some DASH lessons for the committee to observe. The teacher and this particular group of children had only some limited experience with webbing stories in language arts. This was their first attempt to map a science concept.

The eight children and the teacher gathered on the floor around a three by five foot sheet of paper. The only other equipment was a box of colored markers. The session began with the teacher writing the word soil in the center of the paper and drawing a circle around it. She then asked the students what they knew about soil. The students’ contributions came so fast that the teacher
often had to ask the children to be patient until she could write down all their ideas. The end result of this first effort was a rather elaborate concept map that is treasured by the researcher to this day. (See Figure 2.) This map was the beginning of a new and fruitful instructional strategy now used throughout the program that has since been shared with over 10,000 DASH teachers.

The DASH concept mapping process has evolved and changed since the creation of that first map. The children are more actively engaged in creating their maps; they do most of the writing. Pictures and artifacts are encouraged to represent ideas along with words. There is extensive use of color, shapes,
connecting words, and hierarchical structures. The maps are never finished, but instead are revisited regularly for revisions, additions, and corrections. In short, what began as an activity to introduce a new topic has evolved into an on-going constructivist instructional strategy.

Although concept mapping was introduced at the grade two level, it was incorporated almost immediately into kindergarten and grade one. The researcher's class was comprised of a combination of K-2 students. Pictures appeared on the maps very quickly, necessitated by the non-readers in these groups. An interesting bit of history occurred when the project director visited with one of the foremost researchers of concept mapping in the country. The director mentioned to him that DASH kindergarten students were concept mapping. The researcher reflected on how this was hard to believe since these students seldom read or write. The director just happened to have with him a sample of a pictorial concept map created by DASH kindergartners. Since the researcher's work had been with older students, it had not occurred to him to use pictures. Sometimes, not knowing it can't be done produces surprising results! The researcher has developed a related but very different process for mapping knowledge that can be used with young learners.

Once concept mapping had been introduced to kindergarten teachers during DASH professional development institutes and these teachers had time to try it in their own classrooms, enthusiastic reports of success began coming back to the development team.
SETTING THE STAGE FOR THIS STUDY: A BRIEF OVERVIEW

This study was initiated by informal reports from kindergarten teachers using DASH that concept mapping was a successful and effective instructional strategy when used with their students.

The study was designed to first determine if DASH kindergarten teachers were typically finding concept mapping to be successful in their classrooms and if so, to identify what evidence they had that it was an effective instructional strategy with these young students. This was accomplished with a questionnaire that surveyed DASH-trained kindergarten teachers to determine whether or not they found concept mapping to be an effective instructional strategy and if so, their reasons why. Potential reasons for the effectiveness of concept mapping were drawn from the ideas offered by teachers in their questionnaire responses. These suggestions concerned mainly the functions for concept mapping.

The literature was reviewed to determine what findings had been reported concerning the effectiveness of concept mapping. This literature review paralleled most of the ideas culled from the returned questionnaires.

Six case studies were conducted in kindergarten classrooms across the United States where teachers were using the concept mapping process as described in the DASH program. Confirming evidence for the suggested reasons for the effectiveness of concept mapping was sought from the data collected in the case studies.
This study reports on the reasons suggested for and the validation of the effectiveness in using concept mapping as an instructional strategy with kindergarten students.

The remaining chapters of this dissertation on concept mapping with kindergartners are organized in a more traditional manner. Chapter 2 presents a review of the literature regarding the rationale and theoretic background for concept mapping with kindergarten children. Chapter 3 concerns the methodology and details of this study including the study design, case study descriptions, questionnaire information, and data analysis procedures. Chapter 4 describes the findings and results. Chapter 5 discusses interpretations and implications of the study.
CHAPTER 2
REVIEW OF RELATED LITERATURE

INTRODUCTION

This chapter is divided into three sections: A review of the constructivist theory of how young children learn, a description of concept mapping as it is currently interpreted in education, and a review of the literature on the effectiveness of concept mapping with young children. (A complete description of the particular concept mapping strategy used in this study is contained in Chapter 3.)

CONSTRUCTIVISM AND SCIENCE EDUCATION

The purpose of this section is to describe the learning theory known as constructivism. It is not to argue that this particular point of view is the right or correct theory. Rather it is to provide some background about the learning theory on which concept mapping, particularly as used in this study, is based. Joseph Novak, upon whose ideas the DASH concept mapping system was primarily developed, wrote in 1991: “There is now a general consensus among researchers who study human learning that every person constructs his/her own meanings for how the world appears to work.” The key word here is constructs. Catherine Fosnot, in The Case for Constructivist Classrooms presents the following description in the Preface:

Constructivism is not a theory about teaching. It's a theory about knowledge and learning. Drawing on a synthesis of current work (some
of which is described below) in cognitive psychology, philosophy, and anthropology, the theory defines knowledge as temporary, developmental, socially and culturally mediated, and thus, non-objective. Learning from this perspective is understood as a self-regulated process of resolving inner conflicts that often become apparent through concrete experience, collaborative discourse, and reflection (Brooks & Brooks, 1993).

Constructivism as a Theory for Education

Constructivism has emerged from the work of such theorists as Jean Piaget, Thomas Kuhn, Lev Vygotsky, John Dewey, and Jerome Bruner. Some might even argue that Socrates was the first constructivist. His concern for the learner's development is well in line with constructivist thinking.

In order to understand constructivism, one must consider the ideas of reality and perception. George Kelly (1955) has described the relationship between these two concepts. He claims one views the world through transparent frameworks or patterns constructed from previous experiences. The learner tries to fit a new experience into his established frameworks. Things don't always fit very well but without these patterns, one would not have any way of making sense of the world. These very personal understandings form each person's thinking framework.

Piaget has had a great deal of influence on the constructivist movement. It is interesting to note that although his work spanned some 50 years, it was not strongly embraced in American education other than perhaps in the development of science programs in the sixties. This is due no doubt to the strong behaviorist background and orientation in American education. Antonio Bettencourt (1990) has commented on the resurgence of interest in Piaget's work. "The recent attention that constructivism is receiving from science
educators seems to entail a paradox. The work of Piaget is one of the major sources of this view. What justifies then the claim of novelty (or newness) given the Piagetian movement in science curriculum in the 60s? The paradox is apparent. Piaget was assimilated without accommodation by most curriculum developers of the sixties. This made them de-emphasize the epistemological novelty and difficulty of Piaget's ideas. Piaget was read and understood (i.e. misread and misunderstood) within a behaviorist framework. His stages of development were objectified into predictive instruments of what students could and could not do. Curriculum was developed to match these limits instead of challenging students' minds...." 

Piaget's research led him to the belief that the learner's own individual constructions result in the growth of knowledge. Piaget (1971) wrote:

The current state of knowledge is a moment in history, changing just as rapidly as knowledge in the past has changed, and, in many instances, more rapidly. Scientific thought, then, is not momentary; it is not a static instance; it is a process. More specifically, it is a process of continual construction and reorganization.

Piaget (1952) saw constructivism as the way in which learners come to know the world. He saw the mind as a set of ever-changing, sense-making structures that help us to understand the world we perceive and that become more complex with maturity and experience. Accommodation is the process by which these structures are changed to include new information and experience. The new structure allows new information and experience to be assimilated. Piaget called the new cognitive stability which results from a balance between assimilation and accommodation, equilibrium. Piaget claimed the need to reach this cognitive equilibrium is what drives the building of new cognitive structures. In other words, learning or the creation of these new structures occurs when the
learner finds a conflict between reality and perception and a need to reach equilibrium.

Bruner (1964), Chomsky (1977), and Vygotsky (1978) have proposed that such things as language and prior experience are more important to the construction of new structures than is the learner's need for equilibrium. Other cognitive theorists, such as Gardner (1991) have also challenged Piaget's view. However, the influence of Piaget's work cannot be denied. It should be remembered that in his later work, Piaget did move away from a simplistic view of assimilation, accommodation, and equilibrium to a more dynamic interpretation. The same is true for his stages of development (Fosnot, in press).

Some Constructivist Assumptions

Pottenger (1994) has identified four basic assumptions about learning upon which constructivism is founded. First, humans construct a unique view of the world out of personal experience. This view implies that learning is an active process in which the learner must participate. Further, learners need a large amount of in-depth experience and information, usually at the concrete level, in order to understand new concepts and apply them to new situations. Telling is not the most effective way to teach (Young, 1993).

Second, the process of construction on an individual level is incremental, involving adding to, making connections with, and modifying previously established constructs. Learners construct their understandings incrementally, in small sequential steps. Most learners have some misconceptions about how the world works. Students come to school with a set of deeply held conceptions about the natural world (Helm & Novak, 1983; Gardner, 1991). “These concepts
form a foundation on which to build new knowledge and understandings. Knowledge is making connections among ideas. Children...need to see how new knowledge is related to what they already know, how it is relevant to them, how it connects to other areas of knowledge, and to understand that real knowledge comes from making those connections" (Young, 1993).

Third, constructs are normalized through interactions with others. Learning is a social activity. Learning in schools takes place in a social context that includes peers as well as teachers. The child’s communication and language development play a central role in learning. It is currently recognized in the professional literature of most subject areas that communication plays a central role in developing knowledge (NCTM, 1989). Language is one way for the child to make sense of experience. The tools of communication include writing, discussing, drawing and acting out as well as reading and listening. In classrooms, students bring alternative conceptions that may conflict with accepted convention. Learning takes place only when the learner becomes aware of inconsistencies in conceptions. Language provides the tools for the learners to become aware of these misconceptions. Learning takes time and multiple opportunities for learners to express self-constructed understandings and test them against what others know. When there is disagreement, time and many more experiences will be needed to help learners make new connections and construct new meanings (Young, 1993).

And fourth, the process of normalization where humans are involved constitutes teaching. Constructivist “teachers realize that rote learning and drill and practice are not likely to generate real understanding and useful knowledge. Knowledge cannot simply be transferred by means of words without
first an agreement about meaning and some experiential base. Explaining a problem will not necessarily lead to understanding. Learning is the product of self organization and reorganization. Since knowledge is not acquired passively, (constructivist) teachers change their view of problems and solutions. It is no longer possible to accept the view that there is only one solution. It is difficult to justify conceptions of right and wrong answers. Constructivist teachers would rather explore how students see the problem and why their paths toward solutions seem promising to them" (Young, 1993).

Constructivist Teaching

Although, constructivism is a theory about knowledge and learning, not specifically about teaching, the theoretical tenets and assumptions of constructivism described previously, do provide some guiding principles for teaching. These are

(1) posing problems of emerging relevance to learners,
(2) structuring learning around big ideas or primary concepts,
(3) seeking and valuing students’ points of view,
(4) adapting curriculum to address students’ suppositions, and
(5) assessing student learning in the context of teaching

(Brooks & Brooks, 1993).

Likewise, Robert Yager has suggested some strategies that illustrate how constructivism can be applied to teaching. These include

• Seeking out and using student questions and ideas to guide lessons and whole instructional units;
• Accepting and encouraging student initiation of ideas;
• Promoting student leadership, collaboration, location of information, and taking actions as a result of the learning process;
• Using student thinking, experiences, and interests to drive lessons (this means frequently altering the teachers' plans);
• Encouraging the use of alternative sources for information both from writing materials and experts;
• Using open-ended questions encouraging students to elaborate on their questions and their responses;
• Encouraging students to suggest causes for events and situations, and encouraging them to predict consequences;
• Encouraging students to test their own ideas, i.e. answering their questions, their guesses as to causes, and their predictions of certain consequences;
• Seeking out student ideas before presenting teacher ideas or before studying ideas from textbooks or other sources;
• Encouraging students to challenge each other's conceptualizations and ideas;
• Using cooperative learning strategies that emphasize collaboration, respect for individuality, and use division of labor tactics;
• Encourage adequate time for reflection and analysis; respecting and using all ideas that students generate; and
• Encouraging self-analysis, collection of real evidence to support ideas, and reformulation of ideas in light of new experiences and evidence (Yager, 1991).

These examples illustrate how constructivism can be applied to education. Educators, and more pertinently science educators, are calling for change.

Current Trends in Science Education

With the recent emphasis on a constructivist approach to learning and teaching, there have been some major shifts in science education. Following is a description of where science education has been and the direction in which it is moving.

Shift in The Science Learner Audience. Historically, the launching of the Russian Sputnik in 1957 initiated a major focus on science education. More scientists were needed in this country in order to win the space race. The federal government responded with increased funding for science education.
The resulting elementary science programs such as Science Curriculum Improvement Study (SCIS), Elementary Science Studies (ESS), and Science–A Process Approach (SAPA) were designed to enable students to become these scientists (Ravitch, 1983).

Now, the science and education community realize that everyone needs a basic understanding of science in order to be good citizens and to make wise decisions about technology. A constructivist approach provides a way for all students to learn some fundamental science. Several groups have attempted to define what that science might be (American Association for the Advancement of Science (AAAS), 1990, 1993; National Research Council (NRC), 1996; National Science Teachers Association (NSTA), 1989).

**Shift in The Approach to Learning.** During the 1970s test scores continued to drop in spite of the activity-based programs of the late sixties and early seventies. This resulted in the *back to the basics* movement. In science classes, students read the science textbook and answered the questions at the end of each chapter. Little time was devoted to science in the elementary school as it was not considered one of the three *Rs* (Goodlad, 1984).

This is not the way students learn science. Science is inquiry and activity-based. A constructivist approach makes science accessible to both readers and non-readers while integrating and attending to language development (Gardner, 1991).

**Shift in The Teacher's Role.** The teacher has long been the imparter of knowledge, *the sage on the stage* (Goodlad, 1984). The role of the teacher is changing. The teacher cannot open up a student’s head and pour or lecture in the facts. This is not learning.
Rather, using a constructivist approach, the teacher acts as a coach, a facilitator, the "guide on the side," helping the learner to construct new understandings (Brooks & Brooks, 1993).

**Shift in The Focus of Science Education.** The emphasis in science education has been primarily on content. Although process was addressed in the acronym programs of the 1960s and 70s, the disciplines of science drove the content selection in most of these programs. With the *back to the basics* or textbook approach to science, the teacher had to *cover the book.* This often meant a chapter a day as the year drew to a close (Goodlad, 1984). With the explosion of new information in science this has become an impossible task.

The emphasis is shifting to the learner; to helping the student construct basic understandings in science by building on prior knowledge and experience to construct ever broader, more complex understanding (AAAS, 1990).

**Shift in The Purpose of Science Education.** Science has been compartmentalized as have all *subjects,* even in the elementary school curriculum (Goodlad, 1984). Does the student who turns in a practice page of perfect letter *b’s* in handwriting class make that perfect *b* in health class when writing about the benefits of eating broccoli? Usually not. The issue here is relevance. *Why are we doing this stuff in school?* Most students, elementary and high school alike, see little relevance in what is *learned* in school to their personal lives.

How does this information relate to what students need to know; how does it meet their personal and social needs? This has become an important focus in science education, connecting what is occurring in the classroom to the
world outside of school. The emphasis is on the constructivist notion of connecting new knowledge to what is already known (AAAS, 1990).

**Shift in The Approach to Science Content.** In a similar vein with the need to cover all the facts and the lack of connectedness to the real world, is the presentation of atomistic, disconnected facts or information. A little of this, a little of that, and particularly in elementary education, “Oh, I don't like spiders and I don't understand levers so I'll skip those chapters.” Elementary students typically grow a bean seed every year from kindergarten through grade five (Goodlad, 1984).

The constructivist idea of connectedness calls for a science curriculum that is holistic and connected, that looks at how specific information fits into the broad picture or idea. It requires an integrated, thematic presentation of ideas in the science curriculum (AAAS, 1990).

**Shift in Curriculum Design.** “You are new to the school? Too bad, we covered that last year.” A single exposure to a topic has been the norm in science education. Once a topic was taught it was on to something else.

With the constructivist emphasis on big ideas, building on prior knowledge and experience, and multiple experiences to help a student reconstruct idiosyncratic constructs or misconceptions, curriculum developers are now turning toward spiral and sequential designs which Bruner (1960) suggested over thirty years ago. Major ideas and topics are to be revisited throughout the school experience. Topics need to be sequenced in order to build or construct knowledge. For example, a student could hardly be expected to understand the concept of density without first knowing about mass and volume (AAAS, 1990).
Shift in Grouping for Instruction. There has been a shift in focus from independent, competitive learning to cooperation, collaboration, and the social aspects of learning. Learning does not occur in isolation. The learner must test ideas against the understanding of others, be they peers or teachers, and come to some common agreement for learning to occur. Further, students must learn to operate in a society. There are few jobs in this society for the isolationist (Johnson & Johnson, 1986; AAAS, 1990).

Shift in Student Assessment. Testing reflects the behaviorist school of thought that has traditionally dominated American education. The step-by-step, teacher-directed science lab and the memorize the information, take the test, get the A approaches, are direct reflections of the stimulus-response theory of learning that has directed the way education has proceeded for most of this century (Novak, 1977).

With a constructivist approach, rote memorization and rigidly structured science labs are no longer the ways to learn science. Rather, inquiry, thinking skills, and scientific habits of mind are stressed. Assessment has seen some major changes in the past few years. In science education there is a move beyond the traditional paper and pencil tests toward multiple kinds of assessment instruments and portfolios which allow students to demonstrate their knowledge in many and often more appropriate ways (AAAS, 1990; NSTA, 1992).

Given this background of the current trends in science education and constructivism in learning and teaching, the next topic in this section discusses how constructivism has influenced the new standards for science education.
Constructivism in the New Standards for Science Education

"A standard is a statement that can be used to judge quality" (Young, 1995). There are different kinds of standards. This study is concerned with two of these. "Content standards are statements of what all students should know, be able to do, and care about as a result of science education. They are goals for students and teachers to strive for. Teaching standards are statements of what effective teachers do in classrooms that enable students to achieve high content standards" (Young, 1995).

The guiding principles and underlying assumptions of constructivism are reflected in the new standards proposed by national organizations driving the current educational reforms in science education. The National Center for Improving Science Education (NCISE) proposed the following set of standards for science education:

- Accessible to all students.
- Builds on students' prior experience and knowledge.
- Uses an instructional model based on the scientific processes.
- Relates to personal and social needs.
- Selects developmentally appropriate concepts in multiple disciplines.
- Develops scientific thinking skills (e.g., using inference, creating models).
- Develops scientific habits of mind (e.g., curiosity, skepticism, honesty).
- Uses authentic assessment to chart teaching and learning.
- Shifts teacher role from imparter of knowledge to facilitator of learning.
- Seeks relevant applications of science content to students' lives (Laboratory Network Program, 1994).

The constructivist influence is quite evident in this set of standards. Obvious examples based on the prior discussion include the emphasis on prior knowledge, the teacher's role, and relevant applications to students' lives.

The NCISE appears to be the first group in the current reform effort to publish a set of standards for science education. Other standards that have
followed even in fields other than science have continued the call for a constructivist approach to education. The word constructivism is not always apparent, but the constructivist ideas described previously are there.

The American Association for the Advancement of Science (AAAS), first published the following set of goals in 1989. They released their Benchmarks for Scientific Literacy in 1993 which delineated the content to be addressed. These initial goals reflect the way in which science should be taught.

- Being familiar with the natural world, its diversity and unity.
- Understanding key concepts and principles of science.
- Being aware of the interdependence of science, mathematics, and technology.
- Knowing that all three are human enterprises and have weaknesses.
- Having a capacity for scientific ways of thinking.
- Using scientific knowledge and ways of thinking for social purposes (AAAS, 1989).

Both these goals and the AAAS benchmarks are permeated with constructivist ideas. Other groups appear to have paralleled the thinking of this organization.

The National Science Teachers Association (NSTA) has undertaken a major reform effort to define the science scope, sequence, and coordination (SS&C) of secondary school science. They have collected together in a single volume research papers and philosophical statements on how high school students learn science best. These papers serve as the basis for their project. These papers are organized into five sections entitled SS&C Learning Statements. These include

- Spacing content improves learning.
- Learning is not improved by ability grouping.
- All students can and should learn science—encouraging equitable classrooms.
- Students learn by practice-solving problems, designing and carrying out experiments.
• Learning is connecting new information to prior knowledge.

Several of these statements (the first, fourth, and fifth in particular) exemplify a constructivist approach to learning. The last section contains works by Ernst von Glaserfeld and Michael Matthews on constructivist theory. The rest of the papers discuss other constructivist issues such as teaching for understanding. This NSTA effort is clearly based in constructivist theory (NSTA, 1992).

The National Research Council (NRC) has recently proposed a comprehensive set of standards for science education. In the introductory overview of these new standards, they state, “The Standards rest on the premise that science is an active process. Learning is something that students do, not something that is done to them. Hands-on activities, while essential, are not enough. Students must have ‘minds-on’ experiences as well.” The NRC goes on to define learning (in a constructivist manner) as “an active process by which students individually and collaboratively achieve understanding.... Student understanding is actively constructed through individual and social processes” (NRC, 1996).

The National Association for the Education of Young Children (NAEYC) has described what it views as developmentally appropriate practice for children from birth through age eight. This position statement has implications for kindergarten and primary age children, the first of whom are the subjects of this study. The focus on how children learn is evident throughout this work. For example, the following statement in the opening rationale for producing this position statement reads: “The trend toward early academics is antithetical to what we know about how young children learn. Programs should be tailored to meet the needs of children, rather than expecting children to adjust to the
demands of a specific program.” In the following excerpts from the Guidelines for Developmentally Appropriate Practice, constructivist ideas are obvious. “Developmentally appropriate curriculum provides for all areas of a child's development: physical, emotional, social, and cognitive through an integrated approach.” “Curriculum planning emphasizes learning as an interactive (social) process.” “Learning activities and materials should be concrete, real, and relevant to the lives of young children” (NAEYC, 1987).

The National Council of Teachers of Mathematics (NCTM) describes some of the desired characteristics of a curriculum which reflects the new mathematics standards for K-4 students.

A developmentally appropriate curriculum encourages the exploration of a wide variety of mathematical ideas in such a way that children retain their enjoyment of, and curiosity about, mathematics. It incorporates real-world contexts, children's experiences, and children's language in developing ideas. It recognizes that children need considerable time to construct sound understandings and to develop the ability to reason and communicate mathematically. It looks beyond what children appear to know to determine how they think about ideas. It provides repeated contact with important ideas in varying contexts throughout the year and from year to year (NCTM, 1989).

The Elementary Section Steering Committee of the National Council of Teachers of English (NCTE) calls for students to “collaboratively use the language arts to gain new understandings and perspectives” and to “strategically use the language arts to monitor the making and sharing of meaning” in their newly proposed standards (NCTE, 1996).

The underlying constructivist tenets and assumptions are obvious in all of the above examples. It would appear, based on this sort of national support, that constructivism is the current front-runner in learning theory in education.

In summary, according to constructivist theory, learners construct their own understanding about the world and how it operates. This understanding is
constructed through the child's reflection upon interactions between objects and ideas. New experiences are synthesized with existing or prior knowledge. When an idea, event, relationship, or object is encountered that is discrepant or does not make sense in the world as it is presently perceived by the child, it is interpreted to fit with the existing rule set or the rules are adjusted to accommodate the discrepant perception. Perceptions and rules are in a constant state of change, a sort of perpetual, on-going construction called learning (Brooks & Brooks, 1993). These ideas have much import when contemplating the use of an instructional strategy such as concept mapping.

**Multi-Modal Learning and Young Children**

Different children learn in different ways. An effective instructional strategy such as concept mapping should address the needs of different kinds of learners. This section discusses one theory which describes these learning differences.

All learners do not construct meaning identically. They perceive and process information differently. Much has been written on the premise that individual learners construct their knowledge in different ways. Many theorists have proposed ideas or systems to describe the different ways or styles in which students learn. McCarthy (1987) has defined a learning style as a way of perceiving and processing information.

In his early work, Carl Jung (1923) describes two personality types in regard to perception: people who used their minds or thought and people who used intuition or feeling. Rita and Kenneth Dunn (1978) base their ideas on the different ways students respond to instructional materials. They identify four
elements on which learning styles differ: the environment, emotional support, sociological composition, and personal/physical elements. Anthony Gregoric's (1985) Style Delineator is based somewhat on left and right brain function. He classifies learners into four categories: concrete sequential, abstract sequential, abstract random and concrete random. Bernice McCarthy's (1987) 4MAT system goes a step further by integrating learning styles research into a set of comprehensive instructional strategies designed to address learners with different styles. These are but a few of the more well-known contributors to the field known as learning styles.

However, there was little definitive literature found in an Educational Resources Information Center (ERIC) search concerning the learning styles of young children. This is not surprising since the learning styles of these young learners, as well as their literacy, is in an emergent, developing state (NAEYC, 1987). Young students in particular, probably need to be exposed to a wide variety of experiences which support a broad spectrum of learning styles so that they can begin to discover and develop their own. Further, Gardner (1995) claims that to say a learner has a preferred learning style applicable to all learning situations has yet to be documented.

For this study, a more useful framework when considering the idea that children learn in different ways, was to use Gardner's theory of multiple intelligences. This particular framework was selected for several reasons. First, DASH used Gardner's ideas as a part of its theoretical framework in curriculum development (Pottenger, Young, Brennan, & Pottenger, 1995). Next, the theory of multiple intelligences directly addresses the concern for a child's potential ways of learning which is the way in which this study of young children looks at
the issue of different ways of learning. Lastly, based on an ERIC search, Gardner’s ideas are discussed and appear to be accepted by many authors in the current literature on the education of elementary students.

The idea of multiple intelligences is not to be confused with learning styles. “The concept of style designates a general approach that an individual can apply equally to every conceivable content. In contrast, an intelligence is a capacity, with its component processes, that is geared to a specific content in the world such as musical sounds or spatial patterns” (Gardner, 1995). Gardner goes on to comment that in order “to see the difference between an intelligence and a style, consider this contrast. If a person is said to have a reflective or intuitive style, this designation assumes that the individual will be reflective or intuitive with all manner of content, ranging from language, to music, to social analysis. However, such an assumption reflects an non-empirical assumption that actually needs to be investigated. It might well be the case that an individual is reflective with music but fails to be reflective in a domain that requires mathematics thinking or that a person is intuitive in the social domain but not in the least intuitive when it comes to mathematics or mechanics.” The relationship between Gardner’s concept of multiple intelligences and the various conceptions of learning styles has yet to be reported in the literature.

Upon observation, different young children do seem to exhibit different or varying amounts of multiple intelligences. Some students are very adept at music, others appear to grasp mathematical concepts more readily than their peers. Gardner (1995) has recently defined an intelligence as “a biological and psychological potential; that potential is capable of being realized to a greater
or lesser extent as a consequence of the experimental, cultural, and motivational factors that affect a person."

Gardner claims people possess all of these intelligences in varying degrees. These intelligences do not work in isolation except in unusual cases such as that of the savant. The strength of a particular combination of intelligences is what produces a violinist like Yehudi Menuhin. But even the "apparently straightforward role of playing the violin transcends a reliance on simple musical intelligence. To become a successful violinist requires bodily-kinesthetic dexterity and the interpersonal skills of relating to an audience and, in a different way, choosing a manager; quite possibly it involves an intrapersonal intelligence as well" (Walters & Gardner, 1985).

Gardner has attempted to change the common conception of intelligence as something that can be measured by an IQ test. He claims this is too narrow a definition. In his theory of multiple intelligences as described in Frames of Mind (1983) Gardner suggests that intelligence has to do with solving problems and making things in a context-rich and natural setting. Gardner has provided a way to map "the broad range of abilities that humans possess by grouping their capacities into seven comprehensive categories or intelligences" (Armstrong, 1994).

Armstrong has provided a synthesis of some of Gardner's ideas in the following description of the seven intelligences.

**Linguistic Intelligence.** The capacity to use words effectively, whether orally (e.g., as a storyteller, orator, or politician) or in writing (e.g., as a poet, playwright, editor, or journalist). This intelligence includes the ability to manipulate the syntax or structure of language, the phonology of sounds of language, the semantics or meanings of language, and the pragmatic dimensions or practical uses of language. Some of these uses include rhetoric (using language to convince others to take a specific course of action), mnemonics (using language to remember information),
explanation (using language to inform), and metalanguage (using a language to talk about itself).

Logical-Mathematical Intelligence. The capacity to use numbers effectively (e.g., as a mathematician, tax accountant, or statistician) and to reason well (e.g., as a scientist, computer programmer, or logician). This intelligence includes sensitivity to logical patterns and relationships, statements and propositions, (if-then, cause-effect), functions, and other related abstractions. The kinds of processes used in the service of logical-mathematical intelligence include categorization, classification, inference, generalization, calculation, and hypothesis testing.

Spatial Intelligence. The ability to perceive the visual-spatial world accurately (e.g., as a hunter, scout, or guide) and to perform transformations upon those perceptions (e.g., as an interior decorator, architect, artist, or inventor). This intelligence involves sensitivity to color, line, shape, form, space, and the relationships that exist between these elements. It includes the capacity to visualize, to graphically represent visual or spatial ideas, and to orient oneself appropriately in a spatial matrix.

Bodily-Kinesthetic Intelligence. Expertise in using one’s whole body to express ideas and feelings (e.g., as an actor, a mime, an athlete, or a dancer) and facility in using one’s hands to produce or transform things (e.g., as a craftsperson, sculptor, mechanic, or surgeon). This intelligence includes specific physical skills such as coordination, balance, dexterity, strength, flexibility, and speed, as well as proprioceptive, tactile, and haptic capacities.

Musical Intelligence. The capacity to perceive (e.g., as a music aficionado), discriminate (e.g., as a music critic), transform (e.g., as a composer), and express (e.g., as a performer) musical forms. This intelligence includes sensitivity to rhythm, pitch, or melody, and timbre or tone color of a musical piece. One can have a figural or ‘top-down’ understanding of music (global, intuitive), a formal or ‘bottom-up’ understanding (analytical, technical), or both.

Interpersonal Intelligence. The ability to perceive and make distinctions in moods, intentions, motivations, and feelings of other people. This can include sensitivity to facial expressions, voice, and gestures; the capacity for discriminating among many different kinds of interpersonal cues; and the ability to respond effectively to those cues in some pragmatic way (e.g., to influence a group of people to follow a certain line of action).

Intrapersonal Intelligence. Self-knowledge and the ability to act adaptively on the basis of that knowledge. This intelligence includes
having an accurate picture of oneself (one's strengths and limitations); awareness of inner moods, intentions, motivations, temperaments, and desires; and the capacity for self-discipline, self-understanding, and self-esteem (Armstrong, 1994).

In summary Armstrong (1994) has described four key points to the theory of multiple intelligences. “Each person possesses all seven intelligences. Most people can develop each intelligence to an adequate level of competency. Intelligences usually work together in complex ways. There are many ways to be intelligent in each category.” Gardner has suggested the relevance this discussion of multiple intelligences has for education.

It is of the utmost importance that we recognize and nurture all of the varied human intelligences, and all of the combinations of intelligences. We are all so different largely because we all have different combinations of intelligences. If we recognize this, I think we will have at least a better chance of dealing appropriately with the many problems that we face in the world (Gardner, 1987).

