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THE INFLUENCE OF GRAPHIC ORGANIZERS ON STUDENTS' ABILITY TO SUMMARIZE AND COMPREHEND SCIENCE CONTENT REGARDING THE EARTH'S CHANGING SURFACE

by

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A thesis submitted in partial fulfillment of the requirements
for the degree of Master of Education in K-8 Math and Science
in the Department of Teaching and Learning Principles
in the College of Education
at the University of Central Florida
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ABSTRACT

The purpose of this action research project was to determine how my practice of using graphic organizers during instruction influenced my students' ability to summarize and comprehend significant fifth grade Earth Science content regarding the Earth's changing surface. A secondary purpose was to determine the students' perceptions of how concept mapping assisted in making connections to understand the fifth grade Earth Science content regarding the Earth's changing surface.

The three processes used to collect data for this research were concept maps, focus groups and the pre- and post-test results. The themes that emerged were the ability to describe, categorize and classify details, the increased accuracy of the use of vocabulary and the memory of the concepts that students' ability to recall information and understand the Earth Science concepts as evidenced through summarization and comprehension through the pre- and post-test.

In memory of Elizabeth “Lizzy” Ann-Marie Sturm
June 26, 2006 – April 1, 2009

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CHAPTER 1: INTRODUCTION

Rationale for the study

In January, 2002, President Bush signed into law the No Child Left Behind Act (NCLB) - the most comprehensive modification of federal education guidelines in a generation. The legislation, that closely follows the President's agenda to improve America's public schools, passed Congress with significant bipartisan majorities (Bush, 2002). Since 1994 all states have been required to implement challenging academic criteria in the principal educational areas of mathematics and reading/language arts. No Child Left Behind required states to adopt standards in science by 2005–06 (The Education Trust, 2007).

State standards are coherent objectives for the information and aptitudes students should learn in school. Before statewide standards, expectations for learning fluctuated significantly across schools and districts; even within schools, diverse groups of students have traditionally been held to separate standards. These differences in expectations have often worked as a hindrance to low-income students and students of various ethnicities (The Education Trust, 2007). Academic standards are direct and shared statements about what every student should know and be able to do in each state. Yearly evaluations allow teachers and administrators to keep better data of student progress and to intervene promptly to make modifications in instruction to resolve difficulties. Although some states have implemented “high stakes” examinations, these are not required by NCLB. No Child Left Behind has not mandated that

children pass any evaluation in order to go on to the next grade or to obtain a diploma (The Education Trust, 2007).

One component of the NCLB mandate is that the best teaching practices are being used in the classroom. The use of research based practices, such as graphic organizers, is required in today's schools. Therefore, one practice deemed to be effective is the use of *Thinking Maps*™ that encourages the use of graphic organizers to enable students to sequence through flow charts, illustrate cause and effect, and compare and contrast as well as using tree maps to list main ideas and details. The term *Thinking Maps*™ is a registered trademark of a graphic organizer program (Hyerle, 2004). I first became aware of the use of graphic organizers within the science curriculum during the past year through a workshop. The term *graphic organizer* commonly describes two-dimensional visual knowledge representations, including flowcharts, timelines, and tables, that show relationships among concepts or processes by means of spatial positions, connecting lines and intersecting figures (Chang, Sung, & Chen, 2002). Using graphic organizers to enhance and organize the understanding of the science concepts and their relationships was helpful not only to my students but also as a teacher in order to arrange text and supplement the textbook material. This tool was especially helpful when it became evident that the students needed more information.

After receiving scores two years ago, my team of teachers began to enhance the curriculum with lab activities and videos to improve the students' vocabulary. In addition to the hands-on inquiries within the classroom, the students involved in this research study also participated in concentrated lab sessions conducted by the science lab facilitator. Hands-on

activities were carried out during 45 minute sessions for one week during each of the nine week grading period covering each science unit. During these sessions, graphic organizers were implemented and presented to the students to assist them in selection and organization of important text. The students utilized notebooks to record and collect their concept maps for studying as a future reference and to assist me in evaluating their understanding.

Reflecting on my students' needs has been at the core of my current work in my graduate program. During this past year, I have learned many unique strategies that I have been able to use in my classroom including project-based learning and the use of internet tools such as *Kidspiration*® (Lee, Baylor & Nelson, 2005; Liu, 2006). In researching graphic organizers, I found that concept mapping had been used more often than *Thinking Maps*™ in order to understand the text being used in the learning community. Many students have difficulty in comprehending graphs they see in their textbooks or in multimedia lessons, so it is worthwhile to investigate scaffolds, step-by-step procedures used to assist students in identifying important terms and concepts. These may encourage students to engage in appropriate cognitive processing (Mautone and Mayer, 2007). Students need help with mentally arranging material represented in graphs in effective use of concept maps. "The learner takes initiative for their own learning by actively engaging in the process of abstracting ideas, discerning relationships and structuring them coherently…The mapping process facilitates the fundamental constructivist requirement that learners be allowed to manage, construct, and share their own understanding of ideas and experiences" (De Simone, 2007, p. 35).

The term *concept-mapping* is the selection of major ideas (key words), connecting and organizing these concepts using relation links, and presenting the major framework of the article (Chang, Sung & Chen, 2002). The resulting collection of propositions is used to summarize and assist the students in comprehension. The term *proposition* refers to two terms linked by an arrow and phrase (Vainides, Yin, Tomita, & Ruiz-Primo, 2005). In the use of *Thinking Maps*™, a common visual language is provided that assists with the progression of reflection, influences on students' learning experiences and improvement of teaching methods and performances. Eight tools that can be used to assist the students' thinking processes in concept map development.

- The circle map: the basic definition of a concept in context
- The bubble map: describes qualities
- The double-bubble: used to compare and contrast the qualities of two subjects
- The tree map: used for classifying, main idea, supporting ideas and details
- The brace map: organizes the parts and subparts of the whole
- The flow map: sequencing
- The multi-flow map: cause and effect
- The bridge map: illustrates analogies (Hyerle, 2004)

The students in this research used the bubble map when organizing the text on the computer. The major variance between the bubble map and concept mapping is the use of the link between the concepts.

Purpose of the study

The purpose of this action research project was to determine how my practice of using graphic organizers during instruction influenced my students' ability to summarize and comprehend significant fifth grade Earth science content regarding the Earth's changing surface. A secondary purpose was to determine the students' perceptions of how concept mapping assisted in making connections to fifth grade Earth Science content regarding the Earth's changing surface.

Graphic organizers permit more than just the instruction of the content topic, which in this case is science. This tool can also teach information processing skills, models for categorizing information, methodical thinking skills, as well as interaction skills (Ellis, 2004). "Concept maps are useful for several reasons: they give an observable record of an individual's understanding; they demonstrate how information is meaningful; they force an individual to think about his/her own thought processes and knowledge structure; and they are helpful in problem solving, application and integration" (Zimmaro & Cawley, 1998, page 1).

Research Questions

The following questions guided the action research study:

1. How does my practice of using graphic organizers during instruction influence students' ability to summarize and comprehend significant Earth Science content regarding the Earth's

changing surface? By significant earth science content, I am referring to the grade level benchmarks and state standards that have been listed in Table 1 in Chapter 3.

2. How do using graphic organizers assist students' in making connections to understand the fifth grade Earth Science content regarding the Earth's changing surface? The potential influence that is derived from using graphic organizers will be measured through the students' science notebooks, focus groups, and a pre- and post-test. These tools will be used to triangulate themes that emerge through the research study.

Limitations of the Study

Simply having a goal of students independently translating chapter material into coherent graphic organizers, as some suggest may not improve recall (Anderson & Armbruster, 1984). This short term approach may be too ambitious, especially for students with learning disabilities. I currently teach at a low socio-economic elementary school in a highly transient community with a range of learners. Potential threats to internal validity include subject characteristics such as differences in age due to retention(s). Other internal validity threats include subject attitude due to excessive testing; the loss of subjects (mortality) due to high transiency within this neighborhood and ethnic groups and socioeconomic status. Since the classroom facilitator is also the investigator, this may cause researcher bias. An independent variable is the amount of prior knowledge that the participants had of Earth Science themes. "This variable is considered as an independent variable because prior domain knowledge is closely related to the knowledge representations…in other words, the amount of prior knowledge that the participants had might

lead to effective retrieval of concepts stored in long-term memory" (Lee & Nelson, 2005, p. 196). Potential threats to external validity included the generalizability to other classes outside of the research setting. According to Frankel and Wallen (2006),

> "One cannot recommend using a practice found to be effective in only one classroom! Thus, action research studies that show a particular practice to be effective, that reveal certain types of attitudes, or that encourage particular kinds of changes need to be replicated if their results are to be generalized to other individuals, settings, and situations" (p. 573).