CONCEPT MAPS: AN OVERVIEW OF FORMS

Considering this framework and background on constructivism and science education, the next two sections of this chapter discuss the forms and functions for concept mapping. The information reported in this review of the literature was found using the ERIC and UnCover databases to find journal articles concerning concept mapping, science education, and young children. On-line card catalogues were searched for books and other references at the University of Hawai‘i at Manoa, University of California (MELVYL), and Colorado Libraries (through CARL). In addition, many references were discovered through the bibliographies of articles and books found in these searches. Lastly, some resources were recommended by colleagues.
Based on the researcher’s observations when working with elementary teachers to introduce them to concept mapping, many teachers initially perceive concept maps, semantic maps, knowledge maps, mind maps, webs, networks, and even graphic organizers to all be the same thing. The confusion is quite easy to understand given the similarities in many of these mapping techniques. They appear more alike than different. A literature search revealed only concept maps as described by Novak and Gowin (1984), multirelational semantic maps as presented by Donald Dansereau and his researchers at Texas Christian University (Lambiotte, Dansereau, Cross, & Reynolds, 1989), and mind maps as described by Nancy Margulies (1991) to be fully articulated systems for creating maps. These three will be summarized along with a brief look at webbing and several other mapping techniques. No comparative studies between the effectiveness of these different systems or approaches to creating concept maps were found. Lambiotte et al. of TCU describe the differences in some of these systems, but there are no empirical data to support the view that for example, the TCU system is better than the Novak approach. Both Novak and the TCU group did comment on the use of linking words but their comments appear to be based on observation rather than on empirical evidence. Novak (1984) says there is "considerable empirical research behind its (his book, Learning How to Learn) claims," but there is scant evidence of this research in this how to book. On the other hand, there is a fair amount of research on the functionality of concept mapping which is discussed in the next section of this chapter.

The notion of concept mapping was fully articulated in the field of science education by Joseph D. Novak in his and D. Bob Gowin’s book, Learning How to Learn (1984). This work is considered by many educators to be the defining
work on concept mapping. Some, including the developers of the DASH program on which this study is based, have used Novak as a starting point and added their own refinements. For the most part, all versions of the concept mapping process discussed here appear to have a similar beginning.

Where did the idea of a concept map originate? More specifically, where did the idea for a visual representation of knowledge or ideas, often a description of the term, graphic organizer, originate? As one looks around, there are some obvious influences. A flow chart for a computer program and even a schematic drawing for a toaster exhibit a certain amount of similarity to a concept map. The organizational charts and systems analysis diagrams used by businessmen and scientists likewise are related at least visually to this idea. Propositional networks of long term memory structures created by information-processing theorists to represent meaningful learning are very much like concept maps. This is not surprising considering they have been influenced by Ausubel as has Novak (Ormrod, 1990). The first rudimentary map of this sort was possibly scratched with a stick in the dirt around a campfire by a group of prehistoric men and women planning the next day's mammoth hunt. The purpose of the following overview is to describe the forms concept maps take as they are currently used in education.

**Concept Maps**

Theoretically, Novak (1984) gives credit for much of his work to the ideas of David Ausubel. Concept mapping grew out of Novak’s research on Ausubel’s cognitive learning theory. Novak claims this work led to some of the changes seen in Ausubel’s more recent work.
Ausubel (1968) proposed a deductive approach based on meaningful verbal learning. Ausubel claims that, through the teacher's careful structuring of learning materials and experiences, learners are able to translate new content into meaningful knowledge. Ausubel's deductive learning model has three components. The first is the advance organizer which is an abstract term or phrase encompassing what the student is to learn and which provides a conceptual overview or focus. The second is the process of progressive differentiation by which the content is subdivided into more complex ideas so that the information can be more easily understood. The third component is integrative reconciliation which is an attempt to have the learners understand similarities and differences among the components of the hierarchy of knowledge and to reconcile inconsistencies between the ideas presented. Ausubel's model is designed to teach hierarchically organized bodies of knowledge. Lee Shulman has classified Ausubel's model as a type of guided discovery or inquiry (in Orlich, Harder, Callahan, Kauchak, & Gibson, 1994). Ausubel (1988), himself, has said, "If I had to reduce all of educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly." This fundamental principle and the need of Novak and his researchers at Cornell University to evaluate growth in students' understanding of science concepts as the result of audio-tutorial instruction led to their development of concept mapping in 1972. (Novak, 1990a)

Novak (1984, 1990b) defines a concept map as "a schematic device for representing a set of concept meanings embedded in a framework of propositions." The framework is the map or end product. He defines "concept
as a regularity in events or objects designated by some label" such as chair or wind. These labels can be words or symbols such as +, =, $\Sigma$, or a musical note. DASH uses Novak's definitions to describe the terms concept map and concept.

Propositions are two or more concept labels linked by words in a semantic unit such as dogs have legs. Novak (1984) reports that when he first started to use concept maps, he seldom labeled the lines with linking words assuming the implied relationship would be obvious to the map reader. This proved to be true only for persons thoroughly familiar with the concept being mapped. Now, careful attention to the selection of linking words is considered essential to the construction of a map. “This is not to suggest that one and only one correct linking word exists. Often there are two or three equally valid ways to link two concepts, but each will have a slightly different connotation” (Novak & Gowin, 1984).

Novak's (1984) concept maps are organized to show the hierarchical arrangement between the concepts. He uses a top-down approach to this organization. He also states it is sometimes useful to use arrows on the linking lines between concepts to show that the relationship is primarily in one direction. Usually a map's hierarchical arrangement will imply relationships between higher level and subordinate concepts.

Lastly, Novak (1984) says “concept maps need to be redrawn.” This is to correct flaws, either in the hierarchy, in the concept placement on the map or “to clean them up—to make them neater, correct spelling errors, and reduce clutter or crowding. These last ideas are very different reasons for changing maps than those suggested in Chapter 3. Figure 3 summarizes this discussion; it is Novak's concept map of a concept map.
A process to introduce the construction of concept maps has been described in a publication from Cornell University written under the direction of Joseph Novak. It is designed to take from ninety minutes to half of a day. First, the introductory approach is adapted to the audience by assessing the participants' needs and background. This ties in with Ausubel's key principle
described above. Some time is spent discussing what is meant by the notions of concept, linking words, and proposition. The participants next read a passage and as a group identify and rank key concepts.

Then several overhead transparencies are shown with examples of concept maps. This is done in part to introduce the structure and hierarchical nature of Novak’s concept maps. This also introduces some of the potential uses for concept mapping. The participants discuss a concept map which has been made from another paragraph that had the key concepts underlined. Following this come discussions about using concept maps with adults and reasons for doing so.

The participants then work individually, in groups, or as a class to build a concept map. Post-it™ notes are suggested to facilitate rearrangement of the map. There are nine steps to the process:

1. Identify and list six to ten key concepts in a written piece or on a particular subject.
2. Rank the concepts from broadest to most specific, keeping in mind the context in which the concepts are being used.
3. More concepts may be added from the written piece or on the subject.
4. Connect the concepts by lines. Label the lines with linking words.
5. Arrange concepts and linking words. Add more links once concepts are in place.
6. Specific examples of concepts are next added.
7. Reconstruct the map if needed to gain better symmetry and to better cluster relationships.
8. Rearrange the map again if a different way seems better.

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(9) Share the map with others.

The final activity suggested in this introductory session is to create a list of concepts with a partner; each maps the concepts separately; and then, they compare the results. In addition there is a video tape on concept mapping available which can be viewed and mapped (Department of Education of the State University of New York, 1986).

Novak also describes strategies to introduce concept mapping to learners in grades one to three. This seems to be all that Novak has written describing his work with young learners other than a brief article that describes the procedures for working with these young learners (Symington & Novak, 1982). It appears that he assumes these students can read. He lists fifteen preparatory activities and twenty concept mapping activities which are summarized in the following paragraphs.

To prepare these young students to concept map, they name objects and events which the teacher writes on the board. These are defined as concepts. It is pointed out that proper nouns are not concepts. Linking words are next similarly introduced followed by simple sentences (or propositions). Some students construct and write their own simple sentences, while other students identify the concepts and linking words in them. The teacher then introduces the idea that reading is learning how to recognize printed labels for concepts and linking words (Novak & Gowin, 1984). This is very simplistic idea for such a complex process and makes one wonder just how much experience Novak and his researchers have actually had with young children.

In the first mapping activity, the teacher makes a list of ten to twelve related and familiar concept words and organizes them hierarchically. The
teacher then constructs a map on the board for the students. The students read
the propositions on the map. They are asked to add other concepts and links.
Then they copy the map and add two or three of their own concepts and links as
they are able. In the next activity the students are given lists of words to arrange
into their own maps. These are shown and explained to others. The teacher is
encouraged to praise and point out the positive (i.e., correct) features of the
students' maps such as a hierarchical arrangement and *interesting* cross-links.
Novak states here that the teacher will find that students who do poorly in other
classroom work will make good concept maps. A nice claim but there is no
evidence presented. He does acknowledge that they may have some
misspellings or write illegibly (Novak & Gowin, 1984).

Each student then concept maps a familiar piece of text. First they identify
and circle the key concepts on their copy of the text. Then they list them in
hierarchical order. The lists are discussed and the teacher creates a concept
map from them. The students then construct their own maps. The students then
repeat this activity with stories or other text several times on their own. They
retell the stories using only their maps (Novak & Gowin, 1984).

The last introductory activity is to have the students concept map
something they know a lot about and then write short stories based on their
maps. After this Novak claims "almost any classroom activity should be relatable
to concepts and concept maps." He suggests these maps be posted in the
classroom and on students' walls at home and that students be encouraged to
link one map to another because "this cross linking is what makes us *smart.*"
(Novak & Gowin, 1984).
Lastly, although Novak suggests techniques for introducing concept mapping which include groups of learners, it seems his main focus is to encourage learners to gain the skill to construct their own personal rather than group maps. DASH has taken a different view particularly with young learners which is described in Chapter 3.

**Multirelational Semantic Maps**

Researchers at Texas Christian University (TCU) have also described a system for what is more commonly referred to in the literature as concept mapping. They call these maps, knowledge maps, and their particular version, multirelational semantic maps. Semantic maps are a particular type of knowledge representation. "A knowledge representation can be defined as a model or idealization of data; these data can be comprised of objects, relationships, or processes. An adequate representation should capture all the relevant types of knowledge in the domain, and provide a way to derive new knowledge in the domain" (Lambiotte et al., 1989).

Multirelational semantic maps are defined "as two-dimensional diagrams that use a spatial arrangement of nodes and links to communicate about concepts and to specify the multiple relationships among concepts in a given knowledge domain" (Lambiotte et al., 1989). There are two parts to the TCU mapping system. The structural features of the maps including links, nodes, spatial configuration, and unit organizations and the processes used to create, understand, and use the maps. Figure 4 shows a simple example of a multirelational semantic map that summarizes the TCU mapping system.
In the preceding figure, the nodes are the rectangles with words in them. They are similar to Novak's concepts. Nodes have two features, the visual appearance and the content. Nodes generally contain verbal information. They may also contain pictures, formulas, or other symbols. Some nodes may serve as headers or contain reference information. The appearance of the node, such as the borderline, shape, type style and size, and/or color, is used to signal the importance or to categorize the content (Lambiotte et al., 1989).
The links are given particular emphasis in the TCU system. The purpose of the links is to convey relational data between the nodes. The developers have proposed a given or standard set of link types. These are limited to make both constructing and reading the map easier. The links are drawn differently and are labeled. Dynamic relationships use barbed lines and are labeled $I$ for influences, $N$ for next, or $L$ for leads to. Static relationships use solid lines and are labeled $T$ for type, $P$ for part, or $C$ for characteristic. Instructional relationships are dotted lines that are labeled $A$ for analogy, $EX$ for example, or $CO$ for comment. Links can have modifiers such as $?$ or a plus or minus symbol. All links have arrowheads to lead the map reader through the map. The developers of this system do allow for the addition of idiosyncratic links such as $PR$ for proves in mathematics. They also suggest the color and thickness of the connecting lines could be used to signal other sorts of relationships but express a concern that "using too many devices would result in maps that are aesthetically unpleasant and intimidating." The researchers claim that if the mapper uses all these relationships as a guide to what should go on the map, all relevant information to the topic will be addressed. They provide no empirical evidence for this claim (Lambiotte et al., 1989).

The TCU system uses spatial configurations to clarify the organization of the knowledge presented. "Gestalt perceptual principles are used, where possible, to indicate symmetry, similarity, continuation, parallelism, and information gaps." The nodes and links are also manipulated to reflect the organization of the knowledge. There are three suggested knowledge prototypes. If the information on the map is hierarchical, the map may look similar to one of Novak’s concept maps. (See Figure 3.) If the information is
about a process, barbed linking lines may be used to show the direction in which the process proceeds (Lambiotte et al., 1989). Figure 5 illustrates a cluster knowledge prototype.

Figure 5. An example of a cluster knowledge prototype as used in knowledge mapping (Lambiotte et al., 1989).

The last feature of the TCU system is the map unit which is similar to a chapter in a book. “In the TCU system, a map unit can be formatted as a single, large map, or as a hierarchical set of interlocked or cross-referenced maps,” not unlike the way street maps of a city are often organized. There is one overall or master map showing the topics of the sub-maps. The user goes to the particular sub-map as indicated on the master map to locate the expanded information about the topic selected. The issues here are size and complexity. A large map can provide an overview of the whole concept but can be difficult to use. The smaller maps will have less information and may be more practical to use (Lambiotte et al., 1989).

The TCU semantic map developers describe two ways in which maps are produced: from the top-down or from the bottom-up. They claim the top-
down method requires the cartographer to be familiar with the topic or domain being mapped so as to be able to predict an overall structure for the map. This approach would more likely be used by experts such as instructors or advanced students. The novice (to the domain of knowledge being mapped) will know perhaps only a few key ideas and thus be likely to choose a bottom-up approach to map construction. After a critical mass of information has been put on the map, the cartographer will then be able to discern a useful organizational structure (Lambiotte et al., 1989). From the description provided, it appears that maps are created by a single cartographer in the TCU system. However, this is not explicitly stated to be the case.

To read or process a multirelational semantic map requires that the user be familiar the TCU features described previously. The authors suggest scanning the map first, looking for symmetries, knowledge gaps, highlighted information, and a knowledge prototype (e.g. hierarchy). The purpose of the scan is to give the reader clues as to how to proceed to understand the information on the map. They suggest making annotations and creating visual images to help recall information later (Lambiotte et al., 1989).

The authors go on to describe the TCU system in even more detail. They discuss maps in which the nodes are stressed, maps that are link-based, and hybrids of these with spatial arrangement included for good measure (Lambiotte et al., 1989). It would seem that once the elements described above are mastered the cartographer is fairly free to develop his own style within these guidelines.

The TCU knowledge mapping system seems very complex and prescriptive, particularly when it comes to linking the nodes or concepts. In other
ways, Novak's system can be even more rigid such as the requirement for a hierarchical arrangement of concepts. The next method of mapping describes a system with almost no rules.

**Mind Maps**

Nancy Margulies (1991) writes “mind mapping is a revolutionary system for pouring ideas onto paper,” a kind of visual note-taking technique. She makes all sorts of claims such as enhancement of learners' thinking skills and creativity. She states that mind mapping “is rapidly replacing traditional note-taking and outlining in schools and workplaces throughout the world.” There is scant empirical evidence for such claims offered in her book.

Margulies gives credit to Tony Buzan for inventing mind mapping. She claims his “system is designed to integrate the processing styles of the left and right hemispheres” of the brain. She further credits Michael Gelb with developing a system to teach mind mapping (1991). Much of Buzan’s theory is based on the research of Roger Sperry. Sperry’s studies in the early 1960’s revealed that the two lobes of the cerebral cortex functioned very differently. The right side is more active during non-verbal activities such as drawing and listening to music and the left side when using language or doing mathematics (Buzan, 1983). Although much research has been done in the years since, this analogy is still somewhat useful when trying to describe an activity as being *whole-brained* such as mind mapping. The impact of this research on mind mapping is seen primarily in the stress on using pictorial representations for ideas.
A mind map begins with a central topic placed in the center of a sheet of paper. Ideally this concept will be shown by a representative image of some kind rather than a word. The next step is to let the cartographer’s mind freely associate with the topic. Symbols or drawings are put on the paper to represent additional ideas. The use of multiple colors is encouraged. Key words are added to the map. The rule is to use no more than one word on a line. The idea is to limit the words to only essential elements. Further, with single words it becomes easier to add more associated words and lines. Symbols may be used with key words or by themselves. Connecting or linking lines between concepts are shown on all the examples in Margulies’ book but there is no description or suggestion to add them to the map other than with words as mentioned above. One would infer that this is left to the mapmaker’s discretion. If a symbol doesn’t come to mind for a particular idea, Margulies suggests drawing a shape or a cloud and returning to it later to create an image. An entire chapter is devoted to *Symbols and Drawing*. She places much stress on the use and importance of images. She also suggests that if an unrelated idea comes to mind that the mapmaker wishes to remember, that it be recorded off to the side of the map. She further suggests what be done when the mapmaker runs out of space: use a line or arrow, make additional maps of ideas that need expansion, or add more paper (Margulies, 1991). Margulies emphasizes the very practical issues when describing mind mapping.

Once the initial brainstorming phase is complete, the next step is to organize the map. Margulies (1991) suggests the map may be redrawn organizing similar and connected ideas together. She also encourages adding ideas as they occur at a later time and crossing out ideas that no longer are
desired on the map. There is no mention of any hierarchical arrangement of concepts. Figure 6 is an example of a mind map.

Margulies (1991) claims maps can be created using many people's ideas such as a family planning a vacation, or a class planning a project or reviewing a topic. Most of her book is, however, directed to the single cartographer.

Figure 6. A mind map showing the key features and ideas of a mind map (Margulies, 1991).
Mindscapes

Margulies (1991) also describes a technique called mindscaping as a mapping process to use once mind mapping has been mastered. Mindscaping removes the few rules imposed on mind mapping. In particular, the map can be started anywhere; there does not need to be a central topic. Also, more than one word may be written on a line. In other words, Margulies says, anything goes. This is a totally idiosyncratic technique. She encourages the mapmaker to be as varied as possible, to use whatever resources are available such as photographs or magazine pictures, and to use these mindscapes for whatever purposes (or functions) can be imagined.

Concept Circles

James Wandersee (1987), after working with Novak for seven years proposed a new learning tool, the concept circle diagram, that at first appears to be the same as a Venn diagram. Wandersee agrees to that similarity but says concept circles are more closely related to mathematician, Leonhard Euler's circles which were in fact later replaced by Venn diagrams. Concept circles can represent a broader range of relationships than the set theory operations of union, intersection, and complementation of Venn. They are also labeled with words rather than relying on a key to decode letter labels.

Like Novak, Wandersee's (1987) device is based on Ausubelian learning theory and constructivism. To this he has added visual perception research which Novak likewise incorporates to a lesser extent, and Euler's logic diagrams. Wandersee claims that after working for seven years with concept maps and Vee diagrams (described in the following section), he perceived a
need for something simpler with which to introduce students to metalearning. In fact he proposes a sequence for teaching students to use these tools as shown in Figure 7.

![Diagram of concept circle diagrams]

**Figure 7.** A proposed sequence of instruction using concept circle diagrams to learn how to learn science (Wandersee, 1987).

Wandersee (1987) defines concept circles as "two-dimensional geometric figures (circles) that are isomorphic with the conceptual structure of a particular piece of knowledge and are accompanied by concept labels." His definition of a concept is identical to Novak's, described earlier. He lays out a
set of fifteen steps or rules for constructing a concept circle diagram. His system is very structured. Following is a brief summary which highlights the major steps in this process. Figure 8 shows an example of a concept circle diagram.

Each circle represents a science concept. Only five or fewer circles are allowed. Circles must be labeled. Concept labels must be printed horizontally and in lowercase letters. Placement of the circles indicates the relationship. Circles may be separate, overlapping, included, or superimposed. For example, in Figure 8, monocots and dicots are both angiosperms. Hierarchical relationships are indicated by the size of the circles. He provides a template for drawing these specifically-sized circles. In Figure 8, a dicot is an angiosperm, and an angiosperm is a seed plant. Time relationships are represented by nested or concentric circles with a \((t)\) placed near the oldest concept. In Figure 7 the basic principles will be taught first so they are the oldest concept. Likewise, the area of the circles can represent relative amounts. An \((n)\) near the concept label of each circle shows that this relationship is intended. Every diagram must have a descriptive title. Other features include redrawing diagrams to improve them, using empty and shaded space to imply that other concepts have been omitted or not, and connecting to additional circle diagrams by means of telescoping graphics and scrolling paper. Color may be used to “make the relationships between concepts easier to visualize, understand, and recall” (Wandersee, 1987). Exactly how this is to be accomplished is apparently left up to the concept circle constructor. This is surprising considering the specificity of Wandersee’s other directions and the fact that he spends quite a bit of time building a case for using color in these diagrams.
Wandersee (1987) presents an interesting hypothesis: "The meaning of most science concepts is derived from relationships of hierarchy or taxonomy. Hierarchical relationships may best be revealed using concept maps; taxonomic relationships (especially inclusion and exclusion ones) may best be revealed using concept circle diagrams." He further invites research in the use of these diagrams with young children.

The Classification of Seed Plants

![Concept Circle Diagram]

Note: Colored shading on the original student diagram made the individual concepts more distinct.

Figure 8. A typical concept circle diagram with accompanying title and explanation (Wandersee, 1987).
Knowledge Vees

D. Robert Gowin, another colleague of Novak, developed the heuristic device known as the knowledge Vee. "A heuristic is something employed as an aid to solving a problem or understanding a procedure." The Vee was designed to help learners understand the structure of knowledge and the process of knowledge construction. It was first used by college students to clarify the nature and purpose of science laboratory work. Gowin's earlier work produced five questions designed to be applied to any document or work presenting knowledge. These five questions are the basis for the knowledge Vee. "(1) What is the telling (or focus) question? (2) What are the key concepts? (3) What methods of inquiry (procedures) are used? (4) What are the major knowledge claims? and (5) What are the value claims?" (Novak & Gowin, 1984).

A Vee map has two sides, a conceptual or knowing and thinking side and a methodological or doing side. These two sides are in continuous, active interplay. Figure 9 details the elements that go into the construction of a knowledge Vee. Figure 10 presents a Vee framework for upper elementary students to create their own maps suggested by Wolff-Michael Roth and Guennadi Verechaka (1993).
CONCEPTUAL/THEORETICAL

(THINKING)

World View:
The general belief system motivating and guiding the inquiry.

Philosophy:
The beliefs about the nature of knowledge and knowing guiding the inquiry.

Theory:
The general principles guiding the inquiry that explain why events or objects exhibit what is observed.

Principles:
Statements of relationships between concepts that explain how events or objects can be expected to appear or behave.

Concepts:
Perceived regularity in events or objects (or records of events or objects) designated by a label.

FOCUS QUESTIONS(S):
Questions that serve to focus the inquiry about events and/or objects studied.

METHODOLOGICAL

(DOING)

Value claims:
Statements based on knowledge claims that declare the worth or value of the inquiry.

Knowledge claims:
Statements that answer the focus questions and are reasonable interpretations of the records (or data) obtained.

Transformations:
Tables, graphs, concept maps, statistics, or other forms of organization of records made.

Records:
The observations made and recorded from the events/objects studied.

Events and/or objects:
Description of the event(s) and/or object(s) to be studied in order to answer the focus questions.

Figure 9. Gowin’s Vee heuristic invented to illustrate the conceptual and methodological elements that interact in the process of knowledge construction or in the analysis of lectures or documents presenting knowledge (Novak, 1990b).
Webs

A web is, at least visually, the closest thing to a concept map. Webbing is a mapping technique that appears primarily in the field of language arts. Webs are often the result of a brainstorming or summary session. They are used for such things as analyzing stories and planning an essay. Jay McTighe (1992) describes a web as featuring "a central idea or topic located in the middle of the
design. Related categories and supporting details branch out from the center."

Figure 11 illustrates a typical web.

Figure 11. A web about kites (McTighe, 1992).

Zelene Lovitt and Joan Burk (1988) present a similar form for a web. The web is presented to the students with the main idea, theme, or topic and the subtopics supplied. These have been predetermined by the teacher. The students fill in the details. They suggest maps be color coded to help delineate subtopics and details and to identify the chronology of information such as pre-teaching and post-teaching information. Figure 12 shows this basic web design.
Semantic webs and structured overviews are types of webs that have been described in reading and vocabulary development areas. Carole F. Stice and Marino C. Alvarez (1987) describe a semantic web as a graphic organizer much like a concept map that "evolves from a central idea or core concept." Johnson, Pittleman, and Heimlich (1986) add that semantic webs can be hierarchical; they radiate from the central concept with unlabeled linking lines to subordinate concepts to which supporting details are drawn; and, color can be used to differentiate sources of information. Structured overviews were described briefly by Stice and Alvarez as arrangements of the elements of a concept into a hierarchy.

The discussion web is described here only because it is one of the few pieces of research in which results with kindergarten students were reported.
The discussion web presents a question for which students give reasons why the answer might be yes or no. Once this information is recorded, a conclusion is drawn. In the kindergarten example, the question was whether Jack from *Jack and the Beanstalk* should have taken the things from the castle. The teacher conducted the discussion with the whole class and did the writing on the web herself. The author, Donna Alvermann (1991) suggests the discussion web could be applied to science where the results of an experiment go to support one of two hypotheses to a question about the cause of acid rain. The format for a discussion web is shown in Figure 13.

![Figure 13. The basic format of a discussion web (Alvermann, 1991).](image)

**Computerized Concept Maps**

There are several computer versions of concept mapping available. This dissertation was planned using *Inspiration™*, a program intended primarily for business applications. It was also used by AAAS to organize ideas for the K-12 curriculum in Project 2061 (Fisher, 1990). *Inspiration™* readily switches between an outline format and a concept map presentation. These transitions, however, often did not reflect concept relationships as intended by this
mapmaker. *Inspiration™* was also used to create most of the figures included in this paper. The program occasionally had to be employed more as a drawing program than a concept mapping program to achieve the intended results.

*SemNet™* is another computer program designed to create semantic networks, yet another version of concept maps. "A semantic network," according to Kathleen M. Fisher (1990), "captures (in part) each concept's position in psychological space, identifying both the concepts to which it is connected and the nature of the links that bind them together." Fisher describes some of the features of *SemNet™* as "n-dimensional (nets go beyond the two dimensions of concept maps); each concept can be linked to many other concepts; relationships are bi-directional; representations can include images, text, and sound; and, nets can be very large." Disadvantages of *SemNet™* mentioned were the nets being too large to be able to get an overview and all the links look alike. Advantages are "the ability to integrate ideas across a large knowledge base, the ease and rapidity of net creation, the ease with which elements (concepts, relations, or propositions) can be found within nets, and the utility of nets as self-study tools." Fisher further discusses the pros and cons of using the computer and paper-and-pencil to create concept maps. Some of these will be mentioned later in this chapter within the discussion of the functions for concept mapping.

Fisher (1990) describes several other programs available for microcomputers to create concept maps. Leximapper™ uses HyperCard™ to construct concept maps from text. Learning Tool™ has students arrange notecards and link them together on screen. Pathfinder™ claims to construct networks from semantic proximity data. The Semantic Mapper™ lets early elementary students and teachers create concept maps in the reading area. HyperCard™, itself, can be seen as a concept mapping device. It is in fact a programming environment that easily links things (stacks) together. These links are unseen and unnamed in contrast to programs like SemNet™ and Inspiration™ which were designed to display relationships.

Other Versions of Concept Maps

Harry Stein (1988) describes another version of concept mapping. He says “concept maps show relationships between pieces of information. Students use note-taking to label and define parts of the information map.” The teacher prepares an unlabeled map based on the chapter about to be taught. The students fill in the blanks to create a study guide. Alternatively the teacher and students create a map together during a discussion which the students then copy. He suggests using different shapes on the map to denote the main idea, supporting ideas, examples, and so on. Stein claims concept maps are powerful devices which proceed from one assumption: “The teacher has defined what is worth knowing.” He makes a number of claims without providing any evidence. It would appear this is a behaviorist approach to concept mapping based on the uses he has suggested, including a check for comprehension and retention and a test-review device. Visual mapping as
described by Stein seems to be primarily a different name for webbing in a science context.

**Graphic Organizers**

Concept maps, multirelational semantic maps, mind maps, webs, Gowin's Vee, and concept circles are all examples of graphic organizers grounded in Ausubel's learning theory. Graphic organizers is a broad category which includes such things as sequence chains, story maps, attribute wheels, thinking frames, Venn diagrams, and many other sorts of tables and charts. Jay McTighe (1992) has described graphic organizers as providing “a visual, holistic representation of facts and their relationships within an organized frame.” This category is mentioned here only as a clarification. Based on this researcher's experience, some teachers use the more global term, graphic organizer, to mean the same as the more specific term, concept map. This is not incorrect but graphic organizer is generally understood to include a broader spectrum of visual organizers. In addition, Lambiotte et al. (1989) state that much research on knowledge maps has been conducted in the context of reading comprehension wherein maps are commonly referred to as *graphic organizers*.

**CONCEPT MAPS: THE RESEARCH ON FUNCTIONS**

Having described the many forms concept maps can exhibit, the issue of how they can be used or their function will now be addressed. Almost every author and researcher reviewed seemed to have multiple ideas as to how
concept maps could be used. This discussion will be limited primarily to the functions for concept maps within the classroom by the teacher. The perhaps obvious but certainly relevant solution to organizing the vast amount of information collected on the use of concept mapping was to create a concept map. Figure 14 on page 60, illustrates teacher uses for concept maps. DeFrank (1993) suggested the most useful organization schema found in the literature. She proposed five major applications of concept mapping for teachers:

1. Brainstorming and Assessing Initial Knowledge.
2. Cataloging or Record Keeping.
5. Planning and Organizing.

Novak (1984) rather loosely organized his descriptions of the uses for concept maps into the categories of educational applications, instructional planning, evaluation, and educational research. Some authors lumped all uses together in a single section. Others described only the functions that pertained to their particular research. It is interesting to note that the uses teachers suggested in the survey described in Chapters 1 and 3 were nearly identical to the uses described for teachers in the literature.

The end solution was to create an organizational pattern which focused on the particular teacher functions for concept maps that were targeted in this study. The following discussion will also include other functions for concept maps related not only to the classroom but to the field of education. The general categories identified were Assessment, Brainstorming, Summarizing, Record Keeping, Planning, Learner Thinking Skills, Learner Social Skills, Individual Learner Needs, and Special Learner Needs.
These categories are not mutually exclusive. It would be helpful if such an organization could be developed but it seems the nature of concept mapping as used by teachers is usually multi-functioned. Each of these general categories will be discussed more particularly in the following paragraphs.

Considering the quantity of suggestions for the use of concept maps described in the literature, it was surprising to find such a lack of empirical research in the literature search described previously. What little evidence there is supports mainly their use with junior high school through college age students. This finding is supported by Lambiotte et al. (1989), Willerman and Mac Harg (1991), and Roth and Roychoudhury (1993), who likewise attempted to synthesize the literature on concept mapping.
Figure 14. Overview of functions for concept maps by teachers found in the literature review.

**Concept Maps: Assessing**

*(Knowledge Acquisition)*

Assessment as a function category for concept mapping, includes a variety of more specific uses. The literature describes teachers using concept
maps to assess prior knowledge and on-going learning, as well as to evaluate after instruction and to assess their instruction.

The assessment of prior knowledge is perhaps the most cited use for concept maps. This is not particularly surprising since Novak (1984) and his researchers developed concept maps originally to determine the concept development of students, using them as a sort of pretest and post test with an intervention (audio-tutorial instruction) in between. Novak has described how to concept map with students to explore what they already know. Students are given a choice of preselected concepts as the base of their map. They are then helped to identify prior understandings, to construct propositions, and to arrange the concepts into a hierarchy. Novak says this use of a concept map as a preinstructional tool provides a conceptual benchmark from which students can build further meaning but he provides no evidence that this is the case.