Significance of the Study

The significance of this study is that graphic organizers are believed to promote higher order thinking because students are required to classify information, establish relationships, and draw inferences as they read and discuss the text (Armbruster, Anderson & Ostertag, 1987). Graphic organizers may help the teacher transform what may be poorly organized prose into symbolic relationships that more closely match the way knowledge is stored in memory (Armbruster & Anderson, 1984).

According to Vanides, Yin, Tomita, and Ruiz-Rimo (2005) concept maps give students the opportunity to (1) think about connections between science terms being learned, (2) organize their thoughts and visualize the relationships between key concepts in a systematic way, and (3) reflect on their understanding. Concept mapping may assist in integrating literacy concepts with science content by providing a starting point for writing about science (Vanides, Yin, Tomita, &

Ruiz-Primo, 2005). This type of approach may be particularly advantageous to second language learners (Jiang & Grabe, 2007) by allowing students to think deeply about science while storing and retrieving information effectively (Vanides, Yin, Tomita, & Ruiz-Primo, 2005).

Concept maps also are believed to be valuable tools for teachers as they provide information regarding the students' understanding of concepts and relationships. Teachers may use this information to examine how well a student understands the science text by analyzing their concept map. When concept maps are continuously revised during related lessons within the unit of instruction, they show how students' understanding improved over time. Also, teachers can "observe gaps in learning and, in turn, modify the lessons based upon the information from the students' concept maps" (Vanides, Yin, Tomita, & Ruiz-Primo, 2005, page 28).

Summary

The literature I have reviewed has defined and illustrated the use of concept mapping within the concentration of Earth Science. Not only are there many conflicting views of the advantages of this strategy at the elementary level but also various stages of instruction and student proficiency. My questions "How does my practice of using graphic organizers during instruction influence my students' ability to summarize and comprehend fifth grade earth science content regarding the Earth's changing surface?" and "How do using graphic organizers assist students' in making connections to understand the fifth grade Earth Science content regarding the Earth's changing surface? will be investigated with my fifth grade level class of twelve

students to determine the impact of this technique on my teaching. Literature Review of Chapter Two, the methodology of Chapter Three, the Data Analysis of Chapter Four and conclude in the Summary of Chapter Five.

CHAPTER 2: LITERATURE REVIEW

This literature review summarizes how my practice of using graphic organizers during Earth Science instruction does or does not influence students' ability to summarize and comprehend significant topics. The sections in this chapter provide a summary of the work related to graphic organizers and how this tool can impact student learning outcomes.

The chapter opens with a discussion from cognitive psychology followed by the implementation of mapping within the classroom including the suggested sequential steps and components in creating the concept maps. The review is then expanded to using mapping as an assessment strategy as well as the impact mapping has upon the students' ability to summarize and comprehend the scientific concepts. This chapter concludes with advantages and disadvantages of concept mapping.

Cognitive Psychology

Much of the theory behind the use of graphic organizers comes from the cognitive psychology literature. Based upon research by Ausubel (1963, 1968) and others (1978), cognitive psychology is the learning that takes place by *assimilation* of new concepts and propositions into existing concepts and propositional frameworks. Ausubel's distinction between rote learning and meaningful learning denotes that material must be clearly presented with

language and examples linked to the learner's prior knowledge. The learner decides to make the concepts meaningful by use of relevant prior knowledge. Individuals vary in the quality and quantity of the significant facts they possess and in the strength of their incentive to find ways to incorporate new information into existing significant data.

Ausubel's theory of meaningful versus rote learning suggested that meaningful learning intentionally attempts to integrate new information, uses a more extensive network and creates more means of recovery. According to Novak (2002), "retention of information by rote still takes place in the long term memory…the difference is that in rote learning, there is little or no integration of new knowledge with existing knowledge resulting in two negative consequences" (p. 5). Rote learning is merely information memorization with no attempt or motivation to relate information to prior knowledge and makes use of a less extensive network creating fewer retrieval paths. Ausubel's assimilation theory is the validation for concept mapping that entails students thinking about concepts as well as the relationships between these concepts when students process information (Lee, Baylor & Nelson, 2005; Novak & Cañas, 2008; Zimmaro & Cawley, 1998; Novak, 2006). While it is accurate that some students may initially have trouble building and using concept maps, these difficulties may occur from years of rote-mode practice rather than intellectual differences (Novak & Cañas, 2008). One way to improve students' knowledge from rote skills to building connections is through the use of learning strategies. There are three types of spatial learning strategies: graphic organizers, knowledge maps and concept maps (Chang, Sung, & Chen, 2002).

Using Concept Mapping, Knowledge Maps and Graphic Organizers in the Classroom:

"Concept mapping is as much a graphic strategy as knowledge maps and graphic organizers; it has been successfully applied primarily to the learning of scientific subjects" (Chang, Sung, & Chen, 2002, p. 6). Concept maps are different than the other learning strategies because they are a graphic illustration of text (De Simone, 2007).

Chang, Sung, and Chen, (2002), during their research "*The Effect of Concept Mapping to Enhance Text Comprehension and Summarization*", designed three concept-mapping approaches: map correction, scaffold-fading and map generation. Their research involved 126 fifth grade students in four elementary schools in Taiwan. The students were involved in seven weeks of reading, concept map instruction and construction, and pre- and post-test in text comprehension and summarization.

The students were given pre- and post-tests to evaluate comprehension abilities from both scientific and social studies articles. Twenty-five multiple-choice questions were constructed from those articles and another twenty-item multiple-choice comprehension test. The items were classified as text-based questions and inference questions.

The map-correction group was given an expert-generated map that they corrected erroneous concepts and links after reading the text. The scaffold-fading group was trained using five stages: a) read an expert map, b) fill-in-the-blanks of an expert map, c) complete a partial expert map, d) construct the concept map using given concepts and links, and e) determine key concepts and relationships from the text to create a concept map. The map-generation group

were provided with the articles and created concept maps by extracting concepts and links from the text.

The outcome of the research study showed "concept mapping may serve as a useful graphic strategy for improving text learning…combining a spatial learning strategy with a correction method or scaffolding instruction is a potential approach for optimizing the effects of concept-mapping"
(p. 21). Also, fifth graders were able to correctly delete unimportant or redundant messages and grasp the main idea of an article. The concept maps may have assisted the students in answering the text-comprehension test questions. However, in the text-summarizing task, students were required to find and organize the main ideas a more difficult task than answering multiple-choice questions. Training effects of scaffold-fading learning were considered more important for text-summarization than text comprehension. This research has a direct correlation with the research of this thesis in that concept mapping was used to emphasize the major ideas, connecting and organizing these concepts using relation links and presenting the major framework of the text.

Other research, which discusses the effectiveness of concept mapping regarding problem solving include the research by Novak, Gowin and Johansen (1983), that found 7th and 8th grade science students involved in instructor provided concept-mapping performed better than those taught directly without some type of organizer. Also, research by Okebukola (1990) investigated biology student's performance and found that those who created concept maps regarding genetics and ecology achieved higher scores than those students who studied the material

independently. Finally, Coleman (1998) conveyed that the students who produced concept maps exhibited greater problem-solving functioning than those provided teacher-lead instruction.

Complex graphic organizers in relation to curriculum presented before studying the passage are intended to prepare background information of the more difficult content of the material (Mautone & Mayer, 2007). According to Novak and Cañas (2008), "Instructional strategies that emphasize relating new knowledge to the learner's existing knowledge foster meaningful learning" (p. 3)

"Graphic organizers are communication devices that show the organization or structure of concepts as well as relationships between concepts" (Ellis, 2004, p. 1). The brain works to classify information in ordered outlines and learning methods, such as graphic organizers. Various sources of research support that this process significantly expands the learning capability of learners (Bransford et al., 1999; Tsien, 2007). "Early learning of concepts is primarily a *discovery learning process*, where the individual discerns patterns or regularities in events or objects and recognizes these as the same regularities labeled by older persons with words or symbols" (Novak & Cañas, 2008) .