As a part of a professional development seminar, experienced DASH teachers were asked to undertake and report on some action research with their own elementary students. These reports have been published and would appear to have as much validity and perhaps more relevance to this discussion than much of the descriptive evidence included in the more traditional sources found in this literature review. Many of these teachers undertook studies related to concept mapping. One of them surveyed teachers and found concept mapping to be the second most used activity in DASH classrooms after the daily learning calendar. Some of these teachers' other findings will be included in the following discussion.

Fifteen of the twenty-four DASH teacher studies on concept mapping reported using concept maps as an assessment tool. The most cited use was to
determine their students' prior knowledge. Most maps were created as a group activity to provide the teacher and students with a picture of what the class already knew. Teachers described using this information to identify the needs of their students, as a pretest, to alter instruction, to set up meaningful, connection-making learning activities, to identify misconceptions and to begin a unit of study (DASH, 1995; DeFrank, 1993). Grant, Johnson, and Sanders (1990) have also described concept maps as being used to "give the teacher knowledge of the prior understandings of students as they begin a new area of study." Novak (1984) says concept maps are "remarkably effective tools for showing misconceptions" because they graphically portray student's understandings of relationships between concepts. Novak builds a strong theoretical case for most of his claims but seldom goes beyond describing his observations for evidence.

The DASH teacher studies (1995) described using concept maps to record and assess new concepts and connections or relationships being learned during a course or unit of study and as a post assessment tool. This seemed to be done primarily as a whole group activity. One teacher reported that her grade two students gained and/or clarified their knowledge based on their concept maps, teacher observations, student comments, and participation. Her students first did maps in pairs and then as a class activity. Grant et al. (1990) also say that concept maps can be used to give the teacher feedback of student learning resulting from a teaching sequence. They suggest each student be asked to create a map prior to a new area of study and after the topic has been taught. The teacher can then determine what learning has taken place by comparing the two maps. Stice and Alvarez (1987) say concept maps provide the teacher with opportunities for further direct instruction. While not
stated explicitly, it is assumed this direct instruction is in regard to misconceptions and gaps in knowledge found on student-constructed maps. They claim first grade “children’s concept maps can become increasingly detailed and accurate as teachers help clear up misinformation and as children learn.” Stice and Alvarez do provide illustrations of children’s concept maps as examples for this claim.

McTighe (1992) suggests using graphic organizers to assess students’ understanding of new concepts. Diane E. Levin (1986) describes using concept maps to monitor individual student’s activities and progress in a day care program. Novak (1984) says that once students know how to construct maps they can become powerful evaluation tools. He claims concept mapping causes students to analyze, synthesize, and evaluate information which is hard to accomplish, much less assess with a more traditional test.

Kimberly M. Markham, Joel J. Mintzes, and M. Gail Jones (1994) found concept maps to provide “a theoretically powerful and psychometrically sound tool for assessing conceptual change in experimental and classroom settings.” They studied the conceptual differences of fifty advanced college biology majors and beginning nonmajors. They present convincing evidence of the differences in the structural complexity and organizational patterns of the knowledge in the domain of mammals of these two divergent groups as represented on their own concept maps. Although this study was done with older students, it does lend support to the use of concept mapping as an assessment tool.

Anderson and Demetrius (1993), in their study of the use of concept maps to record interview responses, suggest that their method of recording
interview data with flow maps, can graphically represent student responses and that this provides a visual map of current conceptions and may be used to display changes in conceptions. This study seems to provide some evidence that this sort of concept map may be an effective way to record student responses which could in turn be a means to represent prior knowledge of students identified during a class session. The maps in these studies were done with individual students. To extend this to a group of students or a class, with a teacher rather than a trained interviewer is something of a stretch, but there is some indication here that this may be a useful technique.

Several researchers have described ways to score concept maps. Novak (1984) and his researchers were interested in what students maps looked like before and after instruction and over a number of years. They were looking for qualitative changes. They were however asked to devise a scoring system and responded with a scheme based on Ausubel's theory. Their criteria include valid relationships, hierarchical levels, cross links, and examples. Elena Maldonado Vargas and Hector Joel Alvarez (1992) have taken Novak's criteria, modified them somewhat and applied a point system. They have added branching to Novak's scheme. "A branch is a relationship established between one concept and two or more concepts at the next hierarchical level."

One of the DASH teachers described using the class concept maps to reflect on her own teaching. She found students' post knowledge to be greatest in areas where she had spent the most time. She was also able to evaluate which activities were meaningful for her students (DASH, 1995).

Two of the DASH teachers reported using concept maps to share student progress with parents. Levin (1986) describes using concept maps to
communicate with parents what has happened in the classroom. They are used to help explain and justify the activities in which the students engage. Margulies (1991) suggests teaching parents to do concept maps so they can do them at home with their children.

There is some direct evidence that the concept mapping process itself increases knowledge acquisition. Novak (1984) makes a strong argument that this is the case. Several studies with college students have shown concept mapping to be effective in constructing and retaining information (Stewart, Vankirk, & Rowell, 1979; Novak, 1981). Novak, Gowin, and Johansen (1983) had similar results with 7th and 8th grade students in science. Heinze-Fry and Novak (1990) showed concept mapping with college students had a positive effect on SAT scores, initial learning, and retention although it was not statistically significant. Stice and Alvarez (1987) reported that according to the classroom teachers in their study of elementary students, chapter tests improved. This study is included because it is one of few that involved elementary aged students.

Although there does not seem to be much empirical evidence for the effectiveness of using concept maps in assessing young students, the sheer volume of descriptive studies leads one to acknowledge that this area may well be worth investigating.

**Concept Maps: Brainstorming**

Brainstorming is often suggested as a use for concept mapping. This function overlaps the description of assessment, particularly of the prior knowledge of students. This overlap is illustrated by a connecting link in Figure
14. Many of the DASH teachers reports described above suggested concept maps be used in this way. One grade four teacher reported that her students first independently listed words to go on the concept map. Afterwards, during the students’ creation of a class concept map, several students recalled ideas they had omitted on their original lists. The implication here is that the concept mapping activity prompted students to recall further ideas (DASH, 1995).

Several authors have suggested brainstorming with concept maps as a way to generate ideas (McTighe, 1992; Margulies, 1991). Those ideas may be used to write a story, plan a unit of study, and so on but the issue here is on the creation of the concept map. These ideas are often organized as they are placed on the map. Organization will be discussed under Concept Maps: Learner Thinking Skills. No particular research on the effectiveness of using concept maps to brainstorm was found.

Concept Maps: Summarizing (Knowledge Acquisition)

The broad function of concept mapping to summarize information encompasses a variety of more particular uses. Margulies (1991) defines concept mapping as visual note taking. She suggests mapping books, discussions, negotiations, and memories of events. Novak (1984) also says concept maps can be a note taking tool. He (1984, 1991) suggests concept maps be used to take notes on or extract meaning from textbooks, chapters in books, articles, lectures, demonstrations, and lab experiments. Novak (1984) gives three reasons for using a concept map over an outline. “First, good concept maps show key concepts and propositions in very explicit and concise
language." Second, they are succinct and show key relationships in a simple visual way. Third, “concept maps visually emphasize both hierarchical relationships between concepts and propositions and cross-links between sets of concepts and propositions.” Novak claims students seem to prefer concept mapping to outlining. This appears to be based on observational data. A study by Pankratius and Keith (1987) revealed no significant difference in achievement by ninth grade physical science students who used concept maps and those who did outlines. Lehman, Carter, and Kahle (1985) reported similar findings with inner city black students in an eight week biology unit. It would appear more research needs to be done to determine if concept mapping is a more effective way to take notes than outlining. Stice and Alvarez (1987) reported in their study that 4th and 5th grade teachers found that their students discovered material in their textbooks that was difficult to map. Sometimes this was due to poorly written texts. Students experienced difficulty reading and understanding this material. Concept mapping helped the students to reconstruct the information and find logical gaps in the text, according to the teachers.

One of DeFrank’s (1993) categories of functions is to summarize learning. She suggests constructing a concept map as a cumulative activity to a unit of study. A grade one teacher in the DASH (1995) studies reported using concept maps with her students to summarize information. Margulies (1991) suggests using maps for group reviews of a topic. Such summary maps can provide a valuable resource in future studies. Stice and Alvarez (1987) “found evidence that concept maps can serve as a useful aid in reviewing the (elementary aged) children for chapter tests.” They did not describe their
evidence. McTighe (1992) suggests maps are a way to store and retrieve information. A meta-analysis of graphic organizer studies showed some positive effect on learning when the organizers were constructed by the reader as a post reading activity (Moore & Readence, 1984). In a study of community college science students trained in the construction of graphic post organizers in a study skills class, the students recalled and retained significantly more content than the control group students who underlined, reread, or highlighted the material studied (Spiegel & Barufaldi, 1994). College students using the Texas Christian University (TCU) mapping system in a post reading activity significantly outperformed the control group on measures of the main idea but not on details (Holley, Dansereau, McDonald, Garland, & Collins, 1979). Positive effects on comprehension were found on a tenth grade world history class when using post reading graphic organizers (Bean, Sorter, Singer & Frazee, 1986). Similar results were found in an eight week study with eleventh graders in American history. It would seem that the use of graphic organizers which includes concept maps, used as summary and post instruction devices have been shown to be somewhat effective on student comprehension and learning in these studies. However, there have been other studies that tend to negate these findings to some degree. No significant difference was found on traditional classroom tests between ninth-grade students who constructed maps and those who did not (Fraser & Edwards, 1985). Similar results were reported in a study of black inner-city students (Lehman, Carter, & Kahle, 1985) and in a study with high school biology students (Sherris & Kahle, 1984). However, Fraser and Edwards (1985) found after further analysis of their data that over 50% of the students who achieved a high level of concept mapping skill mastery
did show significant achievement while those without mastery of the mapping process did not. This seems to indicate that the degree of concept mapping skill students have may have an effect on their achievement. Considering this contradictory evidence it would appear there needs to be further study on using concept maps as a means to summarize what has been learned.

Both Novak (1984) and Lambiotte et al. (1989) describe using concept maps as advance organizers to a topic of instruction. This is in line with Ausubel's learning theory. These maps are usually created by an expert on the subject, often the instructor. Lambiotte et al. suggest these expert maps can supplement or be substituted for traditional texts, study guides, or lecture presentations. These expert maps have also been used in pre-reading activities to teach vocabulary (e.g., Johnson & Pearson, 1984), to activate appropriate knowledge schemas (e.g., Gold, 1984), and to help generate predictions (e.g., Reutzel, 1985). Willerman and Mac Harg (1991) conducted a study to determine if concept maps used as advance organizers would improve science achievement of eighth grade students. Their study revealed a significant difference in achievement between the map group and the control group indicating that this may be an effective use for concept maps. Several research studies on expert-produced knowledge maps have been conducted at Texas Christian University under the leadership of Donald F. Dansereau. (See semantic maps in the previous section.) Their research has shown that knowledge maps provided as advance graphic organizers can be effective in main idea comprehension and learning (Dansereau, 1988; Hall, Dansereau, & Blair, 1990; McCagg & Dansereau, 1991; Rewey et al. 1992). Lambiotte (1989) reports that other studies by the TCU group on using expert-generated maps
have found that college students can more quickly acquire an overview from a map than from a text; maps of a process or procedure are more effective than maps describing a concept; process or procedure maps are more effective than text for determining main idea and structure of a knowledge domain; there is some evidence that maps may interfere with the processing of pictures related to the content; and, students with little prior knowledge of a topic benefit from using these maps during a lecture.

Considering the studies described in the previous two paragraphs brings up the question of whom the mapmaker should be, the student, a group of students or a class, or the expert. There seems to be no direct research in this area. Novak (1990b) claims that “the primary benefit of concept maps accrues to the person who constructs the maps.” He bases this assertion on the findings of Cardemone and Bogden who reported mostly negative responses to questionnaires given to students to determine the helpfulness of expert maps distributed to them prior to instruction (in Novak, 1990b). Lambiotte et al. (1989) claim that maps actively generated by students facilitate the comprehension of complex information. They cite a number of studies which support this claim. No studies were found on the comparative effectiveness of single learner vs. group constructed maps or on novice vs. expert constructed maps.

**Concept Maps: Record Keeping**

DeFrank (1993) has defined the record keeping function of concept maps to be the revision of the map over an extended period of time. The initial map is a record of a class’s collective prior knowledge. New information is added to the map along with the date as it is learned by the students. This provides a record
of student connections between prior and new knowledge, revised concepts and relationships, as well as of newly learned concepts and relationships. There was no discussion as to the effectiveness of this function found in the literature. This researcher has observed concept maps being used as such but beyond that, nothing has been shown empirically.

Levin (1986) describes the use of concept maps to record and organize information about what occurs in a day care classroom for four and five year olds. Each day the teachers brainstormed ideas and made them into a curriculum web to keep track of what activities had occurred and to plan what might happen next. These webs were then used for a variety of purposes, some of which will be described in some of the following sections. The concern here is with the recording of daily activities and ideas. There was no particular evidence given as to the effectiveness of this technique for recording the information, only a description of it.

O. Roger Anderson and Olive J. Demetrius (1993) reported on the use of concept maps to record and display interview responses of five junior high school students. They used flow maps to show the flow of information, the points in the flow where links were made, and the time required for the students to retrieve and express information. The maps were then analyzed for the relationships between interview emphasis and the number of multiple relationships made by the students. The study, although small, provides some indication that this is as an effective use for concept or more particularly, flow maps. This dissertation study also used concept maps to record and analyze student responses during interviews. This is described in Chapter 3.
It appears concept maps can be used to record a variety of information. There is some evidence that maps are an effective way to record student responses to an interview but there appears to be little evidence other than descriptive reports that concept mapping is an effective recording device in other areas.

**Concept Maps: Planning**

Planning has a strong link with *Learner Thinking Skills* discussed in the following section, in that most planning involves some degree of organization of ideas and/or information. Likewise, organizational skill is often used in a planning context. This link is illustrated above in Figure 14.

Novak (1984) describes using concept maps to plan for instruction. He suggests they be used to plan single lessons, units of instruction, and even a yearly curriculum. Lovitt and Burk (1988) say webbing provides a more comprehensive method to plan activities for lessons than outlining. They claim “outlining forces thoughts to be compartmentalized and restricts the flow of thought.” This appears to be their opinion as no evidence is cited. Levin (1986) describes teachers’ use of curriculum webs to plan, organize, and justify classroom activities. The teachers used the webs to achieve a balance between allowing their preschool children “to pursue their own interests and providing overall guidance and direction to their learning.” Levin also describes using a web with a teaching staff to plan curriculum activities around rocks. As this web evolved it became a record of what had happened in the classroom as mentioned previously. Later it was used to show parents what students had been doing and to assign children to particular activities. Levin claims a single
map can serve several functions. Although only two examples were described as evidence, this multi-function map idea has obvious merit. One of the DASH (1995) action research reports describes using concept maps to organize information about what the students already knew (their prior knowledge), what they wanted to find out, and later, what they had learned. This too is an example of a multi-functioned map.

Margulies (1991) and DeFrank (1993) both suggest using maps to plan projects. This project planning can be done by students, teachers or both. The project might be a class party, a science fair project, an experiment, a field trip, or even a vacation. One of the DASH (1995) reports described students using a concept map to report on their research project.

Concept maps can be used to plan interviews, talks or lectures, presentations, and discussions. Novak (1984) describes using concept maps to design better interviews. He suggests using them to select interview content, to structure the questions, to sequence the questions, and to select auxiliary materials such as photographs to use during the interview. Some of the interviews conducted in this study used a concept map to structure and sequence the questions. Lambiotte et al. (1989) propose that teachers use maps to plan and organize their lectures. They suggest mapping may help to identify potential problem areas. Margulies (1991) uses maps herself to prepare for talks.

Using concept maps to focus student discussion was reported in the DASH (1995) studies. Grant et al. (1990) suggest that concept maps "provide a very useful starting point for students to discuss different understandings they have of science concepts. Previously learned understandings which are held by
students will be challenged when students have the opportunity to talk about their reasons for linking concepts in particular ways, comparing their links with those of other students, and needing to justify them." These are good suggestions but there appears to be no empirical evidence to support their effectiveness.

The largest group of suggestions for using concept maps to plan was in the area of writing. Novak (1984), Lambiotte et al. (1989), Margulies (1991), Lovitt and Burk (1988), McTighe (1992) and six DASH (1995) reports, all claim maps or webs can be used in planning writing. Lovitt and Burk report on a school-wide study where a high percentage (over half of the students were ethnic minorities) fell into high-risk groups. At this elementary school an upward trend emerged in standardized and criteria-referenced tests after webbing was introduced. Twenty-two of the thirty-two teachers voluntarily used this technique. All grades made significant gains in writing on the Texas Educational Assessment of Minimal Skills (TEAMS). In addition, test scores were reported for the Comprehensive Test of Basic Skills (CTBS) in reading and language. Mathematics, science, and social studies test scores were not included. Reading scores improved in grades 1, 3, and 6. Language improved in all grades. This study has some obvious flaws. One wonders how other variables were controlled. Why were all students included? It would have been interesting to see how the students in classrooms with teachers using webs compared to students whose teachers did not use this strategy. Still, this was one of the few studies found with any empirical evidence which reported on elementary students. The DASH (1995) studies reported that using concept maps to plan helped students to organize and connect ideas in their writing.
Several authors suggested using concept maps to plan curriculum. Novak (1984) suggests using concept maps to identify significant content and choose examples when planning and organizing curriculum. Starr and Krajick (1990) say mapping allows curriculum planners to think divergently while ensuring that concepts are connected. Posner and Rudintsky (1986) consider three questions (What? Why? and, How?) when planning a curriculum with a concept map. There seems to be plenty of evidence that concept maps are used in the curriculum planning process. If they are more effective than other curriculum planning strategies, is a question yet to be answered.

In summary, there are lots of ideas for ways to use concept maps as a planning tool, including Novak’s (1984) use in planning for educational research and Margulies’ (1991) suggestions to plan for one’s daily or weekly schedules, for students’ classroom responsibilities, and for one’s personal goals. However, there is little evidence beyond descriptions of successes that they are more effective than other planning devices and techniques.

Concept Maps: Learner Thinking Skills

The remaining categories of functions for concept maps assume that teachers would choose to use a particular instructional strategy over another if that strategy could be used to enhance their students’ thinking skills, increase their social skills, facilitate the learning of different kinds of learners, and/or address the needs of learners with special problems.

Learner thinking skills encompass a wide variety of ideas, definitions, and theories. There is a tremendous amount of literature in this area. Depending on the author and context, thinking skills are referred to as problem
solving, critical thinking, reasoning, creative thinking, process skills, higher order skills, and so on. If the philosophic views on thinking are added to the cognitive psychology literature, the whole topic of thinking and thinking skills becomes incredibly complex (Jones & Idol, 1990) and beyond the scope of this dissertation study. For the purpose of this study, thinking skills are described as the capacity and proficiency with which a person can mentally manipulate sensory input to formulate thoughts, reason about, or judge. This description is based on Costa's (1985) definition of thinking.

This review discusses only those skills specifically mentioned in the concept mapping literature and addressed in this study. Two thinking skills, organization and connection-making, were directly addressed in the study. Organization has been described as a core thinking skill by Marzano et al (1988). This study describes organization to include the categorizing, classifying, and ordering of information. To organize is to arrange ideas or concepts into groups according to some common characteristic and to give those groups labels that communicates that commonality. Organizing also includes placing concepts into groups or categories according to the previously established criteria for those groups.

Connection-making has to do with establishing and describing the relationships between two or more ideas or concepts. This is very similar to Novak's (1984) definition of a proposition. Connection-making has a broader scope in that such relationships do not necessarily appear as words and lines on a concept map. There is not a clear-cut distinction between connection-making and organization. Rather, the student uses connection-making to
organize information. Connection-making is an organizing subskill in this context.

Lambiotte et al. (1989) describe semantic mapping as a learning and thinking tool. Wandersee (1990) calls concept mapping a metacognitive tool. Margulies (1991) claims mind mapping expands thinking skills but does not elaborate beyond the claim. Stice and Alvarez (1987) cited two examples of students using concept maps to solve problems. Second and third grade students frequently tried to map a concept they did not understand and try to figure it out. The students claimed the maps helped them clarify and understand (the problems). In a second grade writing class, a student was reading a draft of her story. When it didn’t make sense and questioning did not seem to clarify it, one of the students suggested they concept map her story to determine what was missing. Although these are examples of students using maps, it would seem the teachers had some role in the selection of concept mapping as a strategy by their students. Lovitt and Burk (1988) say webbing enhances thinking skills. They do at least make an attempt to describe what they mean by the term. They claim “webbing helps students develop skills in critical thinking and problem solving.” They say it is particularly beneficial to students with experiential deficits and cultural differences, and to improve language skills and abstract thinking. They make a case for their claims by describing how webs access prior knowledge and connect new learning to it. Webs, according to Lovitt and Burk, provide a ladder to higher level or abstract thinking by helping students to make sense and order of new information, and generalize information to other content areas. This is not a strong argument but a good lead in to some more specific thinking skills.
Concept maps may help students to organize information. Novak (1991) says concept maps can be used to organize knowledge. By definition they are designed to do this. McTighe (1992) likewise says graphic organizers, including concept maps, help students organize information and ideas. The question is, does concept mapping help students to organize information better? And more specifically, better than what, better than they were able to organize before or better than other organizing techniques? No studies were found other than the DASH (1995) action research reports and Stice and Alvarez (1987) that addressed these questions. Five of the DASH teachers reported that concept maps helped their students to organize, classify, and categorize information by providing them with a strategy for performing these operations. Stice and Alvarez said that all nine teachers in their study, including the three kindergarten teachers, felt concept mapping helped their students with organizational skills such as comparison-and-contrast and cause-and-effect. The DASH teachers cited same-and-different and relevant-and-nonrelevant in their studies. This is a beginning but there is much that could be learned about the effects of concept mapping on learners' organizational skills.

Student connection making is often mentioned as an effect of using concept maps. Novak (1984) says concept maps help suggest connections for the learner between prior and new knowledge. He also states students develop new connections as they draw their maps. Novak (1991) claims students find new ways to relate what they already know to create meaningful learning. Novak’s claims appear to be based on observations of students rather than on experimental research. Grant et al. (1990) go a step further when saying “concept mapping is a valuable strategy to use as it provides intrinsic motivation
to students, especially when new links are made to existing knowledge.” Novak (1984) seems to agree with this idea. He says “nothing has more positive affective impact on encouraging meaningful learning than demonstrated success in substantive accomplishment of meaningful learning.” Grant et al. also claim concept maps enable students to link ideas and knowledge learned in one activity with what was learned in another situation. They provide no information as to what justifies their claims. Margulies (1991) states that maps connect information and facts to a context which make the information more memorable. She provides no evidence that this is so. Cobern, Gibson, and Underwood (1995) describe a lesson designed to promote scientific literacy that uses an introduction to concept mapping to help 10th and 11th grade students connect school science to real world situations. Student responses indicate that they are making these sorts of connections. The DASH (1995) studies reported that students were making more connection when using concept maps and that they were able to connect information on science concept maps to other curricular areas.

Two of the DASH studies reported effects on student questions when concept maps were used. Students questioned what was being said by others and the number of questions students asked increased. These findings would seem to imply concept mapping has some effect on critical thinking.

Both Novak (1984) and Lambiotte et al. (1989) claim that mapping fosters or facilitates creativity. It is interesting to note that the TCU group referenced Buzon’s work in their discussion of creativity which is the basis for Margulies’ (1991) mind mapping technique. Specifically, they claim that semantic mapping capitalizes on the associative nature of the mind. Whether or not creativity
belongs in this category is questionable but a case can be made for including creative thinking.

The evidence for the effects concept mapping might have on thinking skills is scant at best. Based on the indications described above it would appear to be an area worth further investigation.

Concept Maps: Learner Social Skills
(Cooperative Learning and Participation)

Student participation and cooperative learning are the social skills discussed in this section. Much has been said previously in the discussion on constructivism regarding the students' need to participate in their own learning. Further, there is a great deal of research on the positive effect participation has on achievement (e.g., Bloom, 1976; Good & Breckerman, 1978; Borg, 1980). Borg states that participation, engaged time, time on task, and attention are all fairly synonymous terms.

There have been many studies on the benefits of cooperative learning per se by such researchers as R. E. Slavin (1990) and David W. Johnson and Roger T. Johnson (1986). This study agrees with the position that cooperative learning promotes student learning. The question here is whether concept mapping enhances cooperative learning and participation.

Novak (1984) says that concept mapping fosters cooperation between teachers and students. He claims this process creates a "learning atmosphere of mutual respect." Further, he states that concept mapping helps both the student and the teacher understand their roles in the learning process. Novak suggests reasons why this might be so but cites no evidence that it does in fact
occur. It is mentioned here because it concerns teacher-student cooperation. Most of the literature focuses on cooperation between students. This is most likely to happen where groups of students work together to create maps. Novak does not usually include this scenario in his model.

Lambiotte et al. (1989) found that providing expert maps facilitated cooperative interactions between college students. They did not offer any particular evidence to support this claim. One assumes they observed these cooperative interactions. Stice and Alvarez (1987) observed that group efforts by fifth grade students may have produced the best maps in their study. (Best was not explained.) They also found while watching peer-group mapping events, that students seemed more cooperative and responsive. The teachers confirmed this observation. Stice and Alvarez cite Gowin in building their case that this is a desired outcome. Gowin (1981) claims the social interaction that occurs during concept mapping is considered to be a crucial factor in learning how to learn. In the final discussion of their study, Stice and Alvarez state, "Meaningful learning may also be enhanced as a result of children's social interactions during brainstorming, initial mapping, discussions and revisions."

Eight of the DASH (1995) studies reported increased cooperation between students during concept mapping activities. One study in particular described grade two students learning and practicing cooperative skills while concept mapping, with much growth exhibited in these cooperative skills at the end of the school year. Another DASH study reported that when K-5 students worked in small groups they produced more complex ideas on their maps. These descriptive studies provide some indication that cooperative learning and
concept mapping may produce mutual benefit to the learner. These findings would seem to merit further study.

Margulies (1991) claims mind mapping increases participation in learning. No evidence was offered. The classroom teachers in Stice and Alvarez's study said their students' "participation in class discussion was much better and they appeared enthusiastic about class as a direct result of mapping activities. One of the teachers reported, 'All of the children could participate successfully. The notion of concept mapping seemed to make sense to them and they could really get into it.'" Five of the DASH (1995) studies support these findings. All reported increased student participation, two claimed one hundred percent. One study related concept mapping to both cooperative learning and participation. This K-5 teacher reported that her students took more risks when concept mapping in small groups and, after first working in small groups, her students were more likely to participate in a whole group mapping activity. It would seem from these observational studies that student enthusiasm for concept mapping may help increase participation in the activity itself. If increased participation leads to increased learning, concept mapping may be an effective instructional strategy worth considering for classroom use.

Concept Maps: Individual Learner Needs
(Multi-Modal Learning and Self-Esteem)

Students learn in different ways. This was discussed earlier in this chapter. Does concept mapping address the needs of these different kinds of learners? Lambiotte et al. (1989) claim semantic maps require the integration of verbal and spatial processing. In the language of multiple intelligences this
would argue for the use and support of the linguistic and visual-spatial intelligences. Lambiotte hypothesizes that verbal processing leads to the construction of a map. Then, a map’s spatial properties help the learner to identify characteristics of a knowledge domain such as overall complexity, differential complexity between subareas in the knowledge domain, symmetry, and gaps in the domain. This spatial processing can then be used to guide the learner in such verbal activities as making judgments and asking questions. Lambiotte goes on to hypothesize that this interaction between the two is more likely to occur with knowledge maps than with text. This appears to be in the hypothesizing stage but is being used by this TCU group to design future research. McTighe (1992) claims maps and other graphic organizers show relationships and that they can represent abstract information in a concrete form. This would address the visual and possibly the kinesthetic intelligences of students. DeFrank has addressed the relationship between concept mapping and multiple intelligences. She describes how particular techniques for creating concept maps can be used to address the needs of different kinds of learners. For example, concept maps that are constructed with words target the linguistic learner. Arranging concepts into a hierarchical order supports the mathematical-logical intelligence. The use of pictures, shapes, and color addresses the visual-spatial learner. A concept map created with real objects such as leaves or moveable Post-It™ notes enhances bodily-kinesthetic learning. Finding a mapping technique for the musical learner is perhaps the most difficult. DeFrank suggests using aphorisms which “tend by their nature to have beat, rhythm and pitch,” to exemplify concepts on a map. The intrapersonal learner may prefer to construct a concept map of her own while an
interpersonal learner may choose to work with others. These suggestions have been tried with students but direct evidence as to whether they support or help develop the multiple intelligences of learners has yet to be found. The discussion at this point seems to be mostly conjecture.

Six of the DASH (1995) studies with elementary students reported increased self-esteem. Several of these studies suggested that concept mapping was a non-threatening process that reduced student anxiety levels. This seemed to result in increased self-esteem and also more risk taking by students. Novak (1984) and Margulies (1991) agree that concept mapping helps increase self-esteem in learners. Stice and Alvarez (1987) mentioned that students felt good about their mapping efforts and enjoyed and were enthusiastic about the process. Lovitt and Burk (1988) claim that “as a pre-teaching tool, webbing allows a student to access existing knowledge that builds confidence and motivates him or her to become more involved in the learning process.” Jegede, Alaiyemola, and Okebukola (1990) found in a small, one-sample study that concept mapping significantly reduced anxiety and thereby increased achievement in biology students. Odom (1989) found a significant inverse relationship between anxiety and self-esteem in middle school students. These studies and observations address various aspects of student self-esteem. They indicate concept mapping may have some positive impact on this but provide little evidence that this is so. This seems to be another area worth investigation.
Concept Maps: Special Learner Needs

This category includes learners with special needs such as second language students, deaf learners, learning disabled students, special education children, and at-risk students. Although this study does not include these students per se, with the inclusion of such students in many classrooms (including some in this study) such research is relevant.

Novak (1984) described the success of one student who had been labeled learning disabled, partly because he refused to do much of the required class work. The student produced a map included in his book, *Learning How to Learn*. This map and others he drew became the basis for classroom discussions. The student's grades improved over the remainder of the school year. Novak claims to have “found that many students classified as learning disabled are really bright children who lack the skill and/or motivation for rote learning, but who can move to the front of the class when they are given the opportunity for creative, meaningful representation of their knowledge.” He cites Melby-Robb (in Novak, 1984). Margulies (1991) also describes success with mind mapping with learning disabled, dyslexic, and other nontraditional learners. One of the DASH (1995) studies reported on successful concept mapping with special education students operating on pre-kindergarten through grade three levels.

Novak (1984) also describes using concept maps with bilingual learners. He says if pictures are used to represent concepts, teachers can get a picture of students’ understanding. He also suggests the pictures be labeled so students learn the language labels for their concepts. Margulies (1991) also suggests mapping with English second language students. Lovitt and Burk (1988) claim
webbing helps students improve language skills and overcome cultural barriers. “If English is not the native language, or if language or speech difficulties exist, the web provides a visual presentation that highlights existing knowledge and forms a base on which to build. Children with cultural backgrounds that differ from the school’s norm can use the web to create a common frame of reference to which others can relate and share information.” Tippins and Dana (1992) suggest concept maps can be a culturally relevant assessment tool in the science classroom. They appear to base this statement on Novak’s ideas described above.