The purpose of a knowledge map is to "accelerate the learner's access to relevant information for solving a problem" (Lee, Baylor, Nelson, 2005, p.124). Knowledge maps can support learning when students construct knowledge maps by representing their understanding in a domain, facilitate their recognition of patterns and relationships that encourages considering what they know and do not know to construct meaningful knowledge in terms of nodes and links. Knowledge maps can be used as instructional material and as an external measure of

learner's internal knowledge structure in memory. Knowledge Maps facilitate problem solving by externalizing their internal problem-solving processes and recognize useful information embedded in the problem, retrieving and reorganizing their prior knowledge with new knowledge as well as identifying possible constraints (Lee, Baylor, & Nelson, 2005).

Creating maps including electronic maps

Starting points that the map is constructed from can vary depending on the expected previous understanding by the students, the difficulty and novelty of the topic, and the teacher's confidence in mastering the topic. The beginning point for constructing a concept map should consist of the *focus question* (Novak & Cañas, 2008). The type of focus question makes a difference in type of map constructed. The question given is not just a topic but is also used to assist the students to focus on their concept maps.

Concept maps are graphic organizers that assist students in organizing and representing knowledge. The concepts are usually enclosed in circles or boxes and relationship are indicated by a line connecting two concepts. Concept maps are comprised of nodes (terms or concepts), and linking lines, usually with an arrow from one concept to another (Lee & Nelson, 2005; Vanides, Yin, Tomita, & Ruiz-Primo, 2005; Yin, Vanides, Ruiz-Primo, Ayala, & Shavelson, 2005). In agreement with Ausubel's assimilation theory, nodes are ranked and organized by importance, with more broad ideas at the top advancing to the more detailed concepts below. A final feature that may be added to the concept maps is specific examples of events or objects that

assist in clarifying the meaning of the concept. These notes are not enclosed in circles or boxes since they do not actually represent concepts (Novak & Cañas, 2008).

According to Novak and Cañas (2008), using 'expert skeleton' concept maps to scaffold learning beginning with the development of a series of concept maps in a discipline will guide the learners. Zimmaro and Cawley (1998) provided three scaffolding strategies to identify important concepts. These include an instructor generated list that the students are not permitted to add their own concepts, an instructor generated list that the students are permitted to add their own concepts, and a list generated entirely by the students. These three strategies encourage a developmental approach as students become more independent in making their own concept maps. "Beginning with 'expert skeleton' concept maps as starting points reduces the chance that misconceptions or faculty ideas held by learners or teachers will be reinforced and maximize the chance that they will build knowledge structures that in time remove or diminish concepts" (p. 17). It is equally important to identify the important concepts to be included in the concept map.

When creating a concept map, it is important to begin with an area of knowledge that is familiar to the students creating the concept map by providing a segment of text, laboratory activity or stated question or problem. Once the topic has been established, key concepts should be identified and ranked in order from the most general to the most specific. The next step is to construct an initial map that may be written on *Post-it*™ notes to allow a group of students to work on the map with flexibility to move concepts around easily. This movement may assist in establishing the hierarchical organization of the concepts. This type of movement increases students knowledge and can be enhanced today through various computers and web-based tools.

Today the use of concept maps has developed from paper-and-pencil to computer-based tools. Computer software programs are even more adaptable because they allow moving concepts or moving entire groups of concepts to streamline the map. Concept mapping software offers modifications of existing work such as additions, deletions, modifications, or reorganizations. Students often revisit created concept maps to amend them as their understanding of the text develops. A number of students participating in studies or classes conducted by De Simone (2007) stated that electronic concept mapping is useful as it "minimizes the cumbersome and time consuming activity of erasing, revising, and beginning anew. Computer generated concept maps allow students greater freedom to adjust their conceptual thinking and mapped representations, focusing on inconsistencies and gaps in their knowledge or in others' knowledge." Other advantages of the computerized concept mapping are that they allow moving concepts together with linking statements, the moving of groups of concepts and links to restructure the map, as well as permitting a computer printout that may be emailed or shared with others in the class.

Assessments Tools and Impact in Learning

This development of concept maps can be helpful for sharing with peers and teachers. Students can learn from their peer's way of thinking and teachers can use these tools to assess mastery of concepts. Novak noted that one of the most powerful uses of concept maps is not only as a learning tool but also as an evaluation tool (1990). An important benefit of using concept mapping as an assessment method is the ability to detect or illustrate students' content

understanding as well as their misconceptions when they create a personal explanation of subject matter. If state, regional and national achievement exams utilized concept mapping as an evaluation tool, there would be an incentive for teachers to use this tool (Novak, 2006). This has been referred to as the "Chicken-and-egg problem." However, if concept mapping is used during instruction, it can also be used as an evaluation of instruction.

According to Ellis (2004), "Graphic organizers can be powerful tools for assessing students' knowledge of the content, thinking skills, creativity and commitment to quality" (p. 7). "When using concept maps for assessment purposes, it is important to realize that less experienced mappers will most likely produce lower quality concept maps than individuals that are more experienced" (Zimmaro & Cawley, 1998, p. 4). A student may have good understanding of the text but that may not be reflected in the concept map because of lack of practice with concept mapping. It is suggested that the practice of mapping is integrated in the course as an instructional tool when using mapping scores for course credit so that there is a match between the assessment and instruction.

Goldsmith and Johnson (1990) defined an ideal assessment as one that is not only objective and reliable but also minimizes the influence of content on responses, and captures something of the structural nature of the subjects' knowledge. Traditional objective test designs depend upon recollection. "Typical objective tests seldom require more than rote learning" (Holden, 1992). Assessments based upon concept mapping may be more useful for analyzing students' misrepresentations due to perception to the structural nature of their understanding, distortions in students' comprehension of content and errors of omission. Also, in comparison to

the traditional subjective assessment tasks, those required to create a concept map are reasonably easy and less of a risk to the true evaluation of students' knowledge.

Advantages and disadvantages of concept mapping

The use of graphic organizers are advantageous because students are more likely to understand and remember the information that is being taught by separating what is important to know from that which is interesting but may not be important. Also, showing the structure of the information may enhance learning at more complex levels due to a decrease of the demands of processing the information. Finally, other skills such as reading, writing and communication as well as "analytical, critical, and creative thinking skills may improve when students learn to recognize patterns of thinking, construct, and use of graphic organizers" (Ellis, 2004, p. 2). A variety of graphic organizer can be effective when used in conjunction with a diversity of teaching styles, teaching a wide array of subjects and when developing literacy and cognitive skills of students. "Universal in nature…these can be used to improve learning and performance of a wide array of students, ranging from those who may be intellectually gifted to those with mild learning problems" (p.3).

According to Ellis (2004), concept maps may be integrated prior to teaching the text. During this time, students engage in powerful information processing and higher order thinking skills by using cues to recognize important information, making decisions about what is important or essential consolidating information, identifying main ideas and supporting details, and making decisions about the best way to structure the information. After exposure to the text,

organizing information onto graphics allows teachers to implement a variety of robust activities including in depth discussions, prioritizations, elaborations, debates, drawing conclusions, making connections to other ideas, inferences and extending students' understandings.

Graphic organizers are believed to be predominately important because a good visual illustration can show the key parts of a whole and their relations, thereby allowing a holistic understanding that words alone cannot express (Jiang & Grabe, 2007). Graphic organizers representing the construction of the text can ease the comprehension and retention of the subject matter reading material. The research by Jiang and Grabe (2007) concluded that: Graphic organizers have shown to assist in the comprehension and recollection of main ideas for immediate text; being the creator of the graphic organizer also impacts its usefulness in comprehension; graphic post-organizers produced greater effects than pre-reading tasks or graphic advance organizers in general; graphic organizer training combined with summarization training seemed to facilitate better results; and the length of time permitted and educational level of the students were important issues.

When compared to reading text passages, presentations and participating in class discussion, concept map activities are more effective for attaining and maintaining knowledge (Nesbit & Adesope, 2006). Concept mapping was found to profit learners across an extensive variety of educational levels, subject areas, and settings. This benefit may be due to greater learner interest caused by concept mapping in comparison with reading and listening, rather than the properties of the concept maps as an informational method. Across the levels, subject areas,

and settings, it was found that studying concept or knowledge maps is somewhat more useful for maintaining knowledge than studying chapters, lists, and outlines (Nesbit & Adesope, 2006).

Even though there are a number of advantages for knowledge maps to support problem solving there are also a number of limitations of existing knowledge map construction tools (Lee, Baylor & Nelson, 2005). First, conventional knowledge maps are designed to create precise organization of conceptual knowledge that is a part of human knowledge representation systems that denotes facts, concepts, and objects. However, problem-solving performance requires both conceptual knowledge as well as procedural knowledge. Second, conventional knowledge maps do not sufficiently represent the background of a given problem that implies the importance of a situation as understood through a learner's prior knowledge and experience. Third, the number of concepts that can be characterized on a computer screen or paper is limited and may prevent a learner from articulating thoughts as fully as possible if sufficient space were available. Fourth, even though recently developed computer-based tools support learners, most support learners in denoting context through the organization of text and graphics.

The research by Jiang and Grabe (2007) concluded that measures of general or overall learning such as comprehension questions, recognition probes or recall of factual details did not always seem sensitive enough to measure graphic organizer facilitation. Students require time and repeated exposure to develop their abilities to recognize discourse organizing the texts. Most graphic organizer training ranges from a few hours to a few weeks, covering two to eight passages. Drawing and making revisions to the concept maps may be time consuming; though helpful, this often requires that the entire process be restarted from scratch (De Simone, 2007).

According to the research by Chang, Sung and Chen (2002), “Graphic organization construction by the readers themselves is effective in promoting autonomous learning and enhancing the depth of learning, but the required training of students is time consuming. Moreover, the activity demands effort and usually results in cognitive overload and negatively affects learning outcomes and even the willingness to use this strategy” (p. 7).

Studies that examine the influence of graphic organizers on reading comprehension necessitate additional instructional training rather than a short, concentrated experience to visual facilitation. The educational belief behind the use of graphic organizers for reading development is that students need steady experience to practice with graphic organizers. According to Jiang and Grabe (2007), major concerns exist about the use of graphic organizers including the research that has produced incongruent findings and raised questions about their overall effectiveness. An understanding regarding what a graphic organizer is and how it should be designed for research or instructional purposes is critical.

For many students, improved performance on classroom tests will be almost immediate. However, improvement on standardized achievement tests is not immediate but is likely over time if enough stress is placed on teaching students how to use graphic organizers. Graphic organizers should be viewed as part of a complete method of successful pedagogy. By themselves, graphic organizers are not the answer to raising test scores (Ellis, 2004).

High quality research is needed on the use of concept maps in elementary and secondary education. The advantages of preconstructed concept maps is obvious in individual learning but not in cooperative group activities. There is a deficient amount of research on models for using

concept maps in small groups and whole-class settings. Additional studies are needed on the usefulness of concept mapping as a notetaking and prewriting activity for developing reading and writing skills (Nesbit & Adesope, 2006).

A difficulty of using concept mapping may be due to the complicated format (Daley, 2004). Evaluating learning can be complex for assessors uncertain with the format of concept propositions and links. Linkages may be more difficult to see as the concept maps get more involved, therefore this demands using other data analysis in combination with concept maps. It may be complicated for readers to agree on what concepts are of significant importance and which ones are less important. "Despite disadvantages of complexity, concept maps serve as an important advance in qualitative research and data analysis" Daley (2004). "While it is true that some students have difficulty building concept maps and using these, at least early in their experience, this appears to result primarily from years of rote-mote learning practice in school settings rather than as a result of brain structure differences per se" (Novak & Cañas, 2006).

Summary

Maps in education reflect theories of cognitive psychology. The designs of three types of diagrams: concept mapping, knowledge maps, and graphic organizers were presented. Sequential procedures used to create the maps, including electronic maps, was then outlined. The research was then expanded to using mapping as an assessment strategy as well as the impact mapping has upon the students' ability to summarize and comprehend the scientific concepts. This chapter concludes with advantages and disadvantages of concept mapping. The following chapter will

include the analysis of the data collected during this research study. The results will be corroborated with information from previous literature and research findings.

CHAPTER 3: METHODOLOGY

Introduction

The purpose of this research was to examine the questions:

1. "How do using graphic organizers assist students' in making connections to understand the fifth grade Earth Science content regarding the Earth's changing surface?"
2. "How does my practice of using graphic organizers during instruction influence students' ability to summarize and comprehend significant Earth Science content regarding the Earth's changing surface?

By significant Earth science content, I am referring to the grade level benchmarks and state standards that have been listed in Table 2. In this chapter I clarify the design, setting, and data collection methods that were used to answer my research questions.

Research Design

This study is an action research project seeking to identify associations among variables through exploration of the effects caused by participation in a given activity. I completed this action research with the students that had been assigned to my fifth grade classroom. The study took place the first semester of the school year during the instruction of science and concept

mapping. In this research the relationship between the two variables of concept mapping (independent) and summarization/comprehension of the curriculum (dependent) was investigated.

Setting

The purposive sample selected for this study consisted of 12 fifth grade students, consisting of 5 males and 7 females, between the ages of 10 and 12. The students attend an elementary school designated as low socio-economic (SES) in a highly-transient, urban community. The racial makeup of the class was 6 African-American, 4 that are Haitian Creole, and 2 Hispanic students. Other relevant factors include an 83% population of English for Speakers of Other Languages (ESOL) as well as 16% students in Exceptional Student Education (ESE). Finally, there is a variety of reading levels ranging from Emergent Literacy Survey (ELS) that is used to assess reading readiness of kindergarten students entering elementary school, through sixth grade. In addition, all of the students were exposed to the *Scott Foresman Science: Florida* curriculum, *SRA Snapshots Video Science*: *Level C* (2008) DVDs and workbooks, and project-based laboratory activities.

Data Collection

Upon receiving approval from the principal (appendix A) of the school as well as the Institutional Review Board (IRB) approval (appendix B), and county research request approval (appendix C) I requested parental permission (appendix D) to allow students to participate in this

research study. I read the student assent form (appendix E) aloud to the students in order to allow the freewill to participate in the investigation. A total of twelve parents consented to allow their child to participate in this research.

Focus Groups:

Three focus groups were established to discuss the effects of concept mapping on the learning and interest of the members of the class. The focus groups consisted of four members each based upon the pre-test scores. This criterion was used to place the students in heterogeneous groups. Group A was made up of three girls and one boy. Groups B and C consisted of two boys and two girls. This selection was a purposeful sample of the current members of the class. These focus groups took place during a 20 minute discussion session with each of the 4 members in the preselected groups. The following focus questions presented by Liu (2002) were used to "assess the social and affective contexts, particularly the motivational aspect of relational conceptual change created in class by concept mapping" (p. 379).

1. How do you like concept mapping activities in general?
2. How do you like the computer-based mapping using *Thinking Maps*™ and *Kidspiration*® as compared to other ways of concept mapping such as paper and pencil?
3. Have you felt that concept mapping has helped you to understand the scientific concepts and relations among the concepts? How?
4. How do you like revising your concept maps regularly during learning a science unit?
5. What difficulties have you experienced with concept mapping?

6. You have been doing concept mapping in pairs/group. Have you found that working with other students is beneficial? In what way?
7. If you were given a choice to work alone, in pairs, or in groups of three for concept mapping, which would you prefer and why?
8. Do you interact with your teacher during concept mapping? What would you like your teacher to do during concept mapping sessions?
9. Would you like your teacher to continue concept mapping in your science teaching? Why or why not?

The point of the discussion were on the motivational constructs related to students' interests and value of concept mapping and on the interpersonal relations associated with this tool (Liu, 2002). Focus groups were taped and transcribed for later analysis. The procedure used to analyze the transcripts was to first, read the entire transcript to get a sense of themes in various sections of the discussion. Next, the themes were identified within each focus question and within each of the three focus groups. These themes were then classified into categories of influencing the ability to summarize and comprehend significant Earth Science content regarding the Earth's changing surface and making connections to understand the material.

Student science notebooks

The actual science notebooks, which were used by the class to create, revise and document their concept mapping. These notebooks were evaluated for increased use and conceptual understanding of the science text. Graphic organizers also were valuable in

recognizing both justifiable and unsound concepts and have been suggested to be more successful than time-consuming conferences for isolating the significant knowledge a learner acquires before or after instruction (Novak & Cañas, 2008).

Instrumentation

The *Scott Foresman* pre-test was used with permission from Pearson Publishing (appendix F) that has been aligned to the Florida Earth Science State Standards were administered after teaching the basic textbook curriculum but prior to the mapping activity to summarize each chapter. The majority of the points (15 out of 20) concentrated on the benchmark that assesses that the students know that the water cycle is influenced by temperature, pressure, and the topography of the land. Other benchmarks included that water can be changed from one state to another by heating and cooling; that 75% of the surface of the Earth is covered with water; and that people invent tools to solve problems and do work that affects aspects of life outside of science.