Margulies (1991) describes at length the use of mind maps with profoundly deaf children. She elaborates on the differences between American Sign Language (ASL) and English such as the lack of conformity in syntax and that ASL does not have a written component. As a result she says many deaf children do not record their ideas in writing. Mind mapping, according to Margulies, provides a method for recording ideas without the use of English grammar. Mind mapping uses key words, symbols, space, and color to visually represent ideas. Margulies says it does not replace written English but can provide deaf children with many of the benefits of recording their ideas on paper. She claims this visual system is especially suited to ASL users who are visual experts. Considering Margulies’ experience as a psychologist working with deaf children, one cannot readily discount these suggestions.

Lovitt and Burk (1988) claim webbing can be used with all students. For at-risk students who usually have limited background experience, they say “webbing accesses the skeletal framework of knowledge to which additional information can be added. It connects what is known to what is to be learned.”
There were no studies uncovered where at-risk students were defined as one of the variables. However, a number of concept mapping studies did work with disadvantaged students. Lovitt and Burk describe the population of students at the school in which they conducted their study as having a large percentage of high risk students as characterized by ethnicity, ability, and economic status. Stice and Alvarez (1987) describe their sample as having an extremely high percentage of low-income children, with low achievement scores as measured on annual standardized tests. Almost all of the DASH teachers (1995) reported on classrooms that included some disadvantaged students. These were the only studies found with elementary students which described the populations studied. All of these studies reported success with concept mapping.

There appears to be little empirical evidence to support the use of concept mapping with the special needs students described above. Based on the descriptive evidence reported, one could very cautiously infer that concept mapping may be a good instructional strategy to use with special needs learners. Certainly this is a topic worth exploring.

THE REASON FOR THIS STUDY

The literature provides some evidence that concept mapping may be an effective instructional strategy with multiple functions. The evidence itself is limited in a number of ways. First there is considerable confusion over just what concept mapping is or should be. There is no empirical evidence found in the literature search to support any one of the mapping systems described above over any other. Second, rigorous methodology appears to be lacking in much of
the research reported. More often, successes are described, particularly at the elementary level, in informal teacher publications.

Should a strategy that has been shown to be successful with older students be used with young learners? The question of age appropriateness has not been directly addressed. Novak (1990b) describes successfully constructing maps with students in grade one through college. He found students in grade four and beyond were able to more readily create their own maps. Novak (1984) describes successful strategies for all levels of learners. Novak (1990b) also says maps get better with experience and that it could take one to two years for students to become facile with the process. Stice and Alvarez (1987) report mapping success with young children. They found concept mapping to be developmental and that it could be used with kindergarten and grade one students. Levin (1986) describes using already constructed webs with preschool children. Lovitt and Burk (1988) included three kindergarten classrooms in their study. Alvermann (1991) reports on the successful use of discussion webs with kindergartners. Many of the DASH studies (1995) were conducted in kindergarten and primary level classrooms. An unpublished study compared the use of concept maps by kindergarten, first, second, third, and fifth grade DASH students (N=75). Over three fourths of these students were of ethnic minorities and qualified for free or reduced school lunches. The findings support the developmental nature of concept mapping. As these students advanced through the grades, the number of concepts on the same topic increased on their class maps. Older students had better organizational skills and updated their maps more often than the K-2 students. The kindergartners did not use their map to write stories while the older
students did (Duran, Inouye, Mokuau, Leong, & Giuliano, 1994). It would seem concept mapping has the potential for success with kindergartners.

This qualitative study attempts to document evidence for the effectiveness of using concept mapping with very young learners. Several of the functions described above were investigated. In particular, concept maps were studied in the context of thinking skills, assessment, multi-modal learning, student participation, learner self-esteem, cooperative learning, and knowledge acquisition. The next chapter will describe the study and the methodology used. Chapter 4 will report and discuss the results of this investigation of the multiple functions concept maps can have when used with kindergarten students.
CHAPTER THREE
STUDY DESCRIPTION AND METHODOLOGY

An ethnographic design was selected for this study. The terms ethnography and qualitative research are used synonymously (Bogdan & Biklen, 1982; Miles & Huberman, 1994). Ethnographic researchers ask two basic questions. What is going on here? And, what lies behind the actions being observed (Gallagher, 1985). The resulting data are generally reported descriptively with words rather than with numbers. There were several reasons for using a qualitative rather than quantitative approach to this study. When taking into account the nature of the learners involved it was obvious that kindergarten-age children have not yet developed reading or writing skills proficient enough to allow the use of a traditional paper and pencil test that would have any real validity (NAEYC, 1986). More importantly, a qualitative, multiple case study design is an open-ended search for patterns that provides a broad picture and a rich data source to examine a complex process such as the topic of this study which looks at an instructional strategy that by definition includes social interactions and other environmental factors in its use. Yin (1989) defines a case study as an empirical inquiry that investigates a contemporary phenomenon within a real-life context when the boundaries between phenomenon and context are not clearly evident and in which multiple sources of evidence are used. A multiple case study approach was selected based on Yin’s argument that replication, not sampling logic, is the reason for multiple case studies. Replication logic is analogous to that used for multiple
experiments. In other words the researcher is looking to see if replication occurs in similar situations.

This study was designed in several parts which are described in this chapter. The first section provides a description of the DASH concept mapping process. The second topic discusses the data collection procedures for the case studies. The third part describes the case studies. The fourth section covers the questionnaire. The fifth part concerns data analysis procedures. The final segment presents the limitations of this study.

DASH CONCEPT MAPPING: CONCEPT, TERMS, AND PROCESS OF THIS INSTRUCTIONAL STRATEGY

The DASH concept mapping process studied in this dissertation includes a number of things. First are the steps used by the teacher with students to develop student concept mapping skill. These developmental steps along with the forms for and functions of concept mapping as described by DASH make up the total concept mapping process. Concept mapping form includes all the physical characteristics of the resulting map and the process used to construct it. Functions include how concept maps are used and what they do within the teaching and learning environment. The focus of this research was on the functionality of concept mapping. This section describes the developmental steps, the teacher’s role, and the multiplicity of forms and functions that are crucial to the kindergarten context of this study.
Learning to Construct Concept Maps: Five Developmental Steps

DASH Concept Mapping: Step 1. When concept mapping is introduced to kindergartners, it is most often done with the entire class so that the teacher is able to model the process. Modeling is an important role for the teacher in developing a new skill (Vygotsky, 1978). The teacher usually begins with an announcement of the topic for the concept map. The students are asked what they know about the topic or concept. All ideas are acceptable, correct or incorrect, related or not. This is a type of brainstorming session to determine what students think they already know about the topic. In the first step of this developmental process, student ideas are simply connected to the concept name.

The teacher helps the students to record their ideas. Precisely how their ideas are recorded varies a great deal from class to class, teacher to teacher, and grade to grade. With older students words are usually used. This is not the case with kindergarten students who for the most part do not read. Some form of pictorial representation is often used with these young learners. The pictures are usually student drawn but can also be drawn by the teacher or cut from magazines and the like. The pictures are then labeled by the teacher or more-able students. See Figure 15 for an example of the first step map in DASH kindergarten concept mapping. As students become more proficient with written language there is a gradual transition to words, although pictures are never inappropriate on a DASH map. Often one small picture can express far more than a volume of words.
There are also situations when the teacher will choose to use another form for a concept map such as having the students create a kinesthetic concept map wherein they may act out or role play the ideas they contribute. The students might also use real or concrete objects such as leaves, stems, and other plant parts to create their maps. These kinesthetic and concrete forms for maps are then often recorded in a more traditional, visual or written form.

Concept Mapping: Step 2. Even kindergarten students move very quickly to the second step in learning to concept map. At this step the students begin to subcategorize their ideas. For example students constructing a concept map on pets are able to put their ideas into two subcategories such as kinds of pets and needs or care of pets. See Figure 16. (This figure is done using only words for economy of space. Kindergarten students would typically use labeled pictures as in Figure 15.) The teacher will likely model this second step initially but this subcategorization often occurs almost spontaneously with a question
such as, *Do some of these ideas seem to go together?* Colors and shapes are additional elements of form used to indicate different levels in the hierarchical order of the map concepts at this step.

![Figure 16. Step 2 DASH concept map on pets with subcategories.](image)

**Concept Mapping: Step 3.** The third step is closely related to step two in that ideas are further subcategorized into three or more levels. This development of a hierarchical approach to the classification of ideas continues to evolve throughout the students' mapping experiences. With young children, the hierarchies they create, particularly subcategories located at the *same* hierarchical level, are often uneven. The hierarchical arrangement of their maps is usually informal. These young children most often use a center-out organization rather than the top-down arrangement as found in step 5 maps.

The third step also includes the addition of connections between subcategories. This is quite often observed on kindergarten maps. For example, one student may have drawn a canary and placed it with the birds under the *kinds of pets* category. Another student may draw a cage and place it in the...
homes category under Needs of Pets. One of these students will likely see a connection between the cage and the canary or bird category. See Figure 17. This is an example of a cross-link between categories. This cross-linking becomes quite complex as students gain proficiency in the mapping process. Step 3 is usually as far as most kindergarten students progress in learning to construct concept maps.

Figure 17. Step 3 DASH concept map on pets with a cross-link.

**Concept Mapping: Step 4.** Steps 4 and 5 are briefly described to provide a complete overview of the developmental steps in the DASH concept mapping process. Adding labels to show the relationships between linked categories and arrows to the linking lines comprise the fourth step in the development of the concept mapping process. The link labels are seldom seen on kindergarten maps primarily due to the students' lack of proficiency with written language.
However, these young students often do verbalize the connective words when contributing their ideas.

**Concept Mapping: Step 5.** The fifth step in the mapping process is the use of a formal hierarchy. The eventual goal in arranging the concepts on a map, according to Novak (1984) and within the DASH concept map steps, is to create a formal hierarchy in which "the more general inclusive concepts should be at the top of the map, with progressively more specific, less inclusive concepts arranged below them." Older students are encouraged to use a top-down organization for their maps. These students often use different shapes and colors to emphasize the hierarchical order. In DASH the form, or in this case, the choice of particular shapes, colors, and so on are left to the students or teacher. These more advanced students also learn to use directional arrows, different types or colors of lines, and even different styles of print to show the relationships between concepts. Figure 18 shows a concept map that illustrates examples of the more advanced techniques and elements employed by more experienced concept mapmakers.
Figure 18. Concept map on water showing DASH steps 4 and 5.
Table 1 summarizes the development steps in the concept mapping process as described in the DASH program.

<table>
<thead>
<tr>
<th>Step</th>
<th>Form of Entries</th>
<th>Hierarchical Levels</th>
<th>Links</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pictures, words,</td>
<td>2 levels; radiating from center</td>
<td>connecting lines</td>
</tr>
<tr>
<td></td>
<td>labeled-pictures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>same</td>
<td>3 levels; use of shapes and colors for levels</td>
<td>same</td>
</tr>
<tr>
<td>3</td>
<td>same</td>
<td>3 or more levels</td>
<td>cross-links between sub-categories</td>
</tr>
<tr>
<td>4</td>
<td>same</td>
<td>same</td>
<td>labeled links; arrows on lines</td>
</tr>
<tr>
<td>5</td>
<td>mostly words</td>
<td>top-down structure</td>
<td>color and different line types</td>
</tr>
</tbody>
</table>

Finally, it is important to note that the teacher's role in the creation of concept maps diminishes as the students become more adept at the process. In a kindergarten classroom, the teacher will almost always be involved in the process. Initially the teacher models the entire process by first asking questions to solicit student ideas, then helping to categorize and label those ideas. In some cases the teacher may even suggest ideas or categories for the map to stimulate related student responses. The kindergarten teacher's modeling role is reduced as the students become more experienced to the point where the primary function is that of coach or facilitator, asking an occasional question and assisting when the students request help. Kindergarten classes seldom reach a level of proficiency such that they are able to create class maps independently.
DASH Concept Mapping: Form

DASH concept maps take many forms. The physical characteristics and the construction process make up a concept map's form. Included in this discussion are not only ways in which ideas are recorded on maps but also by whom and how concept maps are constructed. Some of this was described in the previous section to provide a clearer picture of the developmental steps.

Teachers and students in DASH are encouraged to be as creative and inventive as they wish in devising ways to create concept maps. An unpublished master's paper by DeFrank (1993) looked at many of the concept mapping forms DASH teachers and students have used successfully. DeFrank organized the forms or techniques for recording ideas to align with the development or support of learners' multiple intelligences described in Chapter 2 (Gardner, 1983). The following examples have been arranged in a similar manner. The ideas presented are drawn from DeFrank as well as the researcher's observations and experience. A certain amount of overlap and redundancy is unavoidable if a list such as the following was to be complete since many of the forms for concept maps support more than one of Gardner's intelligences. Much of the overlap has been eliminated in this list for the sake of brevity. The purpose of this list is only to suggest some of the vast array of possibilities.

Linguistic forms for concept maps include the use of words, both written and spoken. Specific kindergarten examples include the labels on pictures and the discussion involved in the construction of the map.

Mathematical-logical forms for concept maps are exemplified by hierarchical structure and the use of patterns. Another type of hierarchy found
on concept maps is a linear arrangement. This is usually used to show a process such as the steps for planting a seed, and is a type of flow-charting technique. Kindergartners usually use some kind of an informal hierarchy in the construction of their maps. They may also use some basic geometric shapes to indicate their hierarchical levels or categories.

Spatial-visual forms for concept maps include the use of pictures, representative symbols, concrete or real objects, color, and computer programs. The actual visual arrangement of the map supports this mode of learning. Kindergarten teachers have suggested the use of photographs and cartooning to represent concepts on a map.

Bodily-kinesthetic forms include the role-playing and acting out of ideas mentioned previously. The moveable nature (see also the following section on function) of DASH concept maps is especially supportive to this kind of learner. A kindergarten example of a kinesthetic map might have each student pretending to be their favorite kind of pet. The students begin to create subcategories by having all the same kinds of pets such as dogs or cats group together and join hands. To encourage further connections for the map the teacher might next ask each pet to move to their preferred home or food, perhaps represented by pictures drawn earlier by the students. The fish would likely move to the aquarium and join hands with the turtle or the bunny might go to the carrot and so on. This has also been done on a smaller scale on a tabletop or bulletin board using pictures or cutouts. The critical element is the mobility of the ideas or elements and links on the map.

Musical intelligence as described by Gardner is the ability to produce and appreciate rhythm, pitch and timbre. This is perhaps the most difficult
intelligence to accommodate in the concept mapping process but kindergarten teachers are the most likely to invent ways to concept map *musically*. These teachers invent songs and rhymes that encourage children to sing about their ideas on weather. Rhyming, rhythmic aphorisms concerning particular kinds of health habits have been particularly successful with these young students.

Interpersonal and intrapersonal forms for concept maps involve *who* is constructing the map, the mapmakers or cartographers. The transition from class maps to individual maps can come as early as kindergarten. However, in most DASH classrooms the maps continue to be done as class projects throughout the grades.

The mapping efforts of individual kindergartners are usually incomplete representations of what the child actually knows about a particular topic. This is due to their level of writing and drawing development and short attention span. This is not however to say that they should never construct their own maps especially if a child elects to do so. The kindergarten teacher just needs to recognize both the limitations and the benefits. Kindergarten teachers often address the individual learner and perhaps the intrapersonal intelligence by having students sign their own names on their pictures or contributions. More in line with Gardner's description of the intrapersonal intelligence is to have the student reflect on their own contributions to the map and their own understanding of the concept.

Concept maps are also created by small groups of students within a class. In one situation, all groups construct maps on the same concept. These are then compared, contrasted, and combined to create a class concept map. In another scenario where students work in groups, each group will map a
subcategory of the main concept. For example, if the main concept was *insects*, one group might map *kinds*, another *parts*, a third *life cycles, uses*, and so on. All of these *sub-concept* maps are reviewed by the other groups, changed as deemed necessary and then combined to create a class map about *insects*. These cooperative or small group concept maps are sometimes used by kindergarten teachers as they work with small groups of children. They are then reviewed and assembled into a class map by the teacher and students. An additional idea that has been particularly successful in DASH with kindergarten students is to have them work with older, more experienced students in multi-aged, small groups to create concept maps.

This study is concerned with concept maps created by the whole class which would at first appear to neglect intrapersonal intelligence. However both group and individual concept maps are designed to encourage students to reflect individually on what they think they know, what they want to find out, and to make new connections. This will be further clarified in the following section.

**DASH Concept Mapping: Function**

The purpose of this dissertation is to study the functionality of concept maps in DASH kindergarten classrooms. Function includes what the map can do and how it can be used by both students and teachers. This is by no means a clear cut distinction but is useful to describe what function can include. Many of a concept map's uses have been described by DASH but, students and teachers are always encouraged to invent new uses for their maps.

DASH describes concept mapping as an ongoing instructional strategy. A DASH concept map is a dynamic, evolving thing whereas a concept map as
defined by others is most often a one-time event (e.g., Novak & Gowin, 1984). Some do suggest that several maps can be done during the development of a particular concept in an instructional course or unit. Often these multiple maps are done in a pre-test/post-test fashion. DASH however uses the same, initial concept map, changing and modifying it during the period of instruction on the particular concept. Even at the terminus of the particular study it continues to be a part of further instruction when it becomes a reference source. The students are always encouraged to make additions, deletions, or changes to any of their concept maps even after the end of the study on a particular unit or topic.

In DASH the class map about a particular concept is initially created to determine the prior knowledge of the students in the class. All contributions are accepted, correct or incorrect, related or not. This provides the teacher with a more accurate picture of not only what students already know, but also what misconceptions the students may have about the concept. It further sets the stage to reflect the dynamic, changing nature of science. After all, many early scientific ideas have been overturned in more recent history. We now know the sun, not the earth to be the center of the solar system. In DASH students are encouraged to understand that what is thought to be correct today may well change as they further explore and investigate that idea tomorrow. Students are also encouraged to identify questions about the topic or concept they may wish to explore. The map becomes a useful tool for the teacher to plan upcoming instruction.

As the students engage in activities and learn more about the subject, they return to the map periodically as a summary activity. They add new ideas, revise information, and even delete entries from their map throughout the
course of study on the topic. Changes are usually made in a different color and dated to provide an ongoing picture of the development of their understanding of the concept. At the end of the study the map reflects what the class has learned. It further provides the teacher with a tool to develop an assessment instrument and a criterion against which to measure individual student achievement.

Concept maps are also used for purposes in DASH other than to create the class map described above. For example, a class might use a map to describe a process and even to assign responsibilities for an upcoming project such as growing a garden. Small groups may use maps to design or plan a project, to record data, or to present the results of their research. At upper grade levels maps constructed by individual students are used as an alternative to a traditional test.

Concept maps are used across subject areas by many teachers. In language arts they can be used to brainstorm ideas for a story then to organize those ideas much like an outline. Concept maps are used to analyze stories and books. Some teachers have their students use mapping as a way to record notes when reading from a textbook, watching a videotape, or listening to a lecture. Most of the ideas suggested for science are applicable to social studies. In short, the functionality of the concept map is only limited by students' and teachers' imaginations.

In summary, some of the uses for concept maps as suggested by DASH include assessing, organizing, planning, recording, summarizing, brainstorming, and representing the ongoing development of a concept. What a concept map does or sets the stage to be done is an area not fully addressed by
the DASH development team as yet. A number of ideas such as increasing student participation and developing thinking skills have been suggested by kindergarten teachers. It is with these suggestions that this research is concerned. This study investigates the effectiveness of concept mapping by examining the multiple functions of the ongoing concept maps created by a whole class in the DASH context as described in the beginning of this section.

DATA COLLECTION PROCEDURES FOR THE CASE STUDIES

In the original design, four case studies were to be done at three sites, two at one site, one each at the others. When it became apparent that the data from one of the single study sites was rather sparse, a second study was conducted there. The sixth case study was added to the design to provide some comparative data between two similar groups of students, one using the concept mapping process and the other a more traditional instructional strategy.

The case studies were conducted prior to the mailing of a questionnaire to preserve the ethnographic integrity of the observations as much as possible. The researcher was to approach the observations with as little bias as possible, that is to look at what was occurring without judgment and to document the concept mapping process as it happened. The questionnaire was used to identify the research questions and sources of potential evidence. If the research questions had been defined previous to the case studies, the researcher could not help but look for evidence to support or refute those ideas (Bogdan & Biklen, 1982).
Site Selection

The sites selected for the case studies took into account a number of factors. The teachers to be observed were selected with the expectation that they had implemented concept mapping as described in the DASH program. The sites for the case studies were selected based on the practical issue of research access as well as for their geographic diversity.

The teachers expected to have the greatest amount of experience and fidelity to the concept mapping strategy as described by DASH were certified DASH kindergarten instructors. These DASH trainers had been using the program for three or more years. In addition, the selected teachers were to be experienced teachers and experts in their field. Those chosen had masters degrees in education and ten or more years of classroom experience.

The case studies were conducted at laboratory schools located on university campuses. All of these laboratory schools are DASH demonstration sites. Although all the sites were on university campuses, each had a different type of location. One was rural, one urban, and one suburban. Geographically, one was in the eastern United States, one in the south, and one in the far west.

Each site had a student population that was diverse in ethnicity, socio-economic status, and ability. This was documented through school records and teacher and principal interviews. In the case of academic ability, no standardized test data were available for these young children so the expert judgment of their teachers as to ability was relied upon. This information is described in the site descriptions.
Data Collection Procedures

The following protocols were set up prior to the case studies. They were adhered to as closely as possible. Exceptions and modifications are indicated within the individual case study descriptions. The researcher was to collect a diverse and comprehensive set of data during observation of the concept mapping process at each site. These data included field notes, audio and video tapes, photographs, student artifacts, and interviews.

Teacher Interviews

An informal, pre-observation interview with each teacher was conducted to determine the previous experience of the teacher and the students with the concept mapping process. The upcoming topic for the concept map was identified. Plans for related class activities during the observation period were discussed to coordinate schedules and the like. Observation procedures such as where to locate the video camera and the best time for conducting student interviews were also covered.

Students were somewhat randomly selected to be interviewed at this time. The researcher identified six students from an alphabetical class list by counting off every fifth student. Due to the small sample size, these selections were then reviewed by the teacher to ensure there was a balance of gender, ethnicity, and ability as judged by the teacher. Where imbalance was obvious, the last selected student in the redundant category was dropped and the counting resumed until a more appropriate subject was selected for the sample. Some bias was no doubt introduced by not using a strictly random selection.
Post-observation interviews with the teachers were conducted to
determine their perceptions of how the lessons had proceeded. At this time the
teacher was also asked to give a brief description of each of the students
interviewed.

Preliminary Observation

The observer spent one preliminary day in the classroom before
interviewing the students. The purpose of this was to increase the comfort level
of the students with the researcher during the upcoming student interviews and
to familiarize the observer with the particular classroom's setting, schedule, and
routine procedures.

Observer's Role

The observer was to remain as unobtrusive as possible when the teacher
and students were involved in the actual concept mapping process. At other
times, the researcher might become a participant observer as described by
Bogdan and Biklen (1982), again with the intention of becoming a familiar part
of the classroom environment.

Student Interviews

The purpose of the preliminary interviews was to determine what the
students already knew about the upcoming topic. The final interviews covered
the same ground with the intention of comparing the two interviews in terms of
knowledge acquisition. The students were interviewed using a concept
mapping technique. As each student was questioned about the topic, the
researcher mapped their responses. The interviews were also audio taped. In some cases the students drew or wrote their own entries on the concept maps. The original design was to have the students participate more fully in the process but the student drawing proved too time consuming so the procedure was modified.

The interview maps served several purposes. They helped focus the child's attention on the interview by providing something concrete for them to see. The maps provided the researcher with an efficient way of recording the interview. The actual recording process evolved during the course of the case studies. In general, the maps included the questions asked, the students' responses and extensions of those responses, and any connections made by the students between responses. At a later time, the researcher reviewed the maps while listening to the audio recordings of the interviews. The order in which the questions were asked was added to the maps, along with any missing information the child may have contributed during the interview that had not been recorded during the interview. Figure 19 is an example of an interview map.
Interviewing young children is difficult at best. They are often shy and reticent. The selection of classes at laboratory schools facilitated this somewhat as these children are more accepting of outside observers since this is a frequent experience in their particular classroom environment. In addition, the preliminary day spent by the researcher in the classroom and the participation in non-related activities were included to build some level of trust with these students. Another concern, reported by Wellman (1990) is that when young
children are asked the same question repeatedly, they tend to change their answer until the interviewer is satisfied. Young children also tend to duplicate previously accepted answers in a group situation. To circumvent these potential problems, the interviewer attempted to ask differently worded and extending questions rather than repeat questions. The most common of these extending questions was to ask, *What else?* Finally, the students were interviewed in a separate space where they could not overhear the responses given by other students.

Classroom Observations

The researcher spent five consecutive days observing the development of a concept map. The observer sat at the side or rear of the classroom and took notes during the lessons. A video camera was set up, focused on the central area of activity, and left to film for the duration of the lesson. Photographs were made of the developing concept map at the end of each session. Appendix A contains computer representations of the class concept maps produced during each case study. Lessons in which the topic of the map was addressed were observed in a similar manner during the course of the observations.

Additional Data

Each classroom was mapped and photographed. Student artifacts such as pictures drawn, were documented through photographs, photocopies, or on video tape. Principals were interviewed to collect background information on the school and site.
Data Organization

All the evidence for each case study was organized into a separate binder. This included field notes, photographs, tape transcripts, and the like. At a later point, as each case study was analyzed, additional data were added to the collections.

THE CASE STUDIES

Six case studies were conducted at three sites. Following are descriptions of each study organized by sites. General information about each site precedes the specific study descriptions.

Site S

Site Description

This laboratory school site is located on the campus of a large public university in the southern part of the United States. The school is a separate department in the college of education. The university is located in a suburban area near a city of 200,000. The K-12 staff consisted of 50 teachers and two administrators. The 750 students in grades K-12 came from seven surrounding counties. At the elementary level, there were two classes of each grade with 25-35 students in each section. The school population tends to come largely from middle and upper socio-economic families as the tuition is considerable. About 4% of the students who come from less affluent homes, receive free or subsidized lunches. There is ethnic diversity, although it is probably not
representative of the area the university serves. The 14% of the population that are not Caucasian, are primarily African-American, Asian, or Hispanic.

The teacher and students from the same class participated in two case studies at this site. The fall and spring studies were done during the 1992-93 school year. There were 26 students, 15 boys and 11 girls. Incoming kindergarten students were randomly placed into the two classes with a few exceptions such as a child who was repeating kindergarten and had the other teacher the previous year. In the class observed there were four African-American students and one Asian student. According to the teacher, the students had a typical range of academic abilities. Several students had serious medical problems such as hearing impairment. All students appeared to function well in the classroom activities.

The teacher at this site, Ms. S, had been teaching for over fifteen years. Her particular expertise is early childhood education. She had taught kindergarten and first grade in public school systems previous to accepting the kindergarten position at the lab school. She had been at this school for six years prior to these observations. In addition to the teacher there was a full-time aide who was also a certified teacher.

The classroom was spacious even for a kindergarten classroom. There was a large, open, carpeted area with student chairs arranged in a semi-circle for whole class activities. A section with five tables and chairs for the students took up about a quarter of the floor space. Along one side and the back of the classroom were learning centers for art, science, housekeeping, blocks, and the like. Behind the side wall with centers were observation windows made of one-way glass which fronted an observation room located behind the wall. Along the
other side were doors to storage rooms and to the teacher's office. There were also two areas set aside for small group work, a reading or book center, and a teacher workstation. The room was light and airy. The walls were brightly decorated. Student projects were suspended from the ceiling and displayed throughout the room. The concept mapping activities were done primarily in the large whole group area.

This was a full day kindergarten. Each day began at 7:45 a.m. and ended at 2:55 p.m. The morning schedule was much the same from day to day. The first 75 minutes included such standard kindergarten whole group activities as attendance, listening circle, and movement activities. This was followed by 85 minutes of center activities. The teacher and aide worked with small groups during this time while the rest of the students engaged in independent center activities. After lunch and recess came 20 minutes of French or a story time, then a 55 minute rest period, snacks or the music specialist, 30 minutes of health and physical education, a trip to the school library or snack and outdoor play, culminating activities, and dismissal. The concept mapping activities were done during the whole group block in the first part of the morning. Student interviews were conducted primarily during the afternoon rest period.

Case Study S1

The observations for this study were completed over six days in November and December, 1992. The classroom had several class pets such as a rabbit and fish. The students regularly helped to care for these animals through job assignments on their weekly Responsibilities Chart.
Day 1. On the first day after the usual morning activities with the students sitting in a large group circle, the teacher reminded them of their previous construction of a concept map about families. This was their only prior experience in the concept mapping process. Ms. S introduced the new topic, pets, by asking the students what animals make good pets, and then remarking that she wondered what the students knew about pets. She explained to the class that they were going to make a concept map about pets. It would include such things as what they knew about pets, important information about pets, and what they wanted to find out about pets. The teacher then asked the children if they had pets at home or school and what animals made good pets. The students volunteered to share their previous experiences with pets. Ms. S asked for further information such as what they fed their pets. She summed up the discussion by saying she was hearing a lot about pets and taking care of them. She then had the students draw something important of their choice about pets. They worked at tables in small groups for the drawing part of the activity. The teacher encouraged the students to share what they were drawing with those in their group to reduce duplication. As the students were drawing the teacher, the aide, and the researcher helped them to label their pictures.

When the students were finished, they reassembled around a large sheet of paper that was to become their concept map. The students shared what they had drawn. The teacher asked if they should put all the horses together. The students agreed, yes. One student suggested they put all the animals that live in the sea on one side and those that don't on the other. Another student suggested that the other category was the jungle but other students objected that horses don't live in jungles. Ground was suggested by the teacher as a title.
for the other category. The students then affixed their drawings to the map, grouping like animals together such as horses or fish.

One child had a single picture of both a fish and a cat. Another student suggested she put it in the middle between the two categories and another suggested she cut the card in half. A similar problem arose with a bird and fish but that student decided the bird could fly over the water.

When all the pictures had been placed on the paper, the teacher and students reviewed what they had done. The teacher then drew lines from the map's main concept, *Pets* to the two sub-categories, *Live in Water* and *Live on the Ground*.

Ms. S then asked the students if they had all the different kinds of pets on their concept map. The students suggested some more animals including giraffe and leopard. (These were not recorded on the map.) The teacher then reminded the students that they were going to put everything they knew about pets on their map. Cages and air were suggested. Ms. S remarked that she thought they were getting all kinds of animals, not just pets. A student suggested a *lion*. The teacher asked if that would be a good pet. The students said, "No," and contributed reasons why. The discussion shifted to qualities of good pets such as size. (Appendix A contains computer renderings of the day-by-day changes in the classroom concept maps constructed at each site.)

The teacher said they would keep the map and put more on it the next day. The class went to the next activity which included feeding and caring for their classroom pets. When the students moved on to their center activity time, the two groups working with the teacher heard the DASH focus book, *A Surprise for Mom* by Don Buchholz (1991). This is a story about choosing
appropriate pets and caring for them. During this small group activity time, the students participated in further discussion about taking care of pets. Student interviews were conducted during the afternoon of day one.

**Day 2.** The students were all seated in a large circle. The teacher began the related pet activities with a review of what was on the concept map. She brought the class rabbit in its cage to the circle and placed it on some paper. Ms. S asked the children why she had to do this. A discussion of pets the students had at home ensued. The teacher refocused the discussion to what had to be done to keep their pet rabbit, Meatball, healthy. Then she moved on to discuss what the differences were between their pet rabbit and her puppet rabbit. This led to further discussion of the needs of living pets. The class then created a list of instructions for the custodians to use when caring for the class rabbit over vacation periods. Time ran out and nothing further was done with the concept map.

During center and small group time, the remaining third group did the story activity from the previous day. The teacher introduced the next small group activity to another group. Each child was to construct a book about caring for a particular pet.

**Day 3.** The pet activities began with the students seated in their large group circle. They reviewed the care chart they had made the previous day and made some changes. Next, the teacher showed the children pictures of a cat and dog to stimulate a discussion about these particular pets.

Ms. S and a student unrolled the concept map on pets. After a brief review of its contents, the teacher asked the students what else they had to say about pets. One boy said he knew about taking care of pets. The teacher wrote
Taking care of pets on the concept map. A boy volunteered they needed to be brushed. Ms. S drew a picture and wrote *Brushed,* on the map. She drew a line from the labeled picture to the new *care* category. This process continued with students suggesting food, water, bathe, and keeping your pet safe along with appropriate pictures for the teacher to draw. The activity was concluded with the question, *Do all these things go with pets?* A line was drawn from the care category to *Pets.* (See Appendix A.)

During their center time the students working with the teacher began their individual pet care books about such animals as cats, birds, and turtles. Each student chose their own particular animal for their book.

**Days 4 and 5.** The students continued to work on their individual pet care books while working with the teacher in small groups. Some children finished. Nothing was done with the concept map.

**Day 6, AM.** The teacher introduced the students to their new class pet, a turtle. During the whole-group discussion of what their new pet would need which included a home and food, Ms. S had the students relate their responses to what they knew about their pet rabbit. The students contributed what they knew about turtles and suggested ways they could find out more information such as going on a field trip to the zoo or getting books from the library. After this brief introductory discussion, the teacher and students returned to their concept map on pets. After reviewing its contents, the teacher asked if the students could figure out which of the animals in the water and ground categories would make good pets. She added a new category, *Kinds of Pets,* to the map. The teacher asked which of their animals might be a good pet for a house. A girl suggested her picture of a cat. Ms. S had her move the picture to the new category, draw a
circle around the picture, and a line to connect it to *Kinds of Pets*. The teacher asked, “Who else?” When a boy suggested a fish, a new set of subcategories were invented by the students and teacher under *Kinds of pets*. These were *Land*, *Water*, and *Land and Water*. The circles around the pictures and the lines to these subcategories were each assigned a different color. The students then proceeded to reposition their pictures into the appropriate category, draw circles around them, and draw lines from their picture to the category name with the designated color. As the students finished this, they moved on to their center and small group activities. The remaining pet care books were completed during this time. (See Appendix A.)

**Day 6, PM.** In the afternoon, the students once again returned to their concept map. After reviewing the category names, Ms. S asked them if they had anything else to add about the care of pets. A girl suggested *love*. She drew a heart on the map and wrote the word herself. After some discussion, *exercise* and *cleaning the cage* were also added. Students drew lines to connect these ideas to the *care* category. The teacher had a few remaining students complete the repositioning of their pictures activity from the morning. Ms. S then read a book to the class about turtles and tortoises. This was followed by the construction of a class *All Pets Need* chart. Lastly, the need for a home and name for their new turtle was mentioned and then it was nap time. Final student interviews were conducted during this period.

**Case Study S2**

The observations for this case study were done during five days in April, 1993. Prior to the study, the class had been studying nutrition. The students had
been introduced to the four food group system. The teacher had put up a bulletin board on food groups, talked about foods, and done vegetable printing with the children. In class discussions on food, the ideas that food is good for the body and why some foods were grouped together had been covered. On Monday prior to the observations, the students had begun to sprout seeds for a salad to be eaten on Friday. On Tuesday they rinsed their seeds and went on a class field trip. Observations began on Wednesday.

Day 1. The student teacher continued the topic of food with a discussion of how spaghetti could fit into all four food groups. She taught the students the song, *On Top of Spaghetti*, and read the book, *The Hungry Thing Returns* (Slepian & Seider, 1990). The student teacher next introduced the class to a new center about food where they were to classify pictures of foods either as *Eat a Little* or *Eat a Lot*.

The teacher took the class over from the student teacher and unrolled a large sheet of paper for the concept map. Ms. S asked the students if they had noticed anything when they rinsed their seeds that morning. A student said they were growing. A brief discussion on what seeds need to sprout and how the students were to rinse their seeds followed. The students shared what beans they liked and whether they thought bean sprouts would be good to eat.

Ms. S asked the students to look at the word written on the paper. They were eventually able to decode and read *Nutrition*. The teacher asked what the word meant. A student responded, “Good food for your body.” Ms. S asked what the students knew about nutrition. A student said, “Beans.” The teacher asked if beans were nutrition. A student answered, “They’re good for your body.” Ms. S wrote *good for your body* and *beans* on the concept map. The students
suggested other specific vegetables and fruits. Next they separated the foods into fruit and vegetable categories and assigned each category a color. A boy suggested *avocado*. When no one was sure what it was, *avocado* was written on the map with a question mark. A girl suggested *eggs* and the *Meat and Poultry* category was added to the map. The teacher announced that it was time for centers and that they would continue with the concept map the next day.

The group that went to work with the teacher looked at the concept map. Ms. S remarked that there seemed to be a problem with it. She asked what they had on it so far. The students responded, *food*. She asked if there were any foods not good for their bodies. A discussion of *junk food* and what it does to your body followed. Ms. S asked the group what happened when they ate foods good for their bodies. The students responded with appropriate ideas such as *make you big and strong*. When asked the opposite question, they suggested they would *get fat, be tired*, and so on.

Next the teacher had the students run in place and do some jumping jacks. She asked how they felt. The students responded with comments on their breathing and heart rate. The group then discussed what foods do for their bodies. After a bit, Ms. S refocused the discussion to drinks and their need for water. She asked them to remember to add those ideas to their concept map the next day. The second small group that worked with the teacher did about the same thing. A third group finished up their vegetable printing from a previous day. (See Appendix A.)

**Day 2.** The students selected were interviewed in the morning prior to the whole group concept map activity. The teacher explained to the students that they were going to reorganize their concept map. She cut out the word *Nutrition*
from the previous day's concept map and put it in the center of a fresh piece of paper. She then cut out the words, good for your body, and also put them on the new map. Ms. S reminded the students that during their small group discussions on the previous day they discovered that nutrition was more than just food. She added the words, Foods that are, to the words good for your body on the map. Ms. S asked, “What else is good for your body?” Water and exercise were added to the map. The specific food categories, Fruit, Vegetables, and Meat and Poultry, were transferred to the new map using their previously assigned colors. Avocado was still an unknown, so it was written in the class Wonder and Discover Book. This is a DASH book in which student questions and resulting research are recorded. More student examples for the food categories were added to the concept map. (See Appendix A.)

When the class moved on to center time, the teacher worked with the third small group to determine what else might be missing from the concept map. The discussion and activity were similar to the small group activity on the day previous.

Day 3. The students sat in a semicircle around the concept map. The teacher mentioned that someone had suggested that bread needed to be added to their map. She wrote the Breads and Cereals category on it. The class then reviewed what they had on their map. Ms. S asked if anyone had found out what an avocado was yet. No one had. The teacher asked what they could add for the Bread and Cereal group. A boy suggested milk. This resulted in the addition of the Dairy group. The students then suggested examples for the two new categories. They used the bulletin board with pictures of the food groups to get some additional ideas. Another question came up and was added to the
Wonder and Discover Book. Does chocolate milk come from a brown cow? It was decided they could ask someone when they visited the dairy farm during their field trip the next week. The discussion ended with the Exercise category. (See Appendix A.)

During center and small group time the teacher worked with two of the three groups. They talked about the sprouts they were growing and began individual booklets illustrating the process for sprouting seeds.

Day 4. Nothing was done with the concept map. However, several nutrition-related activities occurred. The upcoming trip to the dairy farm was discussed as well as what happens on a dairy farm. The teacher also introduced a DASH activity that has the students measure and graph how much water they drink in a given time period.

On the following two days no observations were done. The observer became a participant in the classroom and helped the children write small group stories which incorporated the planning of nutritional meals for a fictional character.

Day 5. The teacher reviewed the class water graph. Then she introduced Bossy, the cow on the bulletin board, who had a plastic glove filled with water that the children could milk in preparation for their field trip the following day.

Ms. S reviewed the concept map with the class. The students contributed more ideas for the various food categories while the teacher wrote them on the map. A Seafood group and examples were added to the map when the students said seafood was different from meat and poultry. The differences between fresh and salt water, seas and rivers were discussed. Recipe was added as a separate category. When the subject of non-nutritious foods came
up, the students decided that category had to be put on a separate sheet of paper along with its examples. The fact that some foods such as ice cream can be both nutritious and not was discussed. Then Ms. S asked, “Where do we get foods?” The students suggested such things as animals, gardens, the sea, fruit stands, and specific grocery stores. The final question was, “Anything else?” There were no further responses from the students. Final student interviews were conducted during the afternoon of day five. (See Appendix A.)

Site W

Site Description

This laboratory school is located on the central campus of a large state university in the far western United States. The school is a component of the research and development division of the college of education. The university is located in a city of 400,000. The K-12 student population of 350 is drawn from throughout the metropolitan area to represent the very diverse ethnic, socio-economic, and academic ranges found in the state. No tuition is charged but parents must provide student transportation.

At the time of the first case study there were two mixed-level classes of 26-28 students each at the elementary level, a K-2 class and a 3-5 class. Each class was staffed by a master teacher and an assistant teacher. There was also a student teacher assigned to each class. The K-12 school was served by two administrators. The master teacher in the K-2 class had her masters degree in education and over ten years of teaching experience. She worked for the public schools prior to coming to work at the lab school. The lab school was her first
kindergarten experience. She had been at the lab school for three years prior to the study. The male assistant teacher began his experience at the laboratory school as a student teacher. He was hired immediately after graduation and had also been at the lab school for three years. He was working toward his masters degree. Both teachers had taken DASH institutes at multiple levels. The master teacher was a DASH Teacher Trainer.

Two different classes were involved in the case studies at this site. In both studies only the kindergarten students participated. The first study was done with the assistant teacher during the spring semester of 1993. The second was done the next fall with the master teacher.

The primary classroom space occupies one wing in a building that also houses the other elementary classroom, art classrooms, offices, and a child care center. The K-2 classroom is actually three rooms in a row that open into each other. The rooms face out onto a large lanai or porch area that runs the full length of the three rooms and an additional storage room. The students have their own rest room facilities and their own playground which includes a fenced gardening area. During the first case study, the small westernmost classroom was used as an office area and storage space for the teachers with about a third of the space holding the classroom library and a small group learning area with tables. The middle carpeted room was larger and was used for whole class activities. At one end of this room, there were tables and chairs and shelves with materials for math and science. Along one wall was a chalkboard and tables for small group work. The smaller easternmost room contained an extensive classroom pet collection, tables for group work, and a computer center. Double storage closets opened into this room. At the west end of the lanai is a small
group space with tables and a chalkboard. Moving east on the lanai is an open
area containing the students storage cubbies, mailboxes, and plenty of
uncarpeted space for art activities. At the east end of the lanai was a carpeted
area for blocks and a large round yellow table and small chalkboard for group
activities. Much of the concept mapping activity and student interviews occurred
in this area. The classroom is open to the outdoors. Birds fly through the open
windows taking a shortcut from one side of the building to the other. Student
work is displayed on all the walls and spills over into the hallway where other
offices are located.

This is a full day kindergarten program. Class begins at 8 a.m. and ends
at 2 p.m. The day is divided into three large time or learning blocks of 1-1.5
hours each. The teachers use an integrated approach to curriculum employing
DASH topics as the central themes. After the usual early grade, morning
activities and a snack time, the students move into the first learning block. This
time is devoted primarily to integrated language arts and DASH activities. Then
recess and on to the second block which focuses on math. After lunch and a
thirty minute quiet reading or rest time, the students move to the third block
which again integrates DASH with art and social studies activities. The
schedule is very flexible but is used to add structure to the children's day.
During the last part of the afternoon the students have PE with a specialist or
time to choose to work in the wide array of centers available to them.

Prior to the second case study a new master teacher was hired and the
elementary classes were reconfigured to K-1, 2-3, and 4-5 with the K-3 being
housed together in the above described space. The new teacher had
responsibility for the 2-3 class. The classroom space had been rearranged to
the extent that most 2-3 activities occurred in the west classroom and the K-1 in the east room. The center room became the library, office, and computer area.

Student interviews were conducted primarily during morning activities except as noted. The concept mapping activities were done during the first morning time block.

Case Study W1

This study was intended to occur during the entire second semester of the 1992-93 school year. The assistant teacher was to keep a log of what occurred after the initial concept mapping session until the end of the semester. The log was to include a description of changes made to the concept map and of any activities done related to the topic of the map, gardening. In addition he was to photograph the development of the concept map. For one reason and another, no doubt including the researcher's long absence from the environment, these assignments were not completed. A brief list of related activities was all that was provided.

However, student interviews were done prior to the mapping activity and the initial mapping activity was observed and recorded by the researcher in January. Student interviews were again conducted in May to help provide a long term look at what had occurred. In addition, at this time the researcher had each of the kindergarten students create a concept map on their own about gardening. The purpose of this activity was simply to see what they would do with such a challenge. Taken together the data from this somewhat incomplete study seemed to provide a rich source of supplemental data so it has been included.
This kindergarten class was comprised of nine students, five boys and four girls. The first and second grade students were involved in other activities with the master teacher and the student teacher. The students had done at least five class concept maps prior to this session with either the master teacher or the assistant teacher, Mr. W. The initial day 1 mapping activity took place in the west classroom library area. All student interviews and the individual map activity were conducted in the block area on the lanai. The students had recently observed the garden being machine-tilled. All nine students were interviewed during the two days prior to the construction of the concept map. The individual mapping and final interviews were done in May, 1993.

Day 1. The teacher told the students they are going to do a concept map. He wrote the word Garden and they read it. Mr. W asked the group if they knew anything about a garden. A girl said, “It grows in dirt.” The teacher recorded her response and asked her what grew in dirt. The same girl responded, “Flowers and plants.” The teacher recorded student responses on the concept map throughout the discussion. A boy said plants have roots. Mr. W asked if all plants have roots. Some students said yes, one said, “Not weeds.” The teacher asked about the school yard. A student said he saw a plant with roots but it died from too much water. Some discussion on plants needing water ensued. When Mr. W asked what else they knew about gardens, the students named some vegetables and other plants. The teacher read the names of the vegetables and asked what they were. A girl responded, “Things we eat.” A discussion followed on food and soil including a song the students knew about how soil helps make your lunch. The teacher asked for more information. A girl told about planting a seed in a pot. Another student described a plant that helped mosquito bites. A
girl said the same plant helped burns. More fruits and vegetables were suggested. Mr. W had the children classify their examples into these two categories, indicated on the concept map with a v or f. When no one was certain, the tomato received a ? The teacher asked, "What else?" Cacti and the sun were discussed. Mr. W reviewed the plants listed on the concept map. He asked what they all had in common. That led to a discussion of vines and then to the class papaya tree. While talking about the parts of their tree, the students were unable to describe the part that held up the leaves so the teacher had them go outside to look. The remaining students discussed how they could measure the growth of their tree. When the students returned they reported that sticks held up the leaves of their papaya tree. The teacher again asked what else they knew. Student responded with flowers, buds, and food. Mr. W asked what food the garden needed. The group responded with water and sun. This led into a discussion of garden tools such as shovels, rakes, and a hose.

The teacher then asked the students to draw pictures to illustrate the things on their concept map. Some students did several drawings. The final activity was for each student to draw something they would like to grow in the class garden. The researcher did not observe any of the pictures being placed on the concept map. (See Appendix A.)

The teacher's log listed the DASH kindergarten bean sprout activity, two books read about plants, and the sprouting of lima bean seeds as the related activities done during the following month. In addition, these kindergarten students participated in the planting, care, and harvesting of the class garden over the next few months.
Day 2. The researcher became a participant/observer or the teacher for a part of this activity. The kindergarten students were asked to create their own individual concept maps about a garden. The word, Garden, was written on the board. Directions for constructing the maps were illustrated on the board using the students’ suggested examples. The instructions were to write the word garden in the middle of their paper and use circles with pictures and lines to show their ideas. During the final interviews which were conducted during and after this activity, the researcher asked each student to identify what they had drawn on their own map. Appendix B shows an example of one student’s January interview map, a computer replication (without pictures) of his self-drawn map, and his final, May interview map.

Case Study W2

This case study was added to the original plan for four case studies when it became evident that the data from the first study at this site was rather incomplete. The observations were done during three days in early September. There were no pre-observation student interviews. The post-observation interviews were done a week and a half after the observations. These kindergarten students had been in school less than one month. This was their second concept mapping experience. Their first map had been about weather. The master teacher, Ms. W, was described above in site description section. There were seven students in this group, three boys and four girls. A fourth kindergarten boy had been assigned to the first grade group for this block of time.
Day 1. One boy was absent. The six students and the Ms. W were assembled in the block area. The teacher placed a large piece of paper on the floor in front of her and told the students that they had a job to do. One student said, "Weather." Ms. W responded that they had already done a concept map on weather. This map was to be on pets. A student volunteered experiences about her own pets. The teacher passed out markers and large note cards to the students asking them to draw something about pets. The students began drawing while Ms. W moved between them asking questions and giving them encouragement.

When the students were finished Ms. W had them sit in a circle around the large sheet of paper. The teacher asked if the students knew what word she was going to write. The group said pets and helped her to spell it. Ms. W had one girl share what she had drawn, a rabbit and a turtle. The teacher labeled the girl's picture, wrote, then read the word, Kinds, on the concept map, and glued the girl's picture to the map. Ms. W then had the remaining students tell what they had drawn while she labeled and glued their pictures to the map.

The teacher next asked the students what else to write on their concept map. Several students suggested the names of other animals which the teacher wrote. When a student contributed spider, the teacher asked where spiders live. Students responded with web. Ms. W wrote web. She connected web with a line to spider, then connected spider to Where they live which she connected in turn to Pets, all the while explaining to the children what she was doing. After having the students take another round of turns to contribute one more thing about pets, Ms. W asked the students choose between reading a book or drawing another picture for the concept map before recess. (See Appendix A.)
Day 2. Six students were present. One girl was absent. The teacher reviewed what was on the concept map. She read the DASH focus book, *A Surprise for Mom*, described previously. A discussion about whether a dinosaur would make a good pet, the care of pets, what the surprise pet might be, and what animals might be good pets followed. Ms. W wrote categories on the concept map using students' own words. *Not so good pets* was written in dark green and *Good pets* in pink. The students suggested animals for the *Not so good* category as the teacher wrote their responses on the map in green and asked the student to give reasons for their choices. She used the same procedure only in pink with the *Good pets* category. Ms. W included some of their reasons along with their examples in each category. After the lesson, the teacher expressed some concern to the researcher about the use of only words in these additions to the concept map. (See Appendix A.)

Day 3. All seven students were present for the concept map activity in the block area. The teacher unrolled the concept map and reviewed that there are *good* and *not so good* pets. The students gave examples.

Ms. W passed out large note cards to the students and asked them to draw something that pets need. When they were finished she had them sit on the floor around the concept map. A boy chose light blue for the day's additions to the map. The teacher wrote, *What pets need.* She then asked the students to share what they had drawn. Most of the students had drawn animals. The teacher asked each child what their particular animal needed. One boy had drawn a cat. When asked what it needed, he responded, "Cat food." The teacher glued his picture to the map and wrote *cat food* under it. This process continued until all the pictures were on the map and labeled with a need.
The teacher asked the group if they had anything else to add to the map. A girl said, “Love and care.” Other students added ideas such as water, a bath, not pulling their ears, and so on. One boy drew a line from his picture of a cat, that had been labeled cat food and been placed in the food category, to the picture of a dog he had drawn on the first day, reasoning the dog needed food, too. The teacher asked for more ideas about pet needs. She reminded them about their pet care jobs on the class Responsibility Chart. Changing the food and water and cleaning the cages were discussed. (See Appendix A.)

Next Ms. W had the students move into a tight circle on the floor and she released Hina, the class rabbit, into the center of the circle for the students to pet and observe. A student volunteered that they needed to wash their hands when the rabbit was returned to its cage.

Prior to the final student interviews, the students participated in a Clean the Animals Day project. All the class pets and their cages were thoroughly cleaned by the entire K-2 class. They also made a class book on pets and friends. The kindergarten students had moved on to the study of animals in general. They had done another concept map on animals on which the categories Good pets, Not good pets, and Needs appeared. These categories had been suggested by the students. (See Appendix A.) They were to do a plant and animal classification activity on the day of the final interviews and then move on to a study of animal environments.
Site E

Site Description

This laboratory school is located on the campus of a small state university in the eastern United States. The university is located in a rural area next to a small town of 6,000. The university population is actually slightly larger than that of the town. The laboratory school is part of the public school system. It operates through a cooperative agreement between the university and the local school district. There is one administrator who teaches a nursery school class in the afternoon. There are about 125 students in grades K-6 with one class and teacher at each level. A nursery school program accommodates another 30 children. The students come from the neighboring community. This includes some children of the university staff. Ten percent of the students in grades 1-6 receive free or reduced lunch. Kindergarten is a half-day program. Seven percent of the K-6 students are Asian; three percent are Hispanic; and, three percent are African American.

The teacher was the same for both case studies at this site. Two different classes participated. There were always a number of college students observing in the classroom. There was also a full-time aide. The teacher, Mr. E, had been teaching for 15 years. His special expertise is early childhood education. He was a first grade teacher at the laboratory school prior to teaching kindergarten. Mr. E had been at the lab school for 13 years. He has a masters degree and is pursuing a doctorate. Mr. E teaches kindergarten in the morning and college classes in the afternoon.
The kindergarten classroom was located on the second floor of an old but well-kept brick building. The room arrangement was nearly the same for both studies. Across the front of the classroom there were bulletin boards displaying student work and a chalkboard. At one end of the chalkboard, there was a computer center, weather related student work posted on a bulletin board, and the classroom DASH calendar. Below the level of the chalkboard was a large box full of recycled materials for student inventions. Books were displayed on the chalkboard ledge. At the other end of the chalkboard was an old fashioned bathtub painted blue, filled with pillows that served as a reading center. Beyond this was a space storing some audio-visual equipment. The back of the classroom had large windows. In between each window were charts showing the students’ weekly classroom responsibilities, seating assignments, and other student projects. Under the windows were radiators, individual storage spaces for each student, and center activity supplies such as blocks. Student tables and chairs were located across the back and one side of the room. A large carpeted area with a rocking chair for the teacher occupied the front classroom space. This is where most of the concept mapping activities took place. To one side of the classroom were Mr. E’s office, storage for art supplies, and a loft for the children. During the first case study the classroom pets and a reading center occupied the upper part of the loft. During the second study, the homemaking center had been moved to this space and the pets placed on the floor level, under the loft. The classroom pets included a snake and guinea pigs. During the second study, an iguana in a large cage in the back of the room, had been added to the collection. On the opposite side of the classroom during the first study were a large bulletin board displaying a concept map of Charlotte’s
Web (White, 1952), the homemaking center, and a closet with a sink. For the later study, the homemaking center was replaced by supplies for other centers and storage. Class concept maps of day and night were on the bulletin board. Student work was displayed all up and down the school's hallways.

This was a half-day kindergarten. The day began at 8:00 and ended at 11:15 am. The students started the day with 30 minutes of free exploration time in the classroom. The next 60 to 90 minute period centered around whole group activities that focused on mathematics, science, and literature. Recess was at 10 and snack at 10:15. The remaining time was used for wrap-up activities. The class also went to the school library for a 45 minute period once a week, had a Spanish teacher for 10-15 minutes twice each week, had a counselor work with them for 20 minutes each week, and had a swimming class and a gym class, each once a week. Several times each year the entire school engaged in thematic units such as technology during which the classes would visit other rooms and teachers for special lessons.

Case Study E1

This study was conducted in February, 1993. It was intended to include five observation days. Unfortunately due to severe weather, the school was closed part of the time the researcher was at the site. There were 14 students in this class.

Day 0. A preliminary observation and teacher interview were done during the week prior to the scheduled study to familiarize the researcher with the classroom schedule and procedures. The teacher described his plans for the observation period and the students to be interviewed were selected.
During the first half hour, the students arrived, took care of any business and worked at self-selected independent activities such as blocks or computer learning games. Mr. E had the class gather on the rug for a morning discussion. They had been out of school for several days due to a holiday and a snow storm. They discussed whether or not they would have recess and ways to keep warm. The students then selected their classroom responsibilities for the remainder of the week.

Next, the teacher read *Katy and the Big Snow* (Burton, 1943) to the class. They discussed the weather they were experiencing and suggested ways to get rid of the snow. Mr. E related this to the current school-wide unit on technology. They then put rulers and meter sticks end to end on the carpet to represent the depth of the snow in the story. Mr. E had the students lay down next to the rulers to show them the snow was deeper than they were tall. The teacher introduced the technology project they were to do next. Each student was to think of a problem they could solve with technology. They were to draw a picture about it. The teacher would label their pictures and then hang them all on a bulletin board in the hall called *Kindergarten Does Technology*. As the students completed their drawings, they chose which center activities they wanted to do. The researcher left for a short while at this point.

During the final part of the morning the students finished their snacks, completed the classroom calendar, and listened to a chapter from *Charlotte’s Web*. The teacher spoke in Spanish when requesting the students to reassemble on the rug for the story. Dismissal was at 11:15.

**Day 1.** The first observation was done on a Tuesday. School was closed Monday due to another snow storm. Preliminary student interviews were
conducted during the first hour of class. The rest of the students were engaged in independent activities and a class discussion.

The teacher began the concept mapping activity with several pictures that illustrated good health practices. He got out a large piece of paper and wrote SICK in an oval shape in the center of the sheet. He said, “I’m not sure what we know about this.” Mr. E explained to the students that they were going to draw pictures for a concept map. He asked the students what they thought they might draw. Some of the responses included cough, throw up, and headache. Mr. E remarked that those were ways to be sick. He then discussed what size their pictures should be and passed out paper to each student while saying that he wanted to find out what the students knew about being sick. The students got their supplies, went to their tables, and drew their pictures.

Mr. E had the children gather on the carpet around the concept map as they finished. He asked each child to share what they had drawn while he labeled their pictures and glued them on to the concept map. The teacher had the students decide which pictures to group together such as coughing and sneezing. He encouraged them to extend the ideas they had illustrated. For example when a boy said his picture was of throwing up on his dad, Mr. E asked what his dad had done about this. The responses led to a discussion of who helps when one is sick. The teacher concluded the activity with a brief discussion by the children of what happens to them when they get sick, a request for any additions to the concept map, and a review of its contents. (See Appendix A.)

Day 2. The students constructed a concept map on germs. Each student drew a picture of what they thought a germ might look like. They read a DASH
rhyme about germs and made germ sock puppets. The students acted out the rhyme using their puppets. The observer was unable to be in the classroom on this day due to a prior commitment with the local school district.

**Day 3.** The teacher showed the students their concept map on germs from the previous day. He asked the students how to get rid of germs. Mr. E had the students role play germ-spreading situations. For example he asked a girl to demonstrate the correct thing to do when she had to cough. Mr. E asked another student to demonstrate the incorrect thing to do. The student was unable to do this. The boy’s hand just seemed to automatically cover his mouth every time he pretended to cough. The teacher finally asked the original student to pretend to *cough* all over the other students. She was more successful but had a similar problem.

The observer then became a participant and assisted the teacher with puppets during a presentation of the *DASH Germ Rhyme* from the previous day and a story written about germs by children in another school.

The teacher next introduced the DASH *germy goo activity* which is a continuation of the germ poem. The students conducted an experiment about washing their hands and germs while the teacher continued to read the next part of the rhyme. The students put some of the brown *germy goo* on their fingers. They picked up their pieces of *paper pizza* and decided if they wanted to eat it. The response was of course a chorus of *No’s*. The problem then was to find a way to get rid of the germs. They tried various combinations of dry paper towel, cold water, soap, and warm water. After the experiment the students discussed the importance of washing their hands before eating. The class then
went to a special technology related class with another teacher. Mr. E did a paper making activity with an upper grade group of students.

When the class returned, the teacher reviewed their concept map on sick. The students contributed ideas to add to the map. The teacher drew pictures and labeled them to represent their ideas. The additional ideas included a doctor dispensing medicine, a mother giving her child lunch in bed, a mother with a thermometer, and a picture labeled, *Germs spread*. Mr. E dismissed the students to get ready to go home by having them suggest one word that had something to do with being sick. No repeats were allowed. The students suggested such ideas as lying in bed, hospital, coughing, washing hands, and so on. The students completed their classroom responsibilities and were dismissed. (See Appendix A.)

Day 4. This was yet another snow day. Final interviews and germ activities were to have occurred. Instead the researcher provided a set of questions for the aide to ask each of the previously interviewed children the next week. The interviews were audio taped and later transcribed.

Case Study E2

This case study was done in October, 1993. This one day study was designed to gather some comparative data on two similar groups of students. One group did a concept map and the other group had a discussion and drawing activity. The rest of the lesson was the same for both groups.

There were 20 students in this class, 11 girls and 9 boys. The discussion group had 6 girls and 4 boys. The concept map group had 5 each, boys and girls. The teacher had randomly divided the class into the two groups. With the
cooperation of the school librarian, one group worked with her for 30 minutes in
the library while the other group worked in the classroom with Mr. E. Then they
switched groups for the next 30 minutes. Four students were selected to be
interviewed from each group as described previously. The students were
interviewed in the morning prior to these activities.

The daily schedule remained the same as in the previous case study.
The students arrived and settled into independent center activities. During circle
time the teacher assigned the classroom responsibilities for the week. Then the
class developed a Rules of the Pool chart as they were to begin swimming
lessons that week. Mr. E next had the students make booklets about their rules
since there were none to be found in the library. As the students finished this
project they selected an activity to do within the room. The student interviews
were conducted during this time.

**Part 1.** Mr. E began with the discussion group. The students were
gathered around the teacher on the rug. He began the discussion by reminding
the students that they had been talking about weather. He asked them what
made it warm or cold outside. Students suggested the sky, rain, sun, and wind.
Mr. E said that the wind was what they were going to talk about. He asked what
they knew about the wind. A student responded with, “Rain coming out of the
wind.” Mr. E said, “Interesting.” Other students said such things as, “It was cold”
and, “Made the trees blow.” The teacher asked the group if they looked outside
the window, could they see the wind blowing. The students looked, then
reported that it was raining and trees were blowing. Mr. E asked what else they
could look at. Leaves and grass were suggested. He asked if they could look at
a building. At first the students said, “No” but then one child said if the building
had a flag, they could see it *wiggling*. They went on to talk about strong and soft winds and dressing appropriately for the weather.

The teacher introduced the book he was going to read to the group, *Peter and the North Wind* (Littledale, 1977). He asked if the illustration of the old man blowing was real. After discussing some ways to make wind such as swinging a door or using a fan the group appeared to agree this was just a story. As Mr. E read the story, he stopped occasionally to ask a related question such as, "Did you ever play in the wind?" To which a student responded with, "a windmill."