The *Scott Foreman* post-test was administered at the end of this unit. The test of the students who participated in the study was evaluated for increased comprehension by scanning the answers categorically through the Earth Science benchmarks. The same test was used for the pre- and post-test in an effort to measure the same benchmarks. The tests were administered approximately six weeks apart. The tests were not made available to the students during this time to avoid testing bias.

Table 1: Sunshine State Standards: assessed by the Earth Science pre- and post-test

Florida Sunshine State Standard	Test Questions assessing the standard
SC.A.1.2.2: The student knows that common materials (e.g. water) can be changed from one state to another by heating and cooling	Questions: 1,3,5,8,11
SC.D.1.2.2 the student knows that 75 percent of the surface of the Earth is covered by water.	Questions: 4,7
SC.D.1.2.3 The student knows that the water cycle is influenced by temperature, pressure and topography of the land.	Questions: 2,6,9,10,12,13,and 14; 16 (short response) and 17 (extended response)
SC.D.3.2.1 The student understands that people, alone or in groups, invent new tools to solve problems and do work that affects aspects of life outside of science.	Question: 15 (short response)

Procedure

The science content was determined by the county adopted order of instruction. During the course of study, I sequentially followed the scope and sequence as presented in the *Scott Foresman Science: Florida* curriculum, specifically Unit B: "Earth Science". The daily lessons consisted of reading and discussing the lesson being taught as well as viewing the DVD segment that coincides with the content to review the vocabulary. The students participated in whole group, small group, paired and individual work using the *Scott Foresman Science: Florida* workbooks, *SRA Snapshots Video Science*: *Level C* resource book and the students' individual notebooks that they recorded daily concept mapping. The *Scott Foresman* pre-test was administered after each chapter of instruction of the textbook curriculum had been presented to determine the subject content that the student's had acquired.

I began my concept mapping procedure by scanning the Scott Foresman science curriculum unit (see Table 2) and selecting the most important and critical terms related to the key concepts. I then constructed propositions that reflected what students needed to know at the end of the unit as shown on Figure 1.

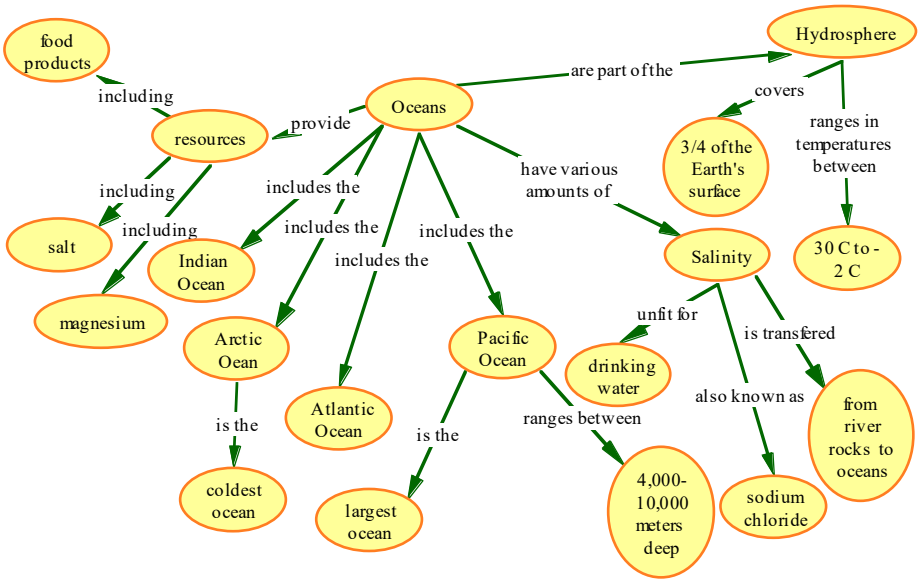

Figure 1: Sample Concept Map

For students' convenience, when primarily using the concept mapping instructional method, science concepts were written on sticky notes to allow students to reposition and classify their thoughts (Vanides, Yin & Ruiz-Primo, 2005). Scaffolding of the students' utilization of concept mapping by not only instructing the students to use the strategy but providing an example concept map, created by the teacher/researcher provided the significant

sequences outlined in the following sentences (Chang, Sung, & Chen, 2002). The students applied the "Fill in the blanks" strategy using the expert concept map (with the entire structure) and then completing partial expert concept map (with incomplete structure). Next, students constructed the concept map using the prearranged concepts and relation links including: "is a measurement of…," "has a property of…," "depends on…," "is a form of…" Finally, the students were required to decide upon the key concepts and relation links from the passage to build the concept map (Yin, Vanides, Ruiz-Primo, Ayala & Shavelson, 2004).

I reviewed specific topics and devised the concept maps that represent important information concepts within topics as I perceive them. As recommended by Lee and Nelson (2005), I presented the map directly to the students. Within the classroom, the students reviewed the concept maps in small heterogeneous groups with partners to find similarities and differences, and merge the concept maps to provide an initial example of important concepts that could be included. These groups consisted of students from diverse academic levels. Next, each group discussed their important propositions and explained their choices within a whole group discussion. I then focused on those terms that were relevant to the state standards in order to create a whole-class map based on discussions and to document class progress. In this way, I engaged the students by providing motivation for in-depth conversations about science. In addition, by redrawing the concept maps, students continued to consider producing additional details (McClure, Sonak & Suen, 1999).

Table 2: Scientific Content: sequential scope and sequence of text and activities addressed during the study

Sequence of Instruction	Scientific Content	Vocabulary	Student Activity	Teacher Activity
Weeks 1-4	Water on Earth: "How can the oceans be described?" "Where is fresh water found?" "What is the water cycle?" "How do clouds form?"	Condensation, evaporation, precipitation	*Complete pre-test Complete skeleton map from "concept bank" *Share with partner *Discuss with group	*Administer Pre-test *Provide "skeleton" concept maps *Provide instructor generated list
Weeks 4-8	*Guided Inquiry:* "What is a cloud?" AIMS Activities: "A Cloud is Born" "Make Dew" "Ice Water in a Tin Can"		*Complete map using *Post-it*™ notes *Add links to illustrate relationships	*Provide concept propositions *Provide feedback and direct discussion
Weeks 9-12	Earth's Changing Surface: "What causes earthquakes and volcanoes?" "What is weathering?" "What is erosion?" "How are rocks classified?" NASA.com: "Let Them Eat Rocks"	Deposition, earthquake, erosion, igneous rock, metamorphic rock, plate, sedimentary rock, volcano, weathering	*Create computer generated concept maps with partner *Complete post-test	*Provide the "focus question" *Administer post-test

Data Analysis

I used the following methods to obtain data for this action research study: focus groups, *Scott Foresman* pre- and post-test and student notebooks. Students' concept mapping examples

were obtained from the students' notebooks. The students provided illustrations of their scaffolding skills in their notebooks using a concept map as a tool to summarize and comprehend the significant Earth Science subject matter.

Focus groups were used to access the perceived operational difficulties, usefulness, and affective acceptance of the concept mapping strategy (Liu, 2002). In an interactive setting, the participants encouraged each other. The responses of each individual generated ideas in others by possibly filling in a void experienced by others. The disadvantage of focus groups includes the possible strong impact, positively or negatively, of the discussion mediator; the complexity of separating personal opinions from the collection group viewpoint; and the difficulty of attaining a representative sample within a sample focus group. People may give acceptable or "politically correct" responses in front of friends. The participants may be aware of the study's sponsorship and tell the researcher what they believe to be the acceptable response.

Pre- and post-test results were analyzed using the state standards and grade-level benchmarks assigned to each of the concepts being assessed. The pre-test consisted of multiple choice questions, short and extended essay response. The post-test consisted of multiple choice questions, short and extended essay response. These tests assisted not only the students' placement within the focus groups to insure heterogeneous groups; they also were assessed to determine the gains obtained through the use of the mapping techniques. The short and extended response questions were analyzed using the rubric that had been provided by and with the permission of the publishing company, Scott Foresman (see appendix F). These rubrics were rescored by the intermediate science lab teacher as well as another National Board Professional

Teaching Certified fifth grade teacher to establish reliability. The multiple choice answers were produced on a scan-tron and electronically assessed to insure reliability of the scores and to eliminate errors and bias.

Item difficulty was assessed using the following procedure: Divide the proportion of students who answered each alternative and who omitted the item by the total number of students. The item difficulty is the proportion of subjects in a sample who correctly answer the item. In order to obtain maximum spread of students' scores it is best to use items with moderate difficulties. Moderate difficulty can be defined as the point halfway between perfect score and chance score. For a four choice item, moderate difficulty level is .625, or a range between .50 and .75 (because 100% correct is perfect and 25% of the group would be expected to answer the correct item through blind guessing. Items that are too easy or too difficult cannot discriminate adequately between student performance levels.

The data obtained from the tests were compared to the themes obtained from the focus groups as well as the student notebooks in order to establish any patterns where the students may not have obtained the knowledge required in order to create an adequate map regarding that concept. The process to analyze the themes was to compare and contrast the information discussed during the focus groups with the missing Earth Science post-test scores. The students' notebooks were used as well to establish triangulation of the missing Earth Science concepts.

Students' notebooks containing the concept maps were used to evaluate themes and correlations in the study in order to present findings (Daley, 2004). According to McClure, Sonak, and Suen (1999), sufficient research has not been completed to establish evidence for the

reliability and validity of concept map assessment tasks suggested. Therefore, they caution that the time for concern and care has not elapsed. The reliability of various concept mapping tasks, the validity of deductions drawn from various concept mapping assignments, the realistic relevance of concept mapping to classroom and large-scale assessment were among areas recommended for further study.

By utilizing the Inspiration Rubric for Graphic Organizers, adapted and used with permission from Karen Franker of the University of Wisconsin-Stout (see appendix G), concept maps were scored by six common techniques: arrangement of concepts; links and linking lines, graphics, content, text, and design. Overall ratings were ranked in categories of (1) exemplary, (2) proficient, and (3) developing. When evaluating each pair of concepts, the accurateness of the map was assessed and then the separate points were combined to obtain a total score. Finally, the concept maps were scored using a rubric created by and with the permission of the University of Minnesota (see appendix H). This rubric ranges from 0-4 including ratings from excellent, good, adequate, marginal, and no credit. The criteria include structure, relationship, exploratory, and communication. Data suggests that the choice of the scoring method is likely to have an effect on the score reliability and that the relational scoring method used in combination with a master map produced the most trustworthy scores (McClure, Sonak, & Suen, 1999).

Factors that may serve as sources of error in a concept map test include: diverse levels in students' concept mapping ability; variations in the subject knowledge of those evaluating the concept maps; and the consistency that the concept maps are evaluated depending upon the

technique that concept maps are scored and the effect of the selection of a grading method on the assessments score reliability.

Reliability and Validity

Content validity of the pre- and post-test was established by the review of the scores using the short and extended response rubric by the members of the science curriculum team, consisting of the intermediate science lab teacher, two fifth grade co-teachers and a Science consultant who is responsible for the implementation of the science curriculum. Reliability of the post-test assessments was determined by comparison to the Earth Science benchmark categories. The same test was used for the pre- and post-test assessments.

The audio tape and transcripts of the focus groups were analyzed for reliability by the members of the focus groups by permitting the students to reflect upon the typed transcripts considering the topics that have been selected as the themes that developed during their dialogue. These were also be evaluated for validity by the science team for accuracy of selected themes that have been established throughout the discussions.

The concept mapping was scored by members of the science team using both the Inspiration Rubric for Graphic Organizers and the University of Minnesota Concept Map assessment rubric. The reliability was established by comparing the scores given by each assessor. These scores were evaluated by averaging the scores in each criteria and technique and converting them to a percentage. The percentages were then compared with the scores assigned by the other assessors. The Inspiration Rubric for Graphic Organizers demonstrated more

validity than the University of Minnesota Concept Map assessment rubric. This finding may be because the Inspiration Rubric was created specifically for the Inspiration software that was used by the students to create the concept maps.

Summary

In summary, the qualitative methodology allowed me to research my question of how my practice of concept mapping impacted the summarization/comprehension of Earth Science. This action research design investigated the two variables of concept mapping (independent) and summarization/comprehension (dependent). The analysis of the data will be evaluated in the following chapter, Data Analysis. Through this analysis, I will reflect upon the affect of the concept mapping strategy on the summarization and comprehension abilities of my students.

CHAPTER 4: DATA ANALYSIS

This chapter provides a systematic description of the information collected during this action research study, "The influence of graphic organizers on students' ability to summarize and comprehend science content regarding the Earth's changing surface". The researcher provides a summary of the themes that emerge related to each of the research questions. During this action research study, the following questions were investigated in the researcher's classroom:

1. How does my practice of using graphic organizers during instruction influence students' ability to summarize and comprehend significant fifth grade Earth Science content regarding the Earth's changing surface?
2. How do using graphic organizers assist students' in making connections to understand the fifth grade Earth Science content regarding the Earth's changing surface?

Concept Maps

This study consisted of a total of approximately 12 weeks of instruction. The paper-pencil technique was the intervention used during 4 of the 12 weeks of the study and was assessed using the rubric created by a University of Minnesota (see appendix I) as well as the Inspiration Rubric for Graphic Organizers. (See appendix J) The actual scores are shown on Tables 6 and 7. By utilizing the Inspiration Rubric for Graphic Organizers, concept maps were scored by six

common techniques: arrangement of concepts; links and linking lines, graphics, content, text, and design. Overall ratings were ranked in categories of (1) exemplary, (2) proficient, and (3) developing. When evaluating each pair of concepts, the accurateness of the map was assessed and then the separate points were combined to obtain a total score. Finally, when contrasting to a master map that had been created by the agreement of a team of teachers was used to score the concept maps using a rubric created by the University of Minnesota. This rubric ranged from 0-4 including ratings from no credit, marginal, adequate, good, and excellent. The criteria included structure, relationship, exploratory, and communication. Tables 6 and 7 illustrate the scores assigned to the electronic mapping (see appendix K) by the five members of the science team.

Table 3: Inspiration Rubric for Graphic Organizers

	Earth's Oceans	Water Cycle	Water on Earth	Water Cycle (2)
Arrangement	2 1 3 1 1	1 1 2 1 1	2 2 3 2 2	1 1 2 1 1
Links	2 2 2 2 2	2 2 2 1 2	1 3 3 3 3	1 2 2 2 2
Graphics	2 2 3 2 2	1 1 2 1 1	1 1 3 1 1	2 1 2 2 2
Content	2 1 2 2 2	1 2 3 2 2	2 2 2 2 1	1 2 3 2 2
Text	2 2 3 3 3	2 2 3 2 2	1 1 3 1 1	2 3 3 3 3
Design	2 2 3 2 2	1 2 2 2 2	1 1 3 1 1	2 2 2 2 2

Table 4: University of Minnesota Concept Maps Rubric

	Earth's Oceans	Water Cycle	Water on Earth	Water Cycle (2)
Structure	1 1 4 2 1	1 1 3 1 1	2 2 4 3 2	1 1 3 1 1
Relationships	2 2 3 2 2	1 2 3 1 1	1 2 3 1 1	1 1 2 1 1
Exploratory	1 1 4 1 1	2 2 3 2 2	1 1 4 1 1	1 3 3 1 1
Communication	2 1 3 3 3	1 1 4 1 1	1 3 4 1 1	1 2 3 1 1

A review of the scores assigned to the concept maps by the members of the science curriculum team: intermediate science lab teacher, two fifth grade co-teachers and a Science consultant were used to ensure reliability. Using a scoring agreement requires that the scorers attain satisfactory agreement in their scoring. This process, is duplicated until the observers reach a desired "correlation of at least .90 among scorers or an agreement of at least 80 percent" (Fraenkel and Wallen, 2006, p. 162). In this study, the final outcome reliability of scores established at a 74% level. The researcher acknowledges that this does not meet the stated criteria.