When he finished the story, the teacher asked the students what they did in the wind. One student said, "Nothing." Another suggested going outside. Mr. E talked about raking leaves and flying things. The students came up with kites and paper airplanes. The teacher had each student draw a picture of things they did in the wind, *A Windy Picture*. He moved from student to student as they worked on their drawings singing songs about the wind that he invented as he went along. He asked questions about their pictures such as which way the wind was blowing and how the student could show that, and whether Batman's cape flew in the wind. He and the aide labeled the pictures with the students' own words. As time ran out Mr. E had the children put their pictures on a chair and line up to go to the library.

**Part 2.** As the concept map group returned from the library, the teacher asked them to put their books away and meet on the carpet with their favorite crayon. Mr. E placed a large sheet of red paper on the floor. One student asked if they were going to make a day and night clock. (They had previously done a concept map on day and night and made clocks.) He said no, this would be something different. He said they needed some ideas before they started their
project. He asked if they remembered what they had done before as he drew a circle in the center of the paper. A student said, "Dark, night." Mr. E wrote and spelled, _W-I-N-D_. He asked what they knew about the word. A student said, "Blowing." Mr. E wrote that word and drew a line to _WIND_. He had the child draw a picture of the wind blowing which Mr. E glued to the paper next to the label. The map construction exploded in a flash of activity as students suggested other ideas such as _flying stuff, cold, blizzard, blowing hair_ and so on.

When the idea of water and wind came up, a boy said, "The wind and the moon made waves." A girl stated that (only) the wind made waves. The boy said the moon carried the water up but it was so heavy that it goes down and that made a wave. The teacher asked if a second boy could demonstrate how wind made waves if he brought him a pan of water. This was done and several students blew on the water trying to convince the first boy that wind made waves. The first boy was not convinced and said if they put the pan of water outside, the moon would make waves. Due to time (and the fact it was cold and raining) the teacher postponed this extension, accepted both theories and went back to gluing the students' pictures onto the concept map.

The teacher introduced the same book and read it to this group. He again stopped occasionally to ask questions about the story including how the wind helped Peter, the boy in the story.

When he finished reading, Mr. E asked the group if there was anything on the map to show how the wind helped them. The students suggested such things as giving them air to breathe and cooling them off. Mr. E asked how they could tell if the wind was blowing outside. A student suggested he open the window. The teacher had several students draw pictures of their ideas which
were added to the map. They ran out of time and space on the map as the first group of children returned from the library.

Mr. E continued to talk about the wind with some of the students as they got ready for dismissal. He asked one girl what would happen to her umbrella in a strong wind. He wondered aloud if they could make something to measure the wind. A student said he could go outside and feel it. Student interviews were conducted the following day, first thing in the morning.

THE QUESTIONNAIRE

Due to the lack of research on concept mapping with young children, a questionnaire was devised to determine how kindergarten teachers felt about the effectiveness of concept mapping with their students. This was a way to create some insight as to how practitioners actually view and use concept mapping rather than only relying on informal reports.

The questionnaire was designed and administered by the researcher after the case studies were completed to prevent bias the responses might have on the data collection during the case studies. Prior to mailing, it was reviewed by an expert in evaluation. The suggestions of the evaluator were incorporated into the design. Appendix C is a copy of this questionnaire.

Each questionnaire asked several background questions to determine when and where the teachers had received DASH training, if concept mapping was covered during their training, if they had received any other training in concept mapping, whether they were in fact teaching kindergarten, and if they were using concept mapping with DASH or in any other instructional areas.
This background information was deemed important because, although DASH training was first provided in 1988, concept mapping was not used in the program until 1990. However, the teachers trained prior to 1990 could have learned of the strategy through DASH follow-up sessions or some other type of staff development. In addition, DASH kindergarten training is usually offered in combination with grade one training. Thus many of the teachers who participated in the kindergarten training and received questionnaires were actually teaching first grade.

The second section of the questionnaire asked the teachers to rate the effectiveness of concept mapping with kindergartners on a scale of zero (not at all effective) to three (very effective). A four point scale was chosen over a five point scale at the suggestion of the above-mentioned expert to encourage respondees to make a more definitive decision as to the effectiveness of concept mapping by eliminating the middle position. The next question asked the respondents to briefly list reasons why or why not they felt concept mapping was an effective instructional strategy with kindergartners. It was primarily from this question that the research questions and suggestions for potential evidence were drawn.

The last section of the questionnaire asked for a brief description of how the teacher created concept maps with their students. This question was designed to determine if the teacher was using the DASH concept mapping process. The final question asked for further comments or ideas on the subject.

The questionnaire was sent to all teachers who had taken DASH training prior to the study. A letter of explanation was included along with a self-
addressed, stamped envelope to increase the return rate. Appendix C also contains a copy of the cover letter.

As the questionnaires were returned the responses were entered into a database. The practicing kindergarten teachers were identified and their responses were separated from other respondents. A simple mean score was calculated from the effectiveness ratings.

Each reason given for effectiveness, positive or negative, was listed. Duplications were counted. Similar reasons were grouped together. Related reasons were further synthesized under broader headings until the data was organized into six research areas. Some data were put aside due to the low number of responses in the particular area.

Once these broad areas had been identified, the reasons for the effectiveness of concept mapping given by the teachers became the foundation for building the supporting evidence. Table 2 in Chapter 4 summarizes the outcome of this process.

DATA ANALYSIS PROCEDURES

Analysis procedures for the questionnaire data used the synthesizing process described previously. Once the research questions had been identified from the questionnaire, the data from the case studies were analyzed for supporting or refuting evidence. Ideas for potential evidence were suggested by teachers responding to the questionnaire. These ideas were described and discussed as to their relevance in Chapter 2 in the section concerning concept mapping functions.
A multiple case study design was selected for two reasons. Yin (1989) states that multiple case studies can be considered as replications or multiple experiments and that any resulting generalizations are based on analytic rather than statistical generalizations. Analytical generalization is a way of generalizing in which a previously developed theory, in this case concept mapping as done in DASH (and described in the first section of this chapter), the data collected from the questionnaires, and the verifying information found in the literature review on the functions of concept mapping, are used as a template with which to compare the empirical results of this multi-case study.

To analyze the wealth of data collected during the case studies, a variety of procedures were employed. First a code as suggested by Miles and Huberman (1994), was invented to identify to which particular area each piece of data applied. This code is included in Table 3, Chapter 4.

The video tapes were the most challenging to encode. A HyperCard® computer program or stack called Qualifiers developed by Thomas Speitel (1993) facilitated this process nicely. As the tape is played, the program enables the researcher to stop the tape, place timing marks for the beginning and end of a selected sequence, describe the sequence in a note, and then place the marks and notes in a particular computer card or file. For example, if the tape showed a student adding a new category to the concept map, the researcher would transfer the beginning and ending timing marks, type a note as to what was happening on the tape including pre-set data about the site, date, and particular tape, and then place that information in the file marked TSO.NC.S for Thinking Skills. Organization. New Connection. by Student. The program then
enables this information to be printed out organized by the evidence coded files shown in Table 3 in the next chapter.

The field notes were organized using the same code. They could have been encoded using the same computer program, but it was more time efficient to code them by hand than to transfer them from one program to another on the computer. Other evidence such as classroom photographs and copies of student artifacts were also coded by hand.

The concept maps created during student interviews and the developing class concept maps were transferred to a computer representation using Inspirations™ by Inspiration Software. This was necessary in the case of the class maps to increase readability. The photographs were not always clear. The computer representations were also considerably easier to handle both physically and analytically.

Some analysis was attempted with the concept maps from the student interviews. A simple count of the number of student ideas or entries was made for each map. The hierarchical levels were also counted. Added together, these produced an interview score. This had some limitations as it was based on the researcher’s interpretation of the student responses during the interviews. (See Limitations of the Study below.) The difference between the interview scores was computed for the pre- and post- interviews and a test (paired t-test) for significance was done.

In a similar manner, the interview scores from the sixth case study with the comparative concept mapping and discussion groups were collected. The differences between the pre- and post-interview scores for students in both groups were computed. These were then analyzed using an unpaired t-test.
An attempt to document engagement time was also made using the video tape from this case study. The tape was stopped every 30 seconds during the concept mapping and discussion portions of the lessons to count the number of engaged students. A student who was focused on or looking at the teacher or the concept mapping activity was counted as engaged. The tape was also carefully observed for 10 seconds before and after every 30 second mark for verification of the observation made on the mark. (See Limitations of the Study below.)

Once all the data had been coded, it was organized and synthesized for presentation in Chapter 4. As with any ethnographic study, the evidence relies primarily on the description of the observations and data provided by the researcher rather than with the limited numerical data. The quantitative data are intended only to provide additional support to the qualitative data.

LIMITATIONS OF THE STUDY

Any study done by a single researcher will inherently contain a certain amount of bias. The researcher's bias toward the DASH program and all that implies must be acknowledged. Although by no means eliminated, this issue was recognized and addressed in a number of ways. By conducting the case studies prior to identifying the particular research questions, the intention was to reduce the number of preconceived notions by the observer as to what made concept mapping effective or not with kindergarten students. The field notes were written as a transcript of events and dialog rather than in an evaluative or judgmental mode. A second set of eyes in the form of video tape, and for the
interviews, audio tape, were used. These tapes were used both to verify the accuracy of the interview notes and as the primary data source to identify evidence for the research questions. Further, the researcher explained to the teachers in the case studies that the observations were to be of what occurred during the concept mapping process, not of whether what they were doing was appropriate or effective.

The issue of replication is addressed by using multiple case studies but the sites and teachers chosen limit generalizations that might be made. All the sites were laboratory schools. One had a particularly small class size. The teachers, except one, were highly trained professionals in their field who additionally had some investment in the study being DASH trainers themselves. Additionally, although Yin (1989) states that two studies are sufficient to claim replication, as many as ten are recommended.

The data collected across the sites was not entirely consistent for one reason or another. The student interviews are of particular concern due to the age of the children and the resulting nature of the interviews. The questions used were not entirely consistent across sites. The same kinds of questions were used but there was some variation depending on the natural progression of the interview. The studies varied in length due to scheduling and weather.

The sample size for the groups in the comparative study was very small (n=8). This same problem exists for all the numerical or quantitative data collected but these were intended to be only supplemental to the study.

Determining the hierarchical levels for the student responses during the interviews was again done by a single researcher. This supports consistency but will also contain some bias. Further, the encoding of interview responses...
using concept maps, although reported as effective in the literature, was a new method for the researcher. The single researcher dilemma holds true for the data collected on engagement time also. In addition, there is only a small amount of engagement time data but it was intended only as supportive data.

Using a more traditional approach (Campbell & Stanley, 1963) when addressing the limitations and validity of this study, the issue of history, or events occurring between the first and second measurements is cause for concern if one were to assume only the concept mapping had an effect on the students. In an ethnographic study, all the factors are described and taken into account as much as possible. Maturation is likewise to be accounted for. Testing, or in this case doing a concept map is again a part of the normal progress of events. Instrumentation is the only thing that seems to support the use of a single researcher. It is assumed the same researcher should score, in this case the concept maps, consistently. There were changes to the instruments themselves when interview questions and the process of recording the responses are considered as discussed previously. Statistical regression is not a likely cause for concern in a study such as this with such limited numerical data. Finally, selection bias is a problem since the selection of sites, teachers, and students to be interviewed was not precisely random. Keeping these limitations in mind, the next chapter will describe and discuss the results of these six case studies.
CHAPTER FOUR
RESULTS AND DISCUSSION

This chapter is divided into two parts. The first section will describe the results of the questionnaire on concept mapping sent to DASH kindergarten teachers and the research questions that were derived from their responses. The second part will present and discuss the evidence found in the case studies regarding the research questions.

RESEARCH QUESTIONS DERIVED FROM THE QUESTIONNAIRE

A total of 1,369 questionnaires were sent to the teachers who participated in DASH kindergarten training from 1988-1992. Those teachers who were DASH trained in the summer prior to the case studies were not included based on the likelihood that they would have little or no experience with the DASH concept mapping process since they were only beginning to implement the program. Fifty-six questionnaires were returned with incorrect addresses. Nineteen percent or 246 were returned. Of these, 160 were kindergarten teachers.

With this low response percentage, a second mailing to increase the number of responses was considered. Two factors caused this idea to be abandoned. The first was cost. Secondly, based on the expert counsel of the aforementioned evaluator, it was decided that the little additional information that might be gained by a second request would be unlikely to provide much further insight into the responses already in hand.
Question 10 read, *How effective do you think concept mapping is as an instructional strategy with kindergartners?* The respondents were to rank their perceived level of effectiveness on a scale of 0 or not at all, to 3 or very. Of the responding kindergarten teachers, 147 answered this question. Table 2 summarizes the response data. The mean score was calculated to be 2.4. This would reflect a positive attitude concerning the effectiveness of concept mapping as an instructional strategy for kindergarten students on the part of the responding kindergarten teachers.

<table>
<thead>
<tr>
<th>Number of Responses (n)</th>
<th>Rank (R)</th>
<th>Points (P=n X R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>72</td>
<td>3.0</td>
<td>216.0</td>
</tr>
<tr>
<td>1</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>53</td>
<td>2.0</td>
<td>106.0</td>
</tr>
<tr>
<td>3</td>
<td>1.5</td>
<td>4.5</td>
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<tr>
<td>17</td>
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<tr>
<td>0</td>
<td>0.5</td>
<td>0.0</td>
</tr>
<tr>
<td>1</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total (N): 147</strong></td>
<td></td>
<td><strong>Total (TP): 346.0</strong></td>
</tr>
</tbody>
</table>

Mean Score: 2.4 (Mean=TP/N)

The more impelling question was number 11 which asked the teachers to provide reasons for their effectiveness ranking decision. Dealing with these data was challenging due to the open-ended nature of the question. A synthesizing procedure described in the previous chapter was used. There were 574 individual ideas suggested. Of these, the 497 which came from kindergarten teachers were used to identify six of the seven research areas.
The responses from other grade level teachers, most being first-grade teachers, provided further verification to the kindergarten teachers’ responses.

Of the 497 kindergarten teacher responses, 32 were categorized as negative. Most of these respondents indicated they had received their DASH training prior to the introduction of mapping into the program and were unaware of the DASH concept mapping process. Some of these teachers even suggested concept mapping might be successful with young children if pictures were used.

This study is primarily concerned with the 465 positive responses. These responses paralleled many of the functions or uses for concept mapping by both teachers and students as described in the literature review in Chapter 2 and in the study description in Chapter 3. The responding teachers also included some new ideas as to why concept mapping supported their reasons for effectiveness. These ideas together with the research discussed in Chapter 2 provided the basis for developing the list of potential evidence to support the claims. Table 3 on page 161, contains the list of types of evidence sought in each research area.

The first research area and the two questions investigated concerned thinking skills. Thinking skills were examined in this study from both the teacher and the student perspective. The next five areas, assessment, multi-modal learning, student participation, self esteem, and cooperative learning were addressed in this study primarily from the teacher viewpoint. The final area, knowledge acquisition, was investigated in terms of the student.
Thinking Skills:

How can teachers use concept maps to help students develop thinking skills?
How do students use their thinking skills when constructing concept maps?

The largest number of responses to the questionnaire (165) were categorized as having to do with the development of thinking skills. The most often mentioned ideas were that concept mapping helped students to organize or categorize their thoughts (65 responses) and that it helped them to make connections (40 responses). Other thinking or process skills such as self-evaluation and recall were suggested but organization and connection making were selected based on the large number of teacher responses and the supporting literature described in Chapter 2.

To create a list of potential evidence to be sought in the case study data (which includes field notes, video tapes, photographs, artifacts, and student interviews) that might support the development of connection-making, the comments from the teachers on the questionnaire concerning this were synthesized. The resulting list includes such things as students drawing lines on the concept maps to show the connection between their new ideas and previously recorded ideas and connections made verbally that might not be recorded on the concept map. In addition, modeling of the connection-making process on a concept map was also included as potential evidence by the researcher since this is one way in which students learn a new skill. They observe an expert and then attempt the skill themselves. This is an example of apprenticeship as described by Vygotsky (1978) and others. (e.g., Bayer, 1990; Raths, 1969)
Organization is different than connection-making in the concept mapping process. The addition of a new category or the use of an established category by a student were suggested on the questionnaire as potential evidence of organizing skills. Modeling of this skill by the teacher was also recorded as potential evidence by the researcher.

Connection-making and organization skills are very much alike and are often difficult to separate which is why they are discussed together in this section. An attempt was made in this study to differentiate them in terms of the actual concept map. Connection-making had to do with the links and organization involved the categories or concept and example entries.

Assessment:

How can concept maps be used by teachers as an assessment tool?

Using concept maps for assessment was the second area most cited (63 times) by teachers on the questionnaire. Over half of the respondents (33) agreed concept mapping was a good way to assess their students' prior knowledge. An almost equal number (26) said it provided an ongoing assessment of what their students were learning. A few mentioned that the class concept map provided a way for parents to see what their students were learning. In order to include the many ways teachers described using concept maps for assessment, a broad research question was asked.

A list of suggestions for potential evidence of teachers being able to use a concept map as an assessment tool was identified from the questionnaire comments. Instances of students sharing prior experiences and knowledge that were recorded on the map might be evidence for the potential use of a concept
map as an assessment instrument. New student ideas being added to and changed on the map might provide a record of the development of students' knowledge. The actual use of this information for assessment by teachers was not addressed in this study. Rather, evidence was to be sought that concept maps could be used by teachers to assess their students' prior knowledge and on-going learning.

**Multi-Modal Learning:**

**How can teachers use concept mapping to support multi-modal learning?**

Children learn in different ways. As discussed in the previous chapter, this study uses Gardner's theory of multiple intelligences as one way to describe how different students learn. Kindergarten teachers suggested 32 ideas in this area, most of them having to do with visual learners. Based on a previous study by DeFrank (1993), the evidence cited in the literature review, and the DASH claim that it is designed for all learners, this researcher elected to expand the question beyond the visual-spatial intelligence and include the other intelligences as well.

The list of potential evidence derived from the questionnaire responses and the literature review includes teachers addressing the needs of all kinds of learners as described by Gardner. Observations of students using their different intelligences while concept mapping were also included.
Student Participation:

What effect does concept mapping have on student participation?

Student participation was a research area suggested in 41 questionnaire responses. These responses indicated that all students could be involved in the creation of a concept map and that concept maps helped students to focus on the topic.

These ideas, along with a look at the relevance of student responses to the topic were suggested as evidence for this research question in the questionnaire responses. In addition, a brief comparison of engagement time was made in one case study which included two similar groups, one of which constructed a concept map while the other did not.

Self Esteem:

How can teachers use concept mapping construction to help build their students' self-esteem?

Forty-one teachers said the concept mapping process helped to develop their students' self-esteem. Due to the difficulty in measuring an increase in self-esteem with such young students, the potential evidence targeted situations where the teachers were observed using opportunities to build their students' self-esteem as suggested by the questionnaire respondents.

The questionnaire responses suggested potential evidence might include situations where the students' own ideas were recorded, students showed ownership of the map, mistakes or misconceptions were accepted as legitimate contributions, a variety of ideas were accepted, duplications of ideas were accepted, and the students were enjoying the mapping process itself.

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Cooperative Learning:

How do students work cooperatively when constructing a concept map?

Questionnaire responses suggested that concept mapping provides a situation or context in which a teacher could use cooperative skills. Potential evidence for this was drawn from the responses to the questionnaire. These include students cueing off each other's suggestions and ideas, working together, and respecting other students' different or conflicting ideas.

Knowledge Acquisition:

What evidence is there that concept mapping helps individual students acquire a knowledge of facts and an understanding of how they are organized or connected to a topic?

Finally, when considering the meaning of the effectiveness of an instructional strategy, the question of whether the students learned something seems obvious. It is interesting to note that only a single kindergarten teacher made any direct mention of knowledge acquisition in all the responses to the questionnaire. This is perhaps developmentally appropriate. The acquisition of factual knowledge is not usually one of the primary goals for kindergarten students (NAEYC, 1986).

This study addressed the question of evidence for knowledge gain in several ways as identified by the researcher. First, students' pre- and post-interview response scores were compared. Secondly, student interview data from the sixth case study in which one group did a concept map and the other did not were compared. Third, the researcher decided potential evidence might be found in case study data which showed students adding and changing
information on their concept maps. This could imply they were increasing their understanding of the topic. (Identifying whether such an increase is due to concept mapping or the additional topic-related activities is one of the limitations of ethnographic study.)

The following figure summarizes the research areas and evidence discussed in this section.
Table 3. Research areas and evidence types for the effectiveness of concept mapping with kindergarten students.

<table>
<thead>
<tr>
<th>RESEARCH AREAS</th>
<th>Question</th>
<th>Evidence Types</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Thinking Skills</strong></td>
<td>Organization:&lt;br&gt;• Student adds new category or idea to map. TSO.NC.s&lt;br&gt;• Teacher adds new category to map. * TSO.NC.t&lt;br&gt;• Student uses an established category on map. TSO.UE.s&lt;br&gt;• Teacher uses an established category on map. * TSO.UE.t</td>
<td>Connection-Making:&lt;br&gt;• Student draws lines to established category. TSC.LE.s&lt;br&gt;• Teacher draws lines to established category. * TSC.LE.t&lt;br&gt;• Student draws lines between categories. TSC.LB.s&lt;br&gt;• Teacher draws lines between categories. * TSC.LB.t&lt;br&gt;• Verbal connections by student. TSC.V.s&lt;br&gt;• Verbal connections by teacher. * TSC.V.t</td>
<td></td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
<td>• Student prior knowledge is added to concept map. APK&lt;br&gt;• Students new or revised ideas are added to the map. AI&lt;br&gt;• Students reorganize concept map. ARO</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Multi-Modal Learning</strong></td>
<td>• Mapping supports musical intelligence. MM.M&lt;br&gt;• Mapping supports logical-mathematical intelligence. MM.L&lt;br&gt;• Mapping supports kinesthetic (move) intelligence. MM.K&lt;br&gt;• Mapping supports visual-spatial intelligence. MM.S&lt;br&gt;• Mapping supports verbal (linguistic) intelligence. MM.V&lt;br&gt;• Mapping supports written (linguistic) intelligence. MM.W&lt;br&gt;• Mapping supports concrete (kinesthetic) intelligence. MM.C&lt;br&gt;• Mapping supports intrapersonal intelligence. MM.I&lt;br&gt;• Mapping supports interpersonal intelligence. MM.T</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Student Participation</strong></td>
<td>• Most students participate to construct concept map. SP.AP&lt;br&gt;• Student responses focus on topic of concept map. SP.F&lt;br&gt;• Student attention is focused on concept map. SP.AT</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Self-Esteem</strong></td>
<td>• Student shows ownership of concept map. SE.O&lt;br&gt;• Student mistakes are accepted. SE.M&lt;br&gt;• All (variety) student input is accepted. SE.V&lt;br&gt;• Duplication of student input is accepted. SE.D&lt;br&gt;• Student shows enjoyment of map construction. SE.E</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cooperative Learning</strong></td>
<td>• Students cue off others responses. CL.C&lt;br&gt;• Students work together. CL.T&lt;br&gt;• Students respect different or conflicting ideas. CL.R</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Knowledge Acquisition</strong></td>
<td>• Comparison of pre/post student interviews. A.NI&lt;br&gt;• Student add new ideas to concept map. A.RO&lt;br&gt;• Students reorganize concept map. A.C&lt;br&gt;• Students add connections to concept map. A.C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CASE STUDY FINDINGS ON THE RESEARCH QUESTIONS

The research findings have been organized to present evidence for each of the seven areas and questions described in the previous section. The examples and data are coded by case study as described in Chapter 3. A summary of the codes used to identify the data sources is provided in the following table.

Table 4. Codes used to identify evidence and case studies.

<table>
<thead>
<tr>
<th>CODE</th>
<th>SITE</th>
<th>CODE</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Southern Site, Study 1</td>
<td>A</td>
<td>(Student) Artifact</td>
</tr>
<tr>
<td>S2</td>
<td>Southern Site, Study 2</td>
<td>FN</td>
<td>Field Notes</td>
</tr>
<tr>
<td>W1</td>
<td>Western Site, Study 1</td>
<td>P</td>
<td>Photograph</td>
</tr>
<tr>
<td>W2</td>
<td>Western Site, Study 2</td>
<td>SI</td>
<td>Student Interview</td>
</tr>
<tr>
<td>E1</td>
<td>Eastern Site, Study 1</td>
<td>VT</td>
<td>Video Tape</td>
</tr>
<tr>
<td>E2</td>
<td>Eastern Site, Study 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How can teachers use concept maps to help students develop thinking skills?

How do students use their thinking skills when constructing concept maps?

Evidence for using thinking skills while concept mapping includes both the teacher modeling the organization of information or making connections between concepts or the student actually doing it. More specifically, to organize ideas, the teacher or the student may add or use a category on the map. To show a connection being made the teacher or the student may draw a line from a new concept to a category or between two categories.
Also included were both teachers and students making verbal connections between ideas. Verbal connections were sometimes not recorded on the map for several reasons. The most obvious was the typical classroom situation with one teacher and 20-25 energetic kindergartners, all sharing ideas with each other as well as the teacher. When students were particularly excited, 10-20 or more responses could be contributed in a single minute [e.g. S2:VT]. It was physically impossible for the teacher to capture every connection suggested by every student on the concept map. Yet, these unrecorded connections are valid connections made by students. So, verbal connections that were not recorded on the map but on tape were also considered as evidence.

Students appeared to do a lot of organizing and connection-making in these studies. The teachers did considerable modeling of these skills for their students on the concept maps.

Students frequently added new ideas and categories to organize their concept maps. In Ms. W's group, a student suggested that some pets are wild. This discussion resulted in the not so good category. Students then suggested all kinds of animals for this category including wolf, shark, and lion. Other students gave a justification for their suggestions for this category such as mean dogs, whales are too big, and crabs pinch [W2:VT]. One of Ms. S's students suggested they group all the horses together on the map. Another suggested they use ground as a pet category rather than jungle. During a later session, a girl came up with the land and water category for pets such as turtles [S1:VT]. The students in Mr. E's class suggested the throwing up category when one boy's picture didn't fit with the coughing group [E1:VT]. The teachers modeled
the addition of a new category by first asking students questions. For example, Mr. E asked the student who had drawn a picture of himself throwing up on his dad, what his dad did. The student replied, “Helps,” and the helper category was added [E1:VT]. In Ms. S’s case, when students suggested a food for the nutrition map that belonged to different food group than the one being discussed, she would ask if they needed a new category. For example, when eggs were suggested, a new category, dairy was added to the map [S2:VT].

Students appeared to be very comfortable using established categories to organize information on their concept maps [W1:VT; W2:FN; E1:VT; S2:FN,VT]. This was evidenced by the large number of examples suggested for categories. The students in Ms. S’s class offered 14 different vegetables so quickly she could barely write fast enough. The same thing happened with student examples of fruits and seafood [S2:VT,P]. Ms. W’s students likewise had many examples for the pet needs category. In addition to their individual pictures, the students added 20 more ideas to this category such as bath, wash the cage, water, love and examples of ways to handle the animals properly [W2:VT,P]. Two students in Mr. E’s class were able to add their pictures to the washing hands category independent of the teacher, once the category had been established [E1:VT]. Mr. W’s students quickly classified the fruits and vegetables that were already recorded on the garden map. Mr. W labeled each with a V or F [W1:VT]. The students at site S were able to identify and reposition their pictures of pets in the established categories, land, water, land and water, on the concept map [S1:VT]. One piece of counter-evidence is the lack of contributions to the where they live category on the pet concept map. Ms. W asked the students for more examples several times during the course of the
case study, but they were unable to suggest any more ideas beyond the original web for a spider [W2:VT].

The most graphic evidence for students making connections to established categories is the video tape of Ms. S's children, each gluing their pictures of pets to the map, selecting the appropriately colored pen, drawing a circle around their picture, and then another line connecting it to the established category [S1:VT]. For the most part these teachers modeled the actual link line drawing on the maps in response to student suggestions. Mr. E talked about how he was going to draw a connecting line from one girl's picture to the word sick [E1:VT]. After the students' ideas about caring for pets had been recorded on the map, Ms. S asked if all those ideas had to do with pets. When the students agreed with a yes, she drew a line from the take care of pets category to pets [S1:VT,P]. Mr. E had the students draw pictures of their ideas of what wind could do. As they placed them on the map, he labeled the picture and drew a line to the central concept, wind [E2:VT,P]. Mr. W wrote words such as apples, leaves and roots, and drew the connecting lines for student subconcept suggestions about what trees have [W2:VT].

Making cross-links or drawing lines between established categories rather than from a new idea to a category is a skill just emerging on these kindergarten maps. This developmental step 3 skill in the DASH concept mapping process is shown in figure 17 in chapter 3. The observer sat mesmerized as a child traced a line with his finger between the picture he had drawn on a previous day of a dog, to a picture he had just completed of a cat with a dish of food on the other side of the map. He was so excited he could not contain himself. When he (finally) got the teacher's attention and asked to
connect his dog to the food, Ms. W had him draw his own, very long line [W2:VT]. Ms. S’s students suggested that both fruits and vegetables be connected to the market on the nutrition map [S2:VT, P]. Several children drew lines from their pet pictures to both kinds of pets and the particular category, land, water, or land and water [S1:P]. The lack of evidence for more of this type of connection making provides the counter-evidence in this particular idea of connection making.

There was an abundance of verbal connection making in all the case studies. This is not particularly surprising since concept mapping is designed to help students connect information (Novak, 1984). Most of the student-made connections recorded on the maps by the teachers were first made verbally. Teachers would, as described above, verbally prompt students to make connections with questions. Students also made connections to other students’ ideas as described in the section on cooperative learning. An example of verbal connection making are the students in Ms. S’s class discussing how the bread and cereal group ought to be connected to the map. They decided to connect it to food [S2:VT]. After establishing the helper category on the sick concept map, students suggested a variety of people who help such as moms, doctors, nurses, and even Mr. E [E1:VT]. When a large cockroach ran across the concept map which was on the floor, a girl remarked that scary animals belonged in the not so good pets category [W2:VT]. Mr. E started a whole series of student verbal connections when he asked if you could tell the wind was blowing by looking at a building. A few students responded with no, but then one said yes, if you look at the flag. Another student said if they took their class flag outside it would blow. Still another student pointed to the class flag in the room to which
another added, "See it wiggling?" It was [E2:VT]. An example of a teacher modeling verbal connection making occurred when Mr. W reminded the students of their class papaya tree in the schoolyard after a student suggested *papaya* for the garden map [W1:VT].

Table 5 summarizes the data collected in the case studies on the evidence for thinking skills in the concept mapping process.