From these rubrics the areas that the twelve students scored highest on average were in the actual hierarchical structure of concept maps and clearly communicating the information and illustrating a level of understanding (of the six concept maps 50% were scored adequate and 19% scored good). The skill of indicating the simple and complex relationships using links within the concept maps was scored the lowest and only three received 75% in this area. For example, one student mapped importance of concepts by creating a non-linear hierarchical structure from top of the map to the bottom, while another illustrated relations that were clear but lacking distinctive relationships by placing the concepts haphazardly. Also, only four students correctly used the arrows of the links to illustrate the flow of the map from the main idea of the concept map and leading to more detailed ideas, while eight did not consistently represent the links appropriately as they sometimes pointed to the details but at other times indicated the relationship incorrectly as indicated in Figure 2. For example in figure 2 the student did create a non-linear hierarchical structure as well as utilized linking words to illustrate the relationship

between the propositions but did not consistently draw the arrows to indicate the directional relationships. Overall, the students reported liking the mapping in the Science notebooks using the paper-pencil technique. (see appendix L)

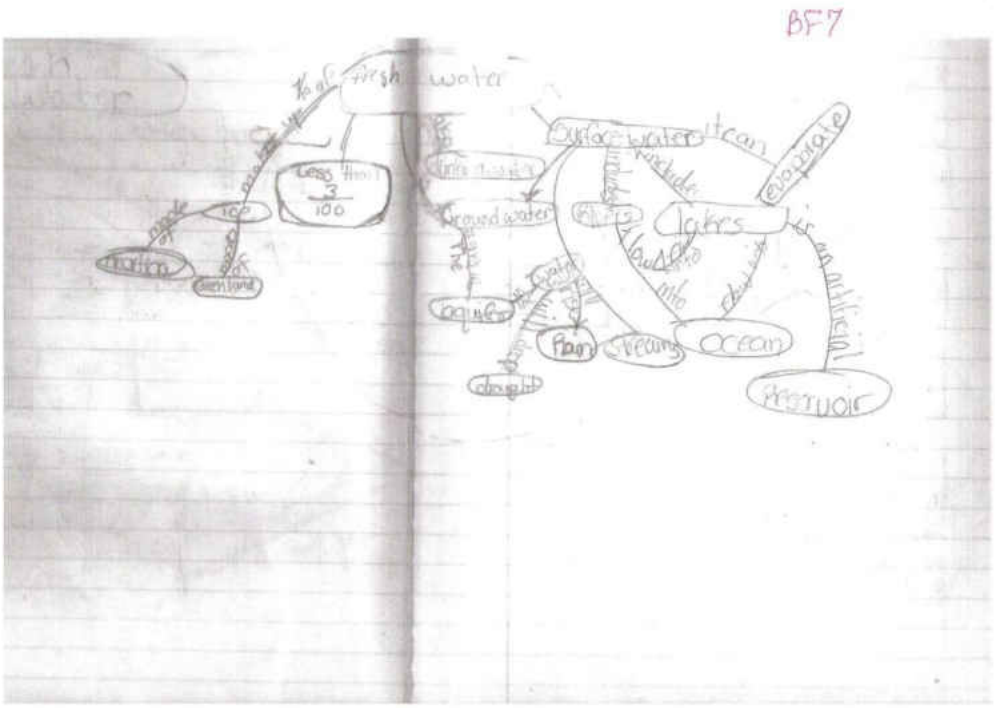

Figure 2: Science Notebooks: Paper-Pencil Concept Mapping

During weeks 4-8, the students were asked to use *Post-it*™ notes to enhance their concept maps. The concepts were written on the *Post-it*™ notes enabling the students to move the concepts around to make revisions to their concept maps. The students expressed dislike for this type of structure for mapping both verbally and in written reflections. One difficulty noted by two students in their journal and two students from focus groups was in the lack of room on the

Post-it™ notes. Another drawback noted by two students was that once the link had been written, it could not be moved; so being able to move the *Post-it*™ concept was useless. Figure 3 provides an example of an adequate *Post-it*™ concept map with the exception that the arrows on the links are not indicating proper relationships while Figure 4 provides an example of marginal mapping with too many relational words written on the links. Finally, Figure 5 demonstrates a non-example because there are limited relational links between the concepts.