<table>
<thead>
<tr>
<th>Evidence</th>
<th>Site S1</th>
<th>Site S2</th>
<th>Site W1</th>
<th>Site W2</th>
<th>Site E1</th>
<th>Site E2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization: Teacher adds new category to map.</td>
<td>FN,VT, P</td>
<td>FN,VT, P</td>
<td>FN,VT, P</td>
<td>FN,VT, P</td>
<td>FN,VT, P</td>
<td>FN,VT, P</td>
</tr>
<tr>
<td>Organization: Teacher uses category on map.</td>
<td>FN,VT, P</td>
<td>FN,VT, P</td>
<td>FN,VT, P</td>
<td>FN,VT, P</td>
<td>FN,VT, P</td>
<td>FN,VT, P</td>
</tr>
<tr>
<td>Connection-Making: Student draws line to category.</td>
<td>FN,VT, SI, P</td>
<td>FN,VT, SI, P</td>
<td>SI</td>
<td>FN,VT, SI, P</td>
<td>SI</td>
<td>SI</td>
</tr>
<tr>
<td>Connection-Making: Student draws line between categories.</td>
<td>SI</td>
<td>FN,VT, P</td>
<td>SI</td>
<td>FN,VT, P</td>
<td>FN,VT, P</td>
<td>SI</td>
</tr>
<tr>
<td>Connection-Making: Teacher draws line between categories.</td>
<td>FN,VT, P</td>
<td>FN,VT, P</td>
<td>FN,VT, P</td>
<td>FN,VT, P</td>
<td>FN,VT, P</td>
<td>FN,VT, P</td>
</tr>
<tr>
<td>Connection-Making: Verbal connections by teacher.</td>
<td>FN,VT</td>
<td>FN,VT</td>
<td>FN,VT</td>
<td>FN,VT</td>
<td>FN,VT</td>
<td>FN,VT</td>
</tr>
</tbody>
</table>
In summary, students do seem to be organizing information and making connections between ideas on concept maps in these case studies. It would seem concept mapping provides a context for teachers to model organizing and connection making skills. It appears there is evidence of students using these skills when contributing to the construction of a concept map.

**How can concept maps be used by teachers as an assessment tool?**

Evidence for this category includes student prior knowledge being added to the map, students new or revised ideas being added to the map, and students reorganizing the map. Most of the recording in these studies was done by the teachers. The students however suggested what was to go on the maps.

In each of the case studies the teacher began the concept map by asking the students to share their prior knowledge about the topic. Mr. W asked the students if they knew anything about a garden [W1:FN]. Ms. W had the students draw something they each knew about pets, and then share what they had drawn, before attaching it to the concept map [W2:FN]. Ms. S began by asking her students if they had pets at home or at school [S1:FN]. In the second study at this site, Ms. S asked the students what the word written on the paper said (nutrition) and if they knew what it meant [S2:FN]. Mr. E asked his students if they knew what sick meant [E1:FN] and in the second study, what the group knew about the wind [E2:FN]. These teachers also supplied a known context for the students to connect their ideas to. For example, Ms. S asked her students about pets they had at home or at school. The classroom had a rabbit and fish. Mr. W extended his question about gardens to include the schoolyard which had a class garden.
The teachers continued to ask students what else they knew about the particular topics with such questions as “What else should we put on our concept map?” [S1:FN]. The teachers appeared to accept and record most contributions. When ideas were omitted from the concept map, it seemed to be unintentional for the most part and not rejection by the teacher of duplicate ideas or misinformation. The identification of student misconceptions is important to building an accurate picture of their prior knowledge. Both class maps on pets had examples of animals such as whale and elephant that are not usually considered kinds of pets [W2:P; S1:P]. The garden map had entries that suggested only some plants have roots and some weeds don’t have roots [W1:P].

There is evidence to support the idea that these teachers could use concept maps to assess the on-going development of their students’ understanding of ideas. The teachers in these studies returned to the class maps to add and change information after the students had engaged in activities designed to further develop the particular concept. Both teachers who were concept mapping pets addressed the question of animals that make appropriate pets after reading the DASH book, A Surprise for Mom. On the second day of the study, Ms. W had the students categorize their suggested animals as Good Pets and Not So Good Pets. She had the children give reasons for their selection of a particular category [W2:P,VT]. Ms. S had the students reposition their pictures of animals to the category Kinds of Pets which subcategorized them further by their type of home: land, water, or land and water. During this activity Ms. S asked a boy if his picture of a dog went with the water category. He moved it to the land category. Ms. S also asked the students
if anyone had drawn an animal that they now thought might not be a good pet. A girl said her bird might not be a good pet. After some discussion, the group decided some birds made good pets and some did not [S1:P, FN, VT]. While reviewing the information in the meat and poultry category on their nutrition map, a student in Ms. S’s group said that lobster and crayfish didn’t belong and suggested they add a seafood category [S2: VT].

It is important to realize that children’s misconceptions are not easily normalized (Rowe & Holland, 1990; Wandersee, Mintzes, & Novak, 1994). The whale picture was repositioned with the water kind of pets [S1: P]. This on-going assessment informs the teacher that students may continue to carry their misconceptions.

These teachers added new information suggested by the students to the concept maps. After reading a story about the wind Mr. E had his students suggest ideas and draw pictures for ways in which the wind helped them. Some of their new ideas included the wind makes you cool and gives you air to breathe [E2: FN, P]. The nutrition map was reorganized on the second day to reflect the food groups the students were learning about. As these students learned about the importance of water and exercise, these ideas were also added to their concept map [S2: P, VT]. After discussing the care of their class rabbit, Meatball, and creating a chart for the custodians to use to care for the pet over the holidays, Ms. S had the students add new ideas such as clean the cage and exercise to the Take care of pets category on their concept map [S1: FN, P]. Table 6 summarizes the data from all the case studies on assessment.

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### Table 6. Summary of the cross-case data on assessment.

<table>
<thead>
<tr>
<th>Evidence</th>
<th>Site S1</th>
<th>Site S2</th>
<th>Site W1</th>
<th>Site W2</th>
<th>Site E1</th>
<th>Site E2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment: Students' new ideas added to map.</td>
<td>FN, VT, P</td>
<td>FN, VT, P</td>
<td>FN, VT, P</td>
<td>SI</td>
<td>FN, VT, P</td>
<td>FN, VT, P</td>
</tr>
<tr>
<td>Assessment: Students reorganize map.</td>
<td>FN, VT, P</td>
<td>FN, VT, P</td>
<td>FN, VT, P</td>
<td>FN, VT</td>
<td>FN, VT</td>
<td>FN, VT</td>
</tr>
</tbody>
</table>

The kindergarten teachers observed in these case studies did not use the concept maps created by their students to create final assessment instruments. Tests were not a part of their kindergarten programs. This is in agreement with the developmentally appropriate practices suggested by the National Association for the Education of Young Children (1987). The maps themselves could serve as evidence of what the class as a group knew about the topic.

These case studies seem to provide evidence that kindergarten teachers could use concept maps to record and assess the prior knowledge of their class including misconceptions, and to record the on-going development of their students’ knowledge about the topic of the map.

**How can teachers use concept mapping to support multi-modal learning?**

Concept mapping provides stronger support for some intelligences. Data for all the intelligences described by Gardner are included in this section. This study is not attempting to make a case for the support of all modes of learning.
by using concept mapping. Some of the data are included to provide a basis for speculation in Chapter 5.

The two learning modalities most frequently mentioned by the teachers on the questionnaire were linguistic and visual. Although a case has been made for support of all the intelligences as described by DeFrank (1993), concept mapping is not the only instructional strategy a teacher should use to reach different kinds of learners. However, if as Gardner claims, most learners have several more-dominant intelligences, concept mapping might usually support at least one of these. Much of this support is dependent on the teacher’s selection of the form for the map and the way in which the map is to be constructed. The following discussion provides evidence of the ways the kindergarten teachers in these case studies addressed the needs of different kinds of learners. It is hard to imagine the construction of a class concept map without employing linguistic or verbal intelligence.

Linguistic Intelligence

The linguistic learner prefers to learn by reading, writing, talking, and listening. All of these language skills were addressed by the teachers in the case studies during the mapping activities. The maps all had writing on them although this was most often done by the teacher due to the developmental level of the students [E1:P; E2:P; S1:P; S2:P; W1:P; W2:P]. Two students in one study were observed labeling their own pictures with the words dog and love [W2:P]. When beginning the concept maps the teachers often asked the students to identify the topic word on the map by asking them to read the name of the concept to be mapped, such as pets, garden, sick, and nutrition [W1:VT;
When reviewing the concept maps with their students, the teachers sometimes read what was written and in other cases asked the students to read. Mr. W read what had been written part way through the initial construction of the map on gardens [W1:FN,VT]. Mr. E reviewed the map on sickness by prompting the students to read some of the entries and reading some himself [E1:FN]. Ms. S asked the students to read the previously recorded ideas in the pet care category before they added new ideas [S1:FN,VT]. There was a great deal of verbal sharing and talking by the students throughout the mapping process in all the case studies [E1:VT; E2:VT; S1:VT; S2:VT; W1:VT; W2:VT]. These discussions provided the information from which the maps were constructed. Even when the teachers used pictures, each student verbally shared what they had drawn with the other students before their drawing was placed on the map [S1:VT; W2:VT; E1: VT; E2:VT]. In summary, all four of these linguistic skills, talking, listening, reading, and writing, were employed in the concept mapping process. In addition, there was evidence of all the teachers modeling these skills for their students [E1:VT; E2:VT; S1:VT; S2:VT; W1:VT; W2:VT].

Visual-Spatial Intelligence

Likewise, there is much evidence in all the case studies to support the use of the visual-spatial intelligence in concept mapping. Visual learners learn by seeing, drawing, and coloring things. All of the maps constructed during the case studies used pictures to represent student ideas. Four of the six maps used student-drawn pictures that were labeled by the teacher [E1:P; E2:P; W2:P; S1:P]. On the fifth map, the initial map about gardens was not completed.
during the observation. The students had however drawn pictures to illustrate the ideas on the map that were to be attached later [W1:FN,VT]. The sixth map on nutrition was created almost entirely with words. That particular study was conducted near the end of the school year and many of these kindergartners had begun to read. There were a few teacher-drawn illustrations on the map of ideas such as the caffeine in coffee and several of the fruits [S2:P].

Color was used in three cases to differentiate between categories. For example, Ms. W used pink to write the names of good pets and green for not so good pets [W2:P]. Ms. S similarly used orange for meats and poultry, red for fruits, and green for vegetables [S2:VT,P]. In the construction of the concept map about pets Ms. S had the students circle their own pictures with the color assigned to the different kinds of pet habitats and draw a line from the picture to the name of the habitat in the same color. Pink was to be used for pets that lived in water. One student for example, circled and drew a line in pink from her picture of a fish to the word water [S1:P]. Interestingly, Ms. S remarked to the students that she had made a mistake; she should have used blue rather than pink for the water pets. The students had no obvious problems using the selected colors.

The actual arrangement of concepts on the concept map also supports the visual-spatial learner. Similar ideas were grouped together on all the concept maps. At site E, all the coughing pictures were glued around the coughing label and the throwing-up pictures around the throw-up label on the sick concept map [E1:P,VT]. Likewise, all the horses were grouped together as were the dogs on the pet map done by Ms. S's class [S1:P,VT]. Ms. W had the
students group all the *good pets* in one place and all the *not so good pets* in another [W2: VT,P].

Just *looking* at the concept maps created during these case studies provides considerable evidence for the support of visual-spatial learners. There is much use of pictures, student drawings, color, and grouping of ideas by categories [W1:P; W2:P; E1:P; E2:P; S1:P; S2:P]. Appendix A contains computer representations of each of the class maps.

**Bodily-Kinesthetic Intelligence**

Much of the map construction process, particularly arranging the concepts on the map as mentioned above, supports learners with a strong bodily-kinesthetic intelligence. These students prefer to build, act out ideas, and touch things to learn. This type of learning is sometimes referred to as concrete. There was considerable evidence that concept mapping can be used to support these learners found in the case study data.

The students actually helped in the physical construction of some of the maps. This was especially strong in the building of the concept map on pets in study S1. Ms. S had the students position and later reposition their own pictures on the map. She also had them draw their own circles and connecting lines themselves [S1:VT]. Ms. W and Mr. E also had the students help to glue their own pictures to the maps on pets and wind [W2:VT; E2:VT].

Other instances of activities to support this kind of learner occurred during the concept mapping activity. When Mr. W's students could not figure out what held up the leaves on their papaya tree, he had two children go outside to find out what it might be. They reported that *sticks* held up the leaves [W1:VT].

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Ms. S cut apart the initial concept map and used the pieces to reorganize the class map on nutrition. She also had the students walk over and look and point at the bulletin board to help them think of more examples for the *dairy* and *bread and cereals* food categories. [S2:VT]. The teachers often had the students *show* what they meant when the student could not think of words to express their ideas. Mr. E had a boy show him what the wind did. The boy moved his hand back and forth to show the wind blowing. Another student made a circling motion with his hand to illustrate the motion of a tornado. A classic example of kinesthetic learning occurred when Mr. E had the students blow on the pan of water to *make* waves. This was a case of capturing a teachable *moment*. The concept map set up the context for this to occur [E2:VT].

The evidence here suggests that teachers need to be aware of opportunities to support the kinesthetic learner. Capitalizing on opportunities for these learners to *do* things during and in conjunction with the construction of a concept map was illustrated by the teachers in these case studies. Mr. E had the students role play being sick and making waves [E1:VT; E2:VT]. Ms. W set the pet rabbit loose on the floor for the students to touch and observe [W2:VT]. Mr. W sent his students out to check on plant parts [W1:VT]. Ms. S had her children *milking* a rubber glove cow and feeding the rabbit and cleaning its cage [S1:FN; S2:FN].

**Logical-Mathematical Intelligence**

Arranging concepts on the map also supports the logical-mathematical learner but in a different way. These students prefer to learn by quantifying things, thinking critically, and problem solving. The hierarchical arrangements
found on the kindergarten maps in this study support this kind of learning. All
the maps produced in these case studies exhibited some form of hierarchical
structure \([E1:P; E2:P; S1:P; S2:P; W1:P; W2:P]\). The classifying or categorizing
of ideas is fundamental to the concept mapping process. In many cases, the
students invented the classification schemes themselves for their maps such as
the \textit{good pets} and \textit{not so good pets} found on Ms. W’s class map \([W2:VT]\), the
fruit and vegetable categories the students suggested for their garden map
\([W1:VT]\), and the various pet habitats and food categories Ms. S’s students
came up with for their pet and nutrition maps \([S1:VT; S2:VT]\).

Asking the children to give reasons for the connection of their ideas to a
particular category would seem to provide further support for developing logical
thinking. Ms. W had her students suggest why their pets were \textit{good} or \textit{not so
good}. One girl said a crab was \textit{not so good} because it might pinch. Another girl
said a whale was too big to be a \textit{good} pet \([W2:FN]\). When Mr. E asked why the
\textit{coughing} and \textit{sneezing} pictures were close together, a student replied that both
make \textit{germs}. After a student suggested ice cream should be added to the \textit{not
nutritious} category and another student said it was made of milk, a lengthy
discussion ensued as to why some foods could be considered both nutritious
and not nutritious. Another example of logical thinking occurred during the
chocolate milk and brown cow discussion. One boy extended the argument for
brown cows not producing chocolate milk by pointing out that the store also had
strawberry milk and he’d never heard of a strawberry cow \([S2:FN,VT]\). Further
evidence for logical and critical thinking was cited earlier in this chapter in the
section concerning thinking skills.
Students suggested logical solutions to problems that occurred during the concept mapping process. When a student at site S had a single card with drawings of a cat and a fish and she needed to put it into both the ground and water pet categories, several solutions were suggested by other students. One said she could put it in the middle of the two categories. Another suggested she could cut the card in half, which she did. A student with a similar problem decided his bird could fly over the water and placed his card to reflect this [S1:P,VT]. Mr. W's group didn't know whether a tomato was a fruit or a vegetable so they put a question mark next to it until they could find out [W1:VT,P]. Ms. S's students on the other hand put cookies in both the not nutritious and the bread and cereal groups [S2:P].

Counter-evidence was observed when Mr. E's students ran out of space on their map about wind for additional ideas, and he asked them what they could do, they just stopped adding ideas to the map and got ready to go home. Of course, it was time to leave [E2:VT].

Musical Intelligence

This is probably the intelligence least supported by concept mapping. These learners learn by singing and rapping. Rhymes with strong rhythmic patterns can also be used to support this type of learning.

These case studies revealed little evidence of music being used in the concept mapping activities. Two teachers had their students sing songs related to the map. Mr. W had his group sing a song about how soil helps make lunch when the idea of soil being food for plants came up during the garden map construction [W1:FN, VT]. Some of Ms. S's students spontaneously began to
sing a song (and Ms. S encouraged them) about peanut butter while they were
discussing where peanut butter might go on their concept map [S2:VT]. Mr. E
invented rhymes and sang them as the students were drawing pictures for the
map on wind. “If the wind blows, the tree goes. “A windy day, a windy day. I’ll go
outside and then I’ll play” [E2:VT].

This appears to be another situation like that of the kinesthetic learner,
only perhaps even more so, where it is up to the teacher to capitalize on
opportunities to support musical learners during the concept mapping activity.
The evidence in these case studies is sparse.

Intrapersonal Intelligence

The next two intelligences concern whether students learn better alone
or with others. Both modes are important. Both seem to be supported by the
DASH concept mapping used in these case studies.

Intrapersonal learners prefer to learn independently of others. They
connect new ideas to their personal life. Concept mapping does support the
idea of connecting to personal experience. This was particularly evident in
these case studies during the initial construction of the maps when the teachers
asked the students to share their prior knowledge and experience. Mr. W asked
his students what they knew about gardening. The discussion became quite
detailed when it was discovered one girl’s father grew plants for a local nursery.
She had much to contribute about growing plants in pots, fertilizing, and so on
[W1:VT, SI]. When discussing pet care, one girl said they had to “watch Griz so
she didn’t fall off the table.” Grizzelda is the pet box turtle in Ms. W’s classroom
[W2:FN]. Ms. S had her students tell about pets they had at home and later
about their care. Several students shared stories about the demise of their pets from over-feeding and other causes [S1:FN,VT]. When the question of whether chocolate milk came from brown cows was posed, one boy shared that he had a brown cow and it did not produce chocolate milk [S2:FN,VT]. Mr. E’s group had a number of experiences to share about being sick. One boy’s story about throwing up on his father was skillfully used by Mr. E to discuss who helped him when he was sick. Most of the students had personal contributions for this new helper category [E1:VT, FN]. During the mapping of prior knowledge about the wind, a student described a hurricane his cousin had experienced which led to other students’ related stories about wind and storms [E2:VT]. The kindergartners in these studies did a particularly fine job of relating what they were learning to their personal experiences when given the opportunity to share this information.

Although concept mapping as done in these studies is primarily a group activity, students did have the opportunity to work independently when they each drew their own pictures for five of the six maps [E1:VT; E2:VT; S1:VT; W1:FN; W2:VT]. Students saw their own ideas recorded on the maps in all cases [E1:VT; E2:VT; S1:VT; S2:VT; W1:VT; W2:VT] and in some cases, their names were on the pictures they had drawn [S1:P; E2:VT; W2:P].

As students become more able, they can create their own personal concept maps. This was attempted with one group of kindergartners during these case studies. The students constructed their own maps about gardens during the last week of school. They were rather incomplete representations of what the students actually knew as determined in the student interviews but could have other value as far as self-esteem, writing assessment and so on are
concerned [W1:A,S1]. (See Appendix B for examples of a computer rendering of a student-drawn map and an interview map done at the same time.) In addition, one girl at site S did make her own map at home (probably with parental help) when it was suggested she do so after she learned the map she helped the researcher create during her interview was not hers to keep. She brought her own map on nutrition to share with the researcher and her teacher the next day [S2:FN]. This would indicate that personal concept maps created by students might well support intrapersonal learners but most kindergarten students probably do not yet have the skills to construct them.

Interpersonal Intelligence

These learners prefer to learn cooperatively. They like to interact with others. The concept mapping process as described by DASH provides strong support for this type of learner. The construction of the class map is a cooperative process. The discussion necessary to the construction provides students a great deal of opportunity to interact.

In all six case studies the students were asked to contribute and share their ideas for the concept maps throughout the construction process. In many cases the process was not ended until the teachers received no response to the often repeated question, “What else?” Ms. W ended each mapping session with a last round of turns for each student [W2:VT]. A lack of time appeared to be the major factor as to when the mapping activity was concluded with students still wanting to share ideas. Mr. E’s students were still discussing the map on wind as they prepared to go home [E2:VT]. Ms. S’s large group never
seemed to run out of ideas before they ran out of time until the very last session for both the pet and nutrition maps [S1:VT; S2:VT].

There is an abundance of evidence for student interaction both between themselves and between themselves and the teacher on the video tapes. (Further evidence is included in the section on cooperative learning.) These kindergarten teachers appeared to recognize the importance of these interactions and encourage them. They asked open ended questions such as what the students knew about gardens, nutrition, wind, and pets, or what happened when they got sick [W1:VT; S2:VT; E2:VT; W2:VT; S1:VT; E1:VT]. These teachers provided specific opportunities for the students to interact in small groups while they were drawing their pictures for the maps [W1:VT; W2:VT; S1:VT; E1:VT]. They encouraged students to discuss their ideas when they had a difference of opinion such as how to classify ice cream, whether all plants had roots, or what causes waves, rather than giving them the answer [S2:VT; W1:VT; E2:VT].

Table 7 summarizes the data from the case studies on multi-modal learning. Questionable data, as described previously, is indicated with parentheses.
Table 7. Summary of the cross-case data on multi-modal learning.

<table>
<thead>
<tr>
<th>Evidence</th>
<th>Site S1</th>
<th>Site S2</th>
<th>Site W1</th>
<th>Site W2</th>
<th>Site E1</th>
<th>Site E2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-Modal Learning: Linguistic-verbal</td>
<td>FN, VT</td>
<td>FN, VT</td>
<td>FN, VT</td>
<td>FN, VT</td>
<td>FN, VT</td>
<td>FN, VT</td>
</tr>
<tr>
<td>Multi-Modal Learning: Kinesthetic</td>
<td>FN, VT</td>
<td>FN, VT</td>
<td>FN, VT</td>
<td>FN, VT</td>
<td>FN, VT</td>
<td>FN, VT</td>
</tr>
<tr>
<td>Multi-Modal Learning: Concrete</td>
<td>FN, VT</td>
<td>(FN, VT)</td>
<td>(FN, VT)</td>
<td>(FN, VT)</td>
<td>FN, VT</td>
<td>(FN, VT)</td>
</tr>
<tr>
<td>Multi-Modal Learning: Intrapersonal</td>
<td>FN, VT, P</td>
<td>FN, VT, P</td>
<td>FN, VT</td>
<td>FN, VT, P</td>
<td>FN, VT, P</td>
<td>FN, VT, P</td>
</tr>
<tr>
<td>Multi-Modal Learning: Interpersonal</td>
<td>FN, VT</td>
<td>FN, VT</td>
<td>FN, VT</td>
<td>FN, VT</td>
<td>FN, VT</td>
<td>FN, VT</td>
</tr>
<tr>
<td>Multi-Modal Learning: Musical</td>
<td>(VT, FN)</td>
<td>(VT, FN)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In summary, these case studies provided considerable evidence for the support of certain of the intelligences. Based on the data collected, the concept mapping process as described by DASH seems to provide strong support for linguistic, visual-spatial, and interpersonal modes of learning. It seems to provide far less support for bodily-kinesthetic, logical-mathematical, and intrapersonal modalities. This study showed no support the development of the musical mode of learning. Since most learners have two or three strong intelligences according to Gardner, it would seem that concept mapping could be a good instructional strategy to use to support some of the multiple modes of learning.
What effect does concept mapping have on student participation?

The kindergarten teachers in these case studies made a particular effort to see that every child in their class was involved, contributed, and participated [E1:VT,P; S1:VT,P; W1:FN; W2:VT,P]. This was accomplished by having each child draw something to contribute to the class map as well as through discussion of the map such as when Ms. S asked her students to share about the pets they had at home. To insure that all the children had a turn to tell about their own pet or one they would like to have, she went around the entire circle of 26 students [S1:VT]. Even students who joined the group late or were absent in Mr. E’s class, were given the opportunity to contribute to class maps [E1:VT,FN]. In the two studies where the teachers were working with smaller groups of children, the students as would be expected, had considerably more opportunities to contribute to the map [W1:VT; W2:VT]. Only one instance of counter-evidence was recorded in which a child had not contributed a drawing to the class map. This was discovered during the post mapping student interview. The student was asked what he had drawn for the map. His response was that he hadn’t drawn a picture. This was during the comparative study in which a much shorter amount of time was allotted to the map’s construction [E2:SI].

The most obvious evidence to support the idea that students were focused on the topic at hand is to look at the relevance of the student responses to the teacher’s questions on the video tapes from each study. Even student responses that were not precisely appropriate were always somehow related to the topic. For example, when Ms. S asked for reasons why a hamster made a good pet, a girl responded she had a hamster at her other school.
In another case Ms. W asked the students where their pets lived. The students continued to name more kinds of pets such as a snake in response to an earlier question by the teacher, rather than suggest where pets might live. As possible counter-evidence, there were instances when the students appeared on the video to be talking to each other or looking at something other than the concept map. What they may have been discussing or looking at is unknown.

Engagement time as described in Chapter 3 is yet another measure of student participation. In case study E2 in which two groups of students were compared, one using a concept map, the other a group discussion prior to reading a story, the researcher closely observed the video tape of these two groups in an attempt to assess engagement time. Using the video rather than direct observation has both advantages and disadvantages. On the tape some of the students occasionally moved out of camera range. The biggest advantage is that when the designated moment occurs, the observer can stop the tape and get a sustained look at what is happening. This does not happen in real time. The results of this brief attempt to measure engagement time are intriguing. The discussion group lasted for a total time period of four minutes. The concept map group lasted for nine full minutes. The time difference in itself points to the importance of hands-on activity when considering the participation of young learners.

There were ten students in the discussion group. Nine samples were taken, using a stop-action look at the tape, every 30 seconds during the four minutes of class discussion prior to reading the book. The engaged time for this group was 87.7%. Table 8 summarizes the data.
Table 8. Engagement time data for the discussion group.

<table>
<thead>
<tr>
<th>Timing Mark</th>
<th>Students Off Task</th>
<th>% Students Engaged</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00:00</td>
<td>1</td>
<td>90</td>
</tr>
<tr>
<td>0:00:30</td>
<td>3</td>
<td>70</td>
</tr>
<tr>
<td>0:01:00</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>0:01:30</td>
<td>1</td>
<td>90</td>
</tr>
<tr>
<td>0:02:00</td>
<td>1</td>
<td>90</td>
</tr>
<tr>
<td>0:02:30</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>0:03:00</td>
<td>2</td>
<td>80</td>
</tr>
<tr>
<td>0:03:30</td>
<td>3</td>
<td>70</td>
</tr>
<tr>
<td>0:04:00</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

Engaged Time = 87.7%

There were ten students in the concept map group. Nineteen samples were taken, one snapshot, every 30 seconds, for the nine minutes the students were involved in constructing the concept map prior to reading the book. The engaged time for this group was 98.9%. The engagement time for the first four minutes was 97.7%. Table 9 summarizes the data for this group.
Table 9. Engagement time data for the concept map group.

<table>
<thead>
<tr>
<th>Timing Mark</th>
<th>Students Off Task</th>
<th>% Students Engaged</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:30:00</td>
<td>1</td>
<td>90</td>
</tr>
<tr>
<td>0:30:30</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>0:31:00</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>0:31:30</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>0:32:00</td>
<td>(1)*</td>
<td>90</td>
</tr>
<tr>
<td>0:32:30</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>0:33:00</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>0:33:30</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>0:34:00</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>0:34:30</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>0:35:00</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>0:35:30</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>0:36:00</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>0:36:30</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>0:37:00</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>0:37:30</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>0:38:00</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>0:38:30</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>0:39:00</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

Engaged Time = 98.9% (Total nine minutes)
Engaged Time = 97.7% (First four minutes)

* Student responding to a question from a visitor.

Both the discussion group and the concept map groups had very high rates of engagement. In the literature, engagement time is usually reported between 50-90% with 70% being considered excellent (Young, 1992). Both of these groups had excellent rates of engagement. No small part of this is due to the exceptional teacher in this case study. However, there is a noticeably higher rate of engaged time for the concept mapping group. If the student who was questioned by a visiting adult during this period was omitted from the
calculations, the percentage for this group would be even greater. The fact that this group of children continued to sustain this almost perfect rate for an additional five minutes provides further supporting evidence for the effect of concept mapping on student participation.

An additional piece of relevant evidence on participation is the amount of time these case study teachers were able to sustain the concept mapping sessions. Kindergarten children are generally able to attend to a particular group activity for 10-15 minutes, perhaps 20 minutes near the end of the school year (NAEYC, 1987). Table 10 shows the amount of time as recorded on the video tapes of each mapping session. Study E2 was omitted since it was designed to be of short duration.

<table>
<thead>
<tr>
<th>Site</th>
<th>Sess. 1</th>
<th>Sess. 2</th>
<th>Sess. 3</th>
<th>Sess. 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>24:48</td>
<td>14:47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W1</td>
<td>36:28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W2</td>
<td>25:36</td>
<td>27:08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1</td>
<td>27:55</td>
<td>12:23</td>
<td>17:12</td>
<td>12:02</td>
</tr>
<tr>
<td>S2</td>
<td>18:13</td>
<td>25:51</td>
<td>58:12</td>
<td></td>
</tr>
</tbody>
</table>

The mapping sessions ranged from 12 to 58 minutes. Nine of the twelve sessions lasted more than 15 minutes. Engagement time, viewed on the video tapes from all sites, appeared to be very high, easily above 75%. In addition, there were several cases where the concept mapping extended into the next activity. Mr. W's students had not yet completed drawing or attaching their
pictures to the garden map [W1:FN]. Ms. S continued to talk with small groups about the class nutrition map when the students moved into their center activities [S2:FN,VT]. It seems that the participation of kindergartners can be sustained for longer than average periods of time with concept mapping.

<table>
<thead>
<tr>
<th>Evidence</th>
<th>Site S1</th>
<th>Site S2</th>
<th>Site W1</th>
<th>Site W2</th>
<th>Site E1</th>
<th>Site E2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Participation: Student construction</td>
<td>FN, VT, P</td>
<td>FN, VT, P</td>
<td>FN</td>
<td>FN, VT, P</td>
<td>FN, VT, P</td>
<td>FN, VT, P</td>
</tr>
<tr>
<td>Student Participation: Focused Student Responses</td>
<td>FN, VT</td>
<td>FN, VT</td>
<td>FN, VT</td>
<td>FN, VT</td>
<td>FN, VT</td>
<td>FN, VT</td>
</tr>
<tr>
<td>Student Participation: Engagement Time/Attention</td>
<td>VT</td>
<td>VT</td>
<td>VT</td>
<td>VT</td>
<td>VT</td>
<td>VT</td>
</tr>
</tbody>
</table>

In response to the research question, it appears that all the case study teachers made an effort to have their students contribute to the class concept maps, that student responses were relevant to the topic if not always to the particular question being discussed, and that concept mapping produced a very high rate of engaged time. It is important to note that DASH activities themselves have been found to generally produce a high rate of engagement (Young, 1992). Considering this evidence, it can be concluded that in these case studies, concept mapping seemed to have a positive effect on student participation.
How can teachers use concept mapping construction to help build their students' self-esteem?

The responses to the questionnaire suggest that possible indicators of high student self esteem are students showing ownership of the concept map and enjoying the construction of the map. They also suggested that the teacher accepting student mistakes or misconceptions, writing duplicate ideas on the map, and accepting a variety of student responses for the map could help students to build their self-esteem. The only empirical evidence directly related to student self-esteem and concept mapping found in the literature review, concerned anxiety level as described in chapter 2. However, there is evidence that the ideas suggested by the teachers in their questionnaire responses do contribute to students' self-esteem.