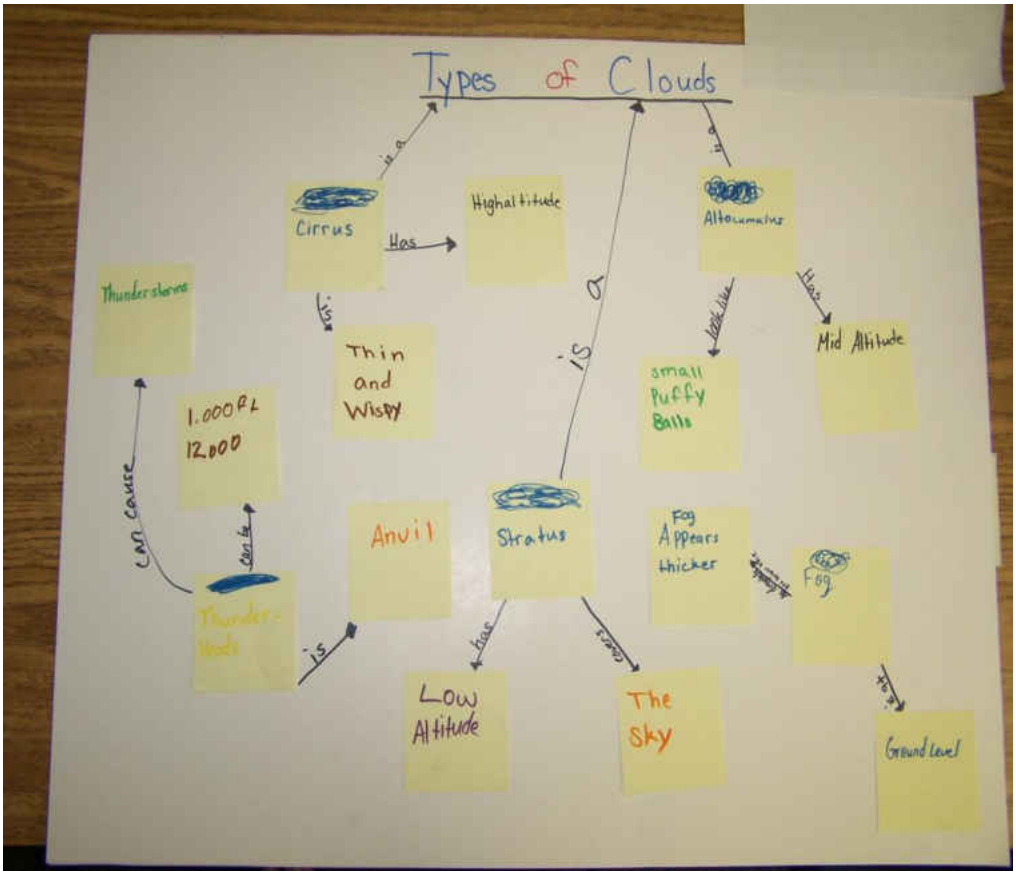

Figure 3: Example: concept mapping using *Post-it*™ Notes

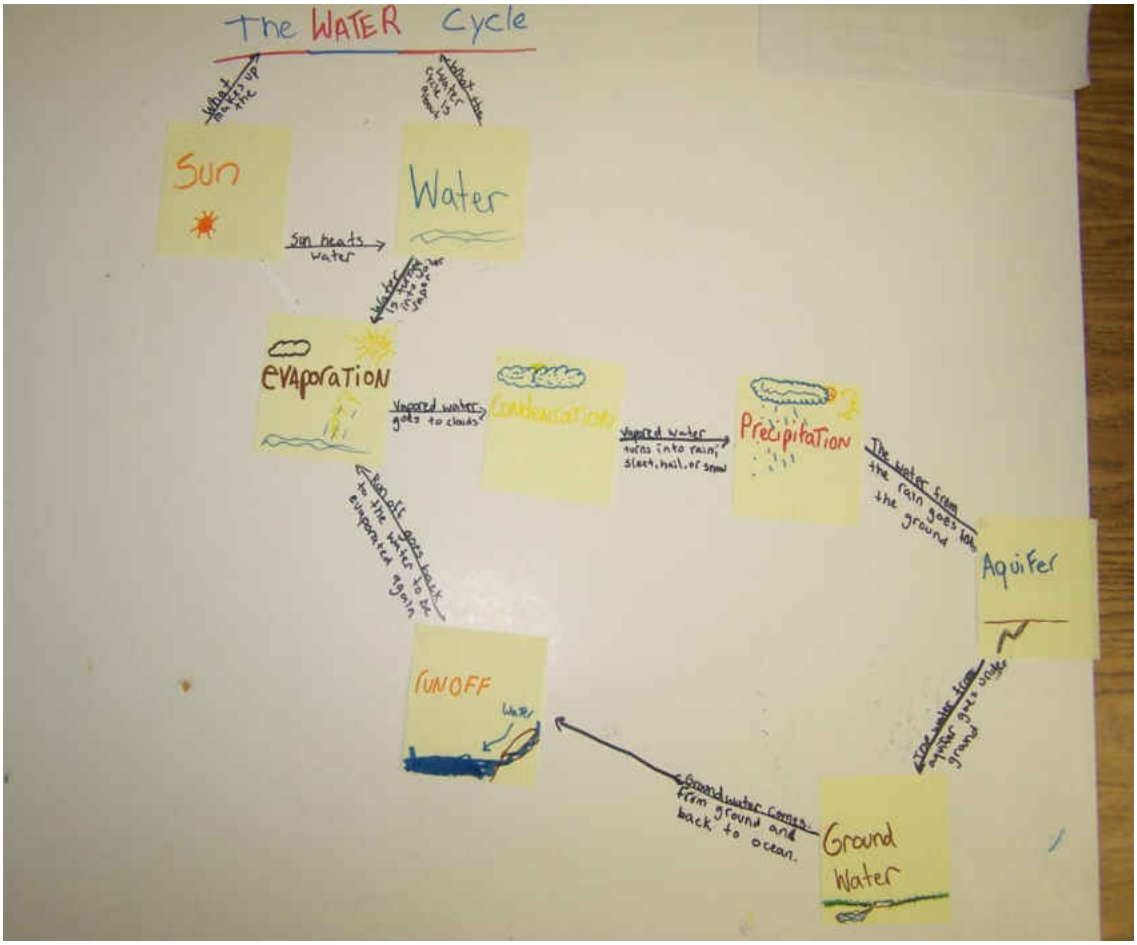

Figure 4: Non-example: Concept mapping using *Post-it*™ notes- too many words on the connecting links

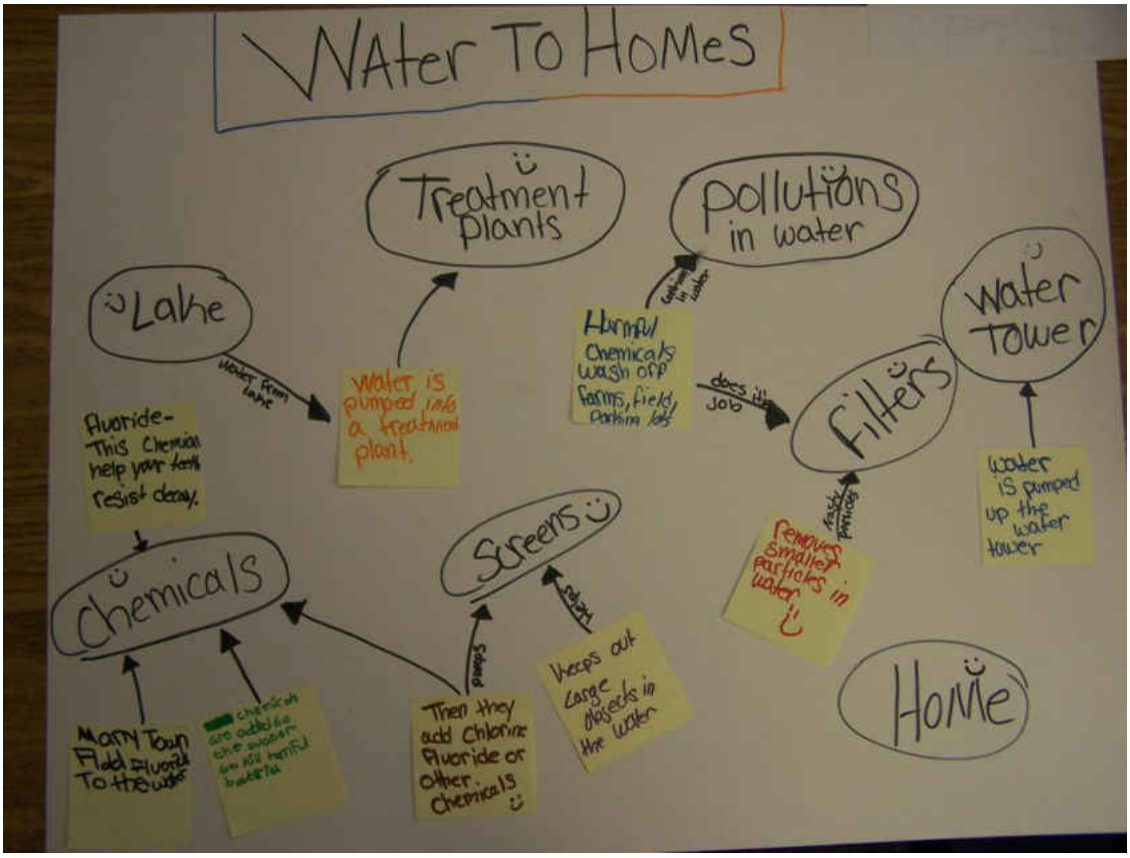

Figure 5: Non-example: Concept mapping using *Post-it*™ notes- concepts are not linked together

During weeks nine to twelve of the action research study, students were paired to complete concept mapping using computer software. Initially, the groups used the *Thinking Maps* ™ website with the bubble map placing an initial concept in the center of the map with details on the outside. Later, concept mapping was created using *Kidspiration*® software. The main difference between the two programs is the use of linking verbs between the concepts. Seven students in the study verbalized that computer mapping was "fun", "easier than the paper-pencil mapping" and enabled them to easily "add more details." Students discussed that the

computer mapping helped them to remember each section. One student stated, **"**Yeah- and like on the homework- when you gave me the soil- remember when we were doing it on the computer- when we were doing the bubble maps on my homework the last question- it told me what is topsoil about- I remembered it because of the bubble maps." Within the same group a student added, "I like it- cause like it helps you remember stuff like when you're taking the science test and stuff- and I remember the homework stuff you gave us- Lessons 1 through 6 …when we learned about Earth's crust, inner core, outer core, mantle and all those stuff." Finally one student in another group discussed, "the computer based mapping was very simple but the paper mapping was like you would have to add more details into it and the computer mapping – it was simple and it helps you memorize it because of all the categorizing and the details you put in the bubble maps and you can remember it because of each section. Figure 6 shows an example using the *Kidspiration*® software. This map shows only one link that is not drawn directionally indicating the proper relationship

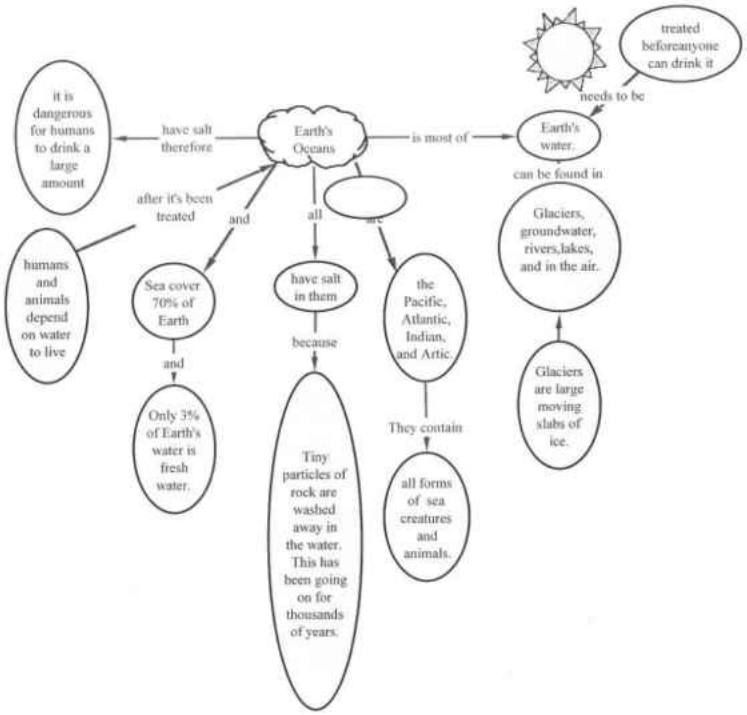

Figure 6: Concept Mapping using Kidspiration®

The outcomes from the action research related to the students' scores on concept maps. Their preference for concept maps revealed that though they verbalized an enjoyment in using the strategy of concept mapping, they are currently at the marginal to adequate proficiency. However, students using Kidspiration™ software stated felt this tool assisted them in retention of the concepts, their relationships, and the vocabulary but students using *Post-it*™ felt that this option was a hindrance due to the permanence of the links written on the posterboard. Overall, the scores using the rubric to evaluate concept maps showed that electronic concept mapping

using Kidspiration™ software