Benjamin Bloom (1976) and Margaret Donaldson (1978) have argued that self-esteem is an important variable when it comes to school success. What teachers can do to insure a positive self image in their students has been suggested by many authors and researchers. (See for example Canfield, 1995; Youngs, 1993; Johnson, 1993; Purkey & Novak, 1984.) The ideas contained on the responses to the questionnaire were also suggested by the experts cited previously. Based on this they were included in the list of potential evidence for self-esteem.

Evidence of student ownership was most obvious with those students who contributed drawings or writing to the maps. Pictures of pets were drawn by students for maps at two sites [S1:VT,P; W2:VT,P]. Windy pictures and sick pictures were drawn in the case studies at site E [E1:VT,P; E2:VT,P]. Mr. W had students draw pictures at the conclusion of the mapping activity that were to
later be placed on the garden map [W1:VT, FN]. Students helped to draw the lines for connections and arranged their own pictures into categories on the pet map at site S [S1: VT]. Ms. W's students asked if they were going to draw on their concept map and one boy said, "I remember, I drew a dog last time. I did it myself" [W2: VT].

Student enjoyment as evidenced by participation and facial expression was observed throughout the mapping process at all sites by the observer [E1: VT, FN; E2: VT, FN; W1: VT, FN; W2: VT, FN; S1: VT, FN; S2: VT, FN]. The most telling evidence for enjoyment might be in the high rate of engagement described in the participation section.

There are many examples of teachers accepting student misconceptions on the class concept maps and in their discussion during the creation of the maps. During the construction of the nutrition map there was an interesting discussion about the origin of chocolate milk. The student question as to whether brown cows produce chocolate milk was recorded in the Wonder and Discover Book for further research and chocolate milk was written on the map [S2: VT, P]. In the earlier study at the same site, deer and zebras were recorded on the map as pets [S1: VT]. Similarly Ms. W's students suggested owls, whales, and dolphins as good pets. When juice was suggested as something pets need, Ms. W wrote juice on the map with a question mark to indicate they would investigate that idea further [W2: VT]. Mr. E accepted all student responses to his questions about wind such as the student who said rain causes wind [E2: VT].

There is also considerable evidence of these teachers accepting student duplication of previously contributed ideas. Mr. W's class map on sickness had 3 coughing pictures, 3 washing hands pictures, and 7 throwing up pictures.
There were two cold pictures on the wind map. Ms. S had the students draw pets. She asked them to check with their small group partners for duplication. However, with such a large class, there were many duplications between the groups. These duplicate pictures of such animals as fish and horses were all included on the map. When Ms. W’s students drew their pet pictures there were 3 dogs and 2 turtles, all of which were glued to the map.

Teachers accepting all or a variety of input includes the acceptance of both misconceptions and duplicate ideas as described above. The teachers in these studies never rejected a child’s contribution or suggestion outright. All were very flexible. When a student in Mr. E’s class asked if she could use a pencil rather than her favorite crayon to draw, Mr. E replied for all to hear that a pencil would be okay and a marker would be delightful.

There is some counter-evidence for total acceptance of all student ideas on the concept maps. An example of counter-evidence occurred when Ms. W responded, “We have those,” to students’ suggestions of the previously recorded ideas, dog, cat, and kitten. However, there is evidence supporting acceptance of duplicate ideas on that same concept map. This particular incident of rejection of duplicate ideas occurred as time was running short, near the end of the lesson.

Some ideas were discussed by the students and left unrecorded by the teacher. Some of these omissions, particularly of incorrect ideas, may have been intentional on the part of the teacher but this question was not asked by the researcher. Some of these teachers also questioned student misconceptions rather than accepting them outright. If the child did not readily
let go of the misconception the teacher usually accepted and recorded it. For example, when juice was suggested as something pets require, the teacher responded, “Pets need juice?” The student affirmed this idea and the teacher recorded it with a question mark [W2:VT]. Whether this was to clarify what the student said or to be certain the child actually believed pets need juice was not a question asked of the teacher by the researcher. Ms. S questioned students on several occasions when they suggested inappropriate animals for pets such as bears, leopards and giraffes [S1:VT, FN]. Again whether this was to clarify or ascertain a misconception is unclear. Time appears to be a major factor when ideas were not recorded on a map. When students are freely and simultaneously contributing ideas as was often the case in these classrooms, it would appear to be an impossible task to record or even hear them all. Table 12 summarizes the data collected on self-esteem.

<table>
<thead>
<tr>
<th>Evidence</th>
<th>Site S1</th>
<th>Site S2</th>
<th>Site W1</th>
<th>Site W2</th>
<th>Site E1</th>
<th>Site E2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student ownership</td>
<td>VT,FN,P</td>
<td>VT</td>
<td>FN</td>
<td>VT,FN,P</td>
<td>VT,FN,P</td>
<td>VT,FN,P</td>
</tr>
<tr>
<td>Mistakes accepted</td>
<td>VT,FN,P</td>
<td>VT,FN,P</td>
<td>VT,FN,P</td>
<td>VT,FN,P</td>
<td>VT,FN</td>
<td>VT,FN</td>
</tr>
<tr>
<td>All input accepted</td>
<td>VT,FN,P</td>
<td>VT,FN,P</td>
<td>VT,FN</td>
<td>VT,FN,P</td>
<td>VT,FN,P</td>
<td>VT,FN</td>
</tr>
<tr>
<td>Accept duplication</td>
<td>VT,FN,P</td>
<td>VT,FN</td>
<td>VT,FN</td>
<td>VT,FN,P</td>
<td>VT,FN,P</td>
<td>VT,FN</td>
</tr>
<tr>
<td>Student enjoyment</td>
<td>VT</td>
<td>VT</td>
<td>VT</td>
<td>VT</td>
<td>VT</td>
<td>VT</td>
</tr>
</tbody>
</table>

Taking into account all the evidence presented, it would seem the teachers in these case studies encouraged student ownership of the concept
map and enjoyment of the process. They accepted a wide variety of student input including duplication and misconception. This evidence would appear to indicate that teachers can use the construction of a concept map to help build self-esteem in their students.

**How do students work cooperatively when constructing a concept map?**

The concept maps constructed during the case studies were done cooperatively with a whole class group. The class size varied from 9 to 26. All the students contributed ideas to the discussion verbally if not through drawings. This was due in part to the expectations of their teachers.

Johnson, Johnson and Holubek (1986) describe four levels of skills students go through in attaining a high degree of cooperation. Forming, the first level, includes "the bottom-line skills to establish a functioning cooperative learning group." Functioning skills are management skills needed to complete tasks and maintain good relationships between group members. Formulating skills work toward understanding and retaining the assigned material. Fermenting skills are reconceptualizing skills which promote cognitive conflict and rationalized decisions. Kindergartners are expected to operate at levels one and two for the most part. (See Table 1 in Chapter 3 for a further description of the DASH concept mapping levels.) The responses on the questionnaire identified students showing respect for another's different or conflicting ideas, students choosing to work together, and students cueing or building on other students ideas as potential evidence for cooperative learning. These appear to be in line with Johnson and Johnson's functioning level.
Students often have different or conflicting ideas when making suggestions for their concept maps. The students in these case studies exhibited, what might be for some, a surprising amount of respect for each others ideas for such young learners. These kindergarten children often discussed their conflicting opinions in a more mature manner than is seen with upper level students based on this researcher's observations. In Ms. S's class when the students couldn't resolve a difference of opinions, the students suggested the problem of whether liver and ice cream were good for you be recorded in the class Wonder and Discover Book for further research [S2:P,VT]. When Mr. W's students couldn't decide if a tomato was a fruit or a vegetable, they elected to put a question mark next to it. When they weren't sure if weeds had roots or not, they had Mr. W record it both ways [W1:P,VT]. All ideas were accepted in Mr. E's class when the students couldn't reach agreement on how waves were formed [E2:VT]

Students helping one another without teacher prompting is another characteristic of cooperative learning. When a student in Ms. W's class objected to what a classmate was drawing for the concept map, a third student said, “Let him draw anything he wants.” During a later observation of this same group, a student was not happy with his drawing and another student suggested he turn his card over and try again [W2:VT]. Mr. E's students encouraged each other to make their circle larger so everyone could see the concept map they were constructing [E1:VT]. When two of Ms. S's students both wanted to draw the donut for the bread group, they decided that one could draw the donut and the other a slice of bread [S2:VT].

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Students working cooperatively often build on or cue off of each other’s ideas. There was much evidence to support this idea. When the students in Ms. S’s class were trying to decode the name of the concept for the map they ran through a series of these cues: from neutron to nutritious to nutrition [S2:VT]. When a student suggested a butterfly might make good pet because it doesn’t sting, another student commented that butterflies are really gentle, and a third student said gentleness was important for a good pet [W2:VT]. On the pet concept map at site S, a boy suggested pets need a bath, to which another added, so they won’t be dirty [S1:VT]. When one of Mr. E’s students said they should cut up their pictures so they would all fit on the concept map, another student clarified the suggestion, saying they could cut their pictures out [E1:VT].

Examples of sharing personal experiences are many and varied. Young children are easily reminded of their own experiences when another child is sharing theirs. Concept mapping provides a context for sharing the students’ related and similar experiences. Ms. S’s children shared their different kinds of pets and examples of how they died [W2:VT; S1:VT]. At site E students told about storms they had experienced and about being sick [E2:VT; E1:VT]. Site S students told about foods they had tasted and stores they had visited to shop for groceries while constructing the map on nutrition [S2:VT].
Table 13. Summary of the cross-case data on cooperative learning.

CROSS-CASE DATA ANALYSIS ON COOPERATIVE LEARNING

<table>
<thead>
<tr>
<th>Evidence</th>
<th>Site S1</th>
<th>Site S2</th>
<th>Site W1</th>
<th>Site W2</th>
<th>Site E1</th>
<th>Site E2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperative Learning: Student cueing</td>
<td>VT, FN</td>
<td>VT, FN</td>
<td>VT, FN</td>
<td>VT, FN</td>
<td>VT, FN</td>
<td>VT, FN</td>
</tr>
<tr>
<td>Cooperative Learning: Work together</td>
<td>VT, FN</td>
<td>VT, FN</td>
<td>VT, FN</td>
<td>VT, FN</td>
<td>VT, FN</td>
<td>VT, FN</td>
</tr>
<tr>
<td>Cooperative Learning: Respect differences</td>
<td>VT, FN</td>
<td>VT, FN</td>
<td>VT, FN</td>
<td>VT, FN</td>
<td>VT, FN</td>
<td>VT, FN</td>
</tr>
</tbody>
</table>

Cooperation among class members seems to be almost a requirement for creating a class concept map. These students exhibited many of the cooperative learning skills described by Johnson and Johnson as well as those suggested on the questionnaire (as shown in Table 13) and described in the evidence. Constructing a group map appears to provide a context for kindergarten students to work cooperatively.

What evidence is there that concept mapping helps individual students acquire a knowledge of facts and an understanding of how they are organized or connected to a topic?

This was not an area of investigation suggested in the responses to the questionnaire as mentioned previously. There is evidence as described in chapter 2 that concept mapping may increase student learning, particularly with older students. Since knowledge acquisition is usually considered a major goal in education, it was included in this study.

The researcher attempted to identify some instances of potential evidence for knowledge acquisition that might be observed during concept
mapping sessions with kindergarten students. These included students adding new ideas or connections to the map and students reorganizing the map. After reviewing the case study data, the researcher decided it would be an impossible task to attempt to separate instances of these events due to concept mapping from those due to the activities the teachers had done in connection with the topic. Table 14 summarizes the data with no attempt to make this separation.

<table>
<thead>
<tr>
<th>Evidence</th>
<th>Site S1</th>
<th>Site S2</th>
<th>Site W1</th>
<th>Site W2</th>
<th>Site E1</th>
<th>Site E2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Knowledge Acquisition</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Add new ideas</strong></td>
<td>FN, VT, SI, P</td>
<td>FN, VT, SI, P</td>
<td>SI</td>
<td>FN, VT, P</td>
<td>FN, VT, SI, P</td>
<td>FN, VT, SI, P</td>
</tr>
<tr>
<td><strong>Add connections</strong></td>
<td>FN, VT, SI, P</td>
<td>FN, VT, SI, P</td>
<td>SI</td>
<td>FN, VT, P</td>
<td>FN, VT, SI, P</td>
<td>FN, VT, SI, P</td>
</tr>
<tr>
<td><strong>Reorganize map</strong></td>
<td>FN, VT, P, SI</td>
<td>FN, VT, P, SI</td>
<td>SI</td>
<td>FN, VT, P</td>
<td>FN, VT</td>
<td></td>
</tr>
</tbody>
</table>

Another type of potential evidence for knowledge acquisition, was to compare the number of entries and levels on the students’ pre- and post-interview maps. These results were likewise confounded by the additional related activities in which the students participated.

Pre- and post-interviews were conducted with 23 children at three of the sites. In case study W1, 9 students were interviewed. In case study E1, 3 students were interviewed. In case study S1, 4 students were interviewed. And in case study S2, 7 students were interviewed. In case study W2, only post-
interviews were conducted. The results of the interviews conducted during the mini-case study (E2) are reported below.

Each interview was scored based on the number of hierarchical levels and the number of concepts as described in Chapter 3. The difference in the pre-interview and post-interview scores was computed for each student. The results of a paired t-test produced $p = .0358$. Although this is statistically significant, the fact that $n=23$, makes caution appropriate for any attempted generalization. Complete statistical data are found in Tables 15 and 16 and Figures 20 and 21.

| Table 15. Descriptive statistics for paired t-test on pre- and post-interview scores for students at all sites in case studies. |
|---|---|---|---|---|---|---|
| | Mean | Std. Dev. | Std. Error | Count | Min. Score | Max. Score |
| pre | 28.74 | 16.98 | 3.54 | 23 | 12 | 84 |
| post | 34.22 | 17.04 | 3.55 | 23 | 10 | 85 |
| No. Missing | 0 | 0 |
Figure 20. Frequency distribution of pre-interview scores.

Figure 21. Frequency distribution of post-interview scores.
Table 16. Paired t-test results and information on pre- and post- interview scores at all sites in case studies.

<table>
<thead>
<tr>
<th>Mean Diff.</th>
<th>DF</th>
<th>t-Value</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pre-, post-</td>
<td>-5.48</td>
<td>22</td>
<td>-2.24</td>
</tr>
</tbody>
</table>

A mini-case study, conducted at site E was structured to compare two groups of students. Both groups experienced the same activities with one exception. One group constructed a concept map and the other had a class discussion. The differences in pre- and post-interview scores for each student were compared between the two groups. Data and results are presented in Tables 17-19. The results of an unpaired t-test produced p=.0302. Although this is statistically significant, the fact that n=8, makes any generalization difficult. In Table 17, it is interesting to note that the concept map group scored well below the discussion group in their pre-interviews and then higher in their post-interviews. All that can be said is that for this particular class, concept mapping produced more knowledge acquisition than group discussion in this lesson. There may also be some indication for further study.
Table 17. Data used to compare student pre-and post-interview scores for concept mapping and discussion groups in mini-case study.

<table>
<thead>
<tr>
<th>MINI-CASE STUDY STUDENT PRE-AND POST-INTERVIEW DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept Map Group</td>
</tr>
<tr>
<td>Student</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
</tbody>
</table>

Table 18. Descriptive statistics for unpaired t-test on pre- and post-interview scores for students in mini-case study.

<table>
<thead>
<tr>
<th>DESCRIPTIVE STATISTICS FOR MINI-CASE STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
</tr>
<tr>
<td>c. map</td>
</tr>
<tr>
<td>diss.</td>
</tr>
</tbody>
</table>

Table 19. Unpaired t-test results and information on pre- and post-interview scores for concept map and discussion groups in mini-case study.

<table>
<thead>
<tr>
<th>UNPAIRED t-test INFORMATION FOR STUDENT INTERVIEWS IN MINI-CASE STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Diff.</td>
</tr>
<tr>
<td>c.map, diss</td>
</tr>
</tbody>
</table>

The teacher's reaction in his post-interview to the student response between the two groups was interesting. He said the concept mapping group had produced many more ideas than the discussion group. An attempt was
made to document this by counting ideas suggested by the children in both
groups as recorded in the field notes and on the video. Prior to the story 27
ideas were suggested by the discussion group and 35 by the concept map
group. After the story, 26 ideas were suggested by the discussion group and 11
by the concept mappers. The concept map group had run out of time and the
teacher cut the session off so the students could prepare to go home. The
shortness of time for the post story activity was due in part to the longer time
spent prior to the reading. No attempt was made to analyze the quality of the
student suggestions. It does seem worthwhile to take note of the teacher’s
enthusiasm.

SUMMARY OF THE CASE STUDY FINDINGS

A great deal of evidence has been presented from these case studies to
support the effectiveness of concept mapping as an instructional strategy with
kindergarten children. This evidence had to do primarily with the functions of
concept mapping in the case study classrooms. Kindergarten teachers do
model thinking skills, specifically organizing and connection making, while
concept mapping with their students. Students do use these skills during the
concept mapping process. These studies showed teachers recording their
students’ prior knowledge and adding students’ new knowledge to concept
maps, thus providing a possible tool for the assessment of these types of
student knowledge and learning. Evidence was presented that showed concept
mapping being used to provide support for several modes of learning. Certainly
concept mapping will not address all learning modes, but it appears to reach
most to some extent. Concept mapping activity appeared to have a high rate of engagement or participation with the kindergarten students in these studies. Concept mapping can provide a setting for teachers to build student self-esteem. Students worked cooperatively to construct the maps in these studies thus providing a potential context for cooperative learning. Data on the individual knowledge acquisition of these young students were inconclusive. If the ideas described here are of value to kindergarten teachers in an educational setting, concept mapping as done in these case studies, is one instructional strategy they should consider using in the classroom.

This chapter has presented the evidence that was found in the case studies for the effectiveness of concept mapping as an instructional strategy with kindergartners. In the next chapter these findings and the resulting implications and recommendations are discussed in light of the research reported in the literature review.
CHAPTER FIVE
SUMMARY, RECOMMENDATIONS, AND IMPLICATIONS

The case studies conducted as a part of this study in kindergarten concept mapping appear to support the findings of earlier research described in the literature review on the effectiveness of concept mapping for students, teachers, and other educators. In this final chapter, the related findings of this study and the findings of the literature review are summarized, with notation of author recommendations and discussion of further implications.

SUMMARY AND RECOMMENDATIONS

Thinking Skills:
How can teachers use concept maps to help students develop thinking skills?
How do students use their thinking skills when constructing concept maps?

Much of the research found in the literature review addresses this question. The fact that concept mapping was developed for the purpose of organizing and connecting information would seem to support helping students learn and use these two thinking skills. The research described in Chapter 2 found for the most part that concept maps did in fact help older students to organize and connect information. The evidence found in the case studies described and discussed in Chapter 4 supports students using these skills and teachers modeling them for their students. Taking all of this information as a whole, kindergarten students appear to use their organizing and connection-making skills when helping to construct a group concept map. And further,
teachers may be able to use concept mapping to help their students develop these skills by encouraging them to organize and connect their ideas on their concept maps.

Due to the descriptive nature of the evidence provided in these case studies, further research on the relationship between concept mapping and thinking skills is indicated. More ethnographic studies with a wider variety in learner, teacher, and site selection are recommended. Extending this research to include students in other elementary grades is particularly recommended. Further investigation into precisely how teachers use concept mapping to accomplish this would help other teachers replicate the process. In addition, study of how students transfer their concept mapping organization and connection-making skills to other contexts would provide valuable information on the effectiveness of using this strategy to teach these skills.

Assessment:

How can concept maps be used by teachers as an assessment tool?

There was a considerable amount of research found in the literature review to address this question. It was, however, conducted for the most part with older students. The fact that concept mapping was developed to show the conceptual development of students would support the idea of using concept maps as an assessment tool. This research found that concept maps could be and were used to determine prior knowledge of students and to assess concept development in their learning. The case study evidence discussed in Chapter 4 supports the idea that concept maps can be used as an assessment tool by kindergarten teachers.
The kindergarten teachers in these case studies were observed recording their students' prior knowledge and on-going learning on the class concept maps. Whether they used this information for student assessment was not addressed. This would indicate a need for further study in order to answer this question. In addition, studies including a wider range of learners, teachers, and subject areas are recommended to investigate how this information might be used. For example, teachers may use the data on a concept map to plan for instruction, to keep records of students' learning or to communicate student progress to parents. Investigation of the use of concept maps as a post-instructional test with older students would help address the need for alternative assessment tools.

Multi-Modal Learning:

**How can teachers use concept mapping to support multi-modal learning?**

There was a very limited amount of directly related literature found in this area. Concept mapping was designed to support visual learners. There is considerable research to support the use of graphic organizers which includes concept maps. Based on this a case could be made for the support of visual learners with concept mapping. The case studies provide some fairly strong evidence for using concept mapping as done in these studies, to support not only visual-spatial, but verbal-linguistic and interpersonal modes of learning as well. There was some indication of support for bodily-kinesthetic, mathematical-logical, and intrapersonal learning modalities, but almost none for musical. It would appear that concept mapping supports several modes of learning.

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More research in this area needs to be done in order to say anything definitive about concept mapping support for logical-mathematical, bodily-kinesthetic or intrapersonal learning modalities. In addition, the question of whether teachers actually use concept mapping to provide this support needs to be investigated. Research including a broader selection of learners and teachers is recommended to determine which concept mapping techniques are most effective with particular modes of learning and to identify ways to concept map that will reach an even broader spectrum of learners.

**Student Participation:**

*What effect does concept mapping have on student participation?*

The literature search and review produced sparse evidence that concept mapping affects student participation. Only a few descriptive reports were found. The importance of active participation by students in learning seems to have been documented extensively. As a part of this study, an attempt was made to determine if concept mapping had an effect on student participation. The evidence presented in Chapter 4 found that the students in these case studies did have a very high rate of engagement time. This supports the finding of an earlier study on DASH activities.

The sample in the engagement time mini-study was very small (n=20). Further investigation involving more subjects at other sites is required before any generalization can be attempted. This study provides only an indication that concept mapping has a positive effect on student participation. Further investigation could also reveal whether some methods of concept mapping produce higher rates of student engagement than others.
Self Esteem:

How can teachers use concept mapping construction to help build their students' self-esteem?

The only related literature found on concept mapping and self-esteem was a single study concerning anxiety level. Although anxiety is related to self-esteem in students, this study looked at other indicators of self-esteem described by researchers in other contexts. Evidence was reported in Chapter 4 for the teachers in these case studies using concept mapping construction activities to build their students' self-esteem. These teachers accepted students' mistakes, duplicate answers, and variety of input. Students showed ownership of their maps and enjoyment while constructing them.

Whether this finding can be extended to other less experienced teachers needs to be investigated. This study would indicate this may occur but further study with more teachers is recommended in a broader range of environments. In addition, other elements in the concept mapping process may be identified which promote student self-esteem. If this is the case, identification of such elements could help teachers to focus on them when building self-esteem was a goal for a particular lesson.

Cooperative Learning:

How do students work cooperatively when constructing a concept map?

There was little evidence of research in this area in the literature review. The descriptive evidence reported was also sparse. Data collected in the case studies reported in Chapter 4 found students working cooperatively to construct
class concept maps. Students were observed cueing off each other’s responses, working together without teacher prompting, and respecting each other’s different and conflicting ideas. Whole-class concept mapping can provide teachers with a context for building students’ cooperative learning skills. Cooperation is necessary to construct such a map.

The data on cooperative learning presented in this study was entirely descriptive. Although the study included six case studies involving 4 teachers and 78 students at 3 sites, further research is recommended to determine the generalizability of these findings and to discover, if in fact teachers do use concept mapping as an opportunity to build cooperative learning skills in their students and how precisely they use it to accomplish this. If such techniques were identified, other teachers could be made aware of them so they could likewise employ them to help their students with cooperative learning skills.

Knowledge Acquisition:
What evidence is there that concept mapping helps individual students acquire a knowledge of facts and an understanding of how they are organized or connected to a topic?

There was some evidence for this cited in the literature review. The research reported a positive effect with older students. This study produced positive results also. A statistically significant (p<.05) difference in pre- to post-interview score gains was found in the students using a concept map over those in a class discussion. Also, the post-interview scores of students engaged in concept mapping were significantly higher than their pre-interview scores.
Although this would indicate a gain in knowledge by these students there are several confounding factors included in this evidence.

The number of subjects was very small but the results were consistent. When comparing the concept mapping and class discussion groups, a random sample of four students were interviewed in each of the two groups of ten students at a single site. Although all sites were included when comparing the pre- and post- concept mapping interview scores, only 23 students completed both pre- and post-interviews. In addition, the interview experience itself may have produced a possible confound. The need for further study is indicated when such small numbers are reported. In addition, the activities students engaged in that were related to the topic of the concept maps could well have produced the increased knowledge effect as well as the concept mapping. The short term mini-study which involved an environment controlling for this factor, had an n=8. There is perhaps some indication that concept mapping may increase knowledge acquisition, but further controlled studies with larger numbers of students are recommended before any such claim can be made. An investigation into what specifically it is in the concept mapping process that might influence knowledge acquisition in individual students would help educators to emphasize such factors. In addition, an investigation of class concept maps as representations of the collective prior knowledge of a class and then of the knowledge acquisition of that class during a unit of study could provide a valuable data source for instructional planning and assessment. Lastly, a study of concept maps and the questioning used to produce them during individual student interviews might well yield results showing a potential
for a positive effect on the knowledge acquisition, particularly in the linking between concepts, of those students.

In conclusion, this study has produced some evidence that concept mapping is an effective instructional strategy to use with kindergarten students in the DASH or science context. Further research including a wider range of learners, teachers, subject areas, and sites is recommended in order to extend these findings to a broader population of young learners.

STUDY IMPLICATIONS

The evidence in this study indicates that concept mapping is a worthwhile instructional strategy when used in kindergarten classrooms. The discussion and reflection of the children and teachers communicated and organized the tremendous amount of personal understanding that these young students had already garnered in their short lifetimes. This reflects a best use of a constructivist learning environment where critical thinking and imagination are encouraged. Concept mapping seems to affect a number of areas which are of concern in the kindergarten classroom. Helping students to build self-esteem, to develop and use thinking and cooperation skills, and to participate in classroom activity, are goals worth pursuing in a kindergarten classroom. To use a strategy that would address a number of these simultaneously would seem a logical selection. In addition, a concern for reaching all students would indicate the choice of a strategy such as concept mapping that can potentially address the needs of several different kinds of learners is wise.
Since concept mapping appears to be a worthwhile instructional strategy for kindergarten teachers to use in their classrooms, it ought to be included in preservice and staff or professional development programs. And further, curriculum developers may want to include concept mapping as an instructional strategy to be used with students in their kindergarten curricula. Finally, if educators are going to begin to assess students in more appropriate ways as the new science education standards are suggesting, concept mapping is one tool worth considering.
APPENDIX A
CLASS CONCEPT MAPS

Figure 22. Class concept map about sickness on 2/23/93 at site E1.
Figure 23. Class concept map about sickness on 2/25/93 at site E1.
Figure 24. Initial class concept map about wind on 10/12/93 at site E2.
Figure 25. Final class concept map about wind on 10/12/93 at site E2.
The happy whale swims through the water.

Figure 26. Class concept map (Part 1) about pets on 11/30/92 at site S1.
Figure 27. Class concept map (Part 2) about pets on 12/2/92 at site S1.
Figure 28. Class concept map (Part 1) about pets on 12/8/92 at site S1.
Figure 29. Class concept map (Part 2) about pets on 12/8/92 at site S1.
Figure 30. Class concept map about nutrition on 4/14/93 at site S2.
Figure 31. Class concept map about nutrition on 4/15/93 at site S2.
Your body is mostly made of water.

EXERCISE IS GOOD FOR YOUR BODY.

FOODS THAT ARE GOOD FOR YOUR BODY.

WATER IS GOOD FOR YOUR BODY.

Figure 32. Class concept map about nutrition on 4/16/93 at site S2.
Figure 33. Class concept map about nutrition on 4/22/93 at site S2.
leaves -stems -trunk
vines -curly -brown
leaves -stems -trunk
papayas
-grass
-apples
-leaves -stems -trunk
-growing bigger (can look at it) (measure it, ruler)
-don't have roots, flowers -bud

It grows in dirt
-flowers
-plants
-grow
-help us heal mosquito bites, burns
-roots -sometimes
-weeds -haven't any roots

cactus
-doesn't need too much water
-desert-dry place

soil
-helps plants grow: gives it things to make it grow

food
-water
-sun

water
-plants need it
-if you water it too much it will die
-plants don't have mouths for water

Figure 34. Class concept map about gardening on 1/21/93 at site W1.
Growth of Plants
- Plants grow
- Can measure growth with ruler

On Our Papaya Tree
- Buds on papaya tree
- Flowers on papaya tree

What Plant Do For Us
- Make seeds for new plants
- Some plants help mosquitoes (aloe)
- Some seeds don’t grow
- Give us food
- Give animals food

Plants in Garden
- Papaya
- Grass
- Tomatoes
- Carrots
- Lettuce
- Weeds
- Pears (not in ours, but could be)

Where Plants Grow
- In flower pots: Holes in pots to drain water
- Soil
- Seeds are needed to grow plants

Figure 35. Teacher notes for final class concept map about gardening on 1/21/93 at site W1.
Figure 36. Class concept map about pets on 9/2/93 at site W2.
Figure 37. Class concept map about pets on 9/7/93 at site W2.
Figure 38. Class concept map about pets on 9/9/93 at site W2.
Figure 39. Student pre-interview concept map about gardening at site W2.
Figure 40. Student post interview concept map about gardening at site W2.
Figure 41. Student-drawn concept map about gardening at site W2.
Dear DASH Teacher,

Enclosed is a questionnaire concerning concept mapping with kindergarten children. We would greatly appreciate your efforts in responding to the questions. A self-addressed, stamped envelope is also enclosed for your convenience.

We have had many teachers report on the use of concept mapping with their students. Your feedback will help to identify ways this strategy can be better implemented with children. Any insights you might share will help in the understanding of this process. We will share our findings with you in a future newsletter.

Thank you for your time and prompt response.

Aloha,

Carol Ann Brennan, DASH Assistant Director
National and International Training Operations
Concept Mapping
Kindergarten Teacher Questionnaire

• What year(s) did you take a DASH Kindergarten Institute? ____________
• In what state did you take a DASH Kindergarten Institute? ____________
• Was concept mapping covered during your institute? ____________
• Have you attended any DASH Follow-up Sessions? ____________
• Was concept mapping covered during any of your Follow-up Sessions? ____________
• Have you had other training in concept mapping, webbing, or semantic mapping? ____________
• Have you used concept mapping in teaching DASH with kindergarteners? ____________
• In which other subject areas have you used concept mapping with kindergarten students? ____________

• Do you think concept mapping is a successful instructional strategy with kindergarteners? ____________
• Please briefly list the reasons why or why not you think concept mapping is a successful instructional strategy with kindergarteners.

Please complete the back side of this questionnaire.
Please briefly describe how you typically do a concept map with kindergarteners.

Please list any further comments or ideas you have concerning concept mapping with kindergarteners.

If you would be willing to further discuss concept mapping with the researcher, please write your name, address, and home and work phone numbers below.

Name: ___________________________
Address: _________________________
                                   _________________________
                                   _________________________
Home Phone:_______________________ Work:_______________________

Thank you!
REFERENCES


Stein, H. (1988). On that note...: The ways students take down information in class can have a big effect on how well they process it and remember it. *Science and Children, 26*(3) 16-18.


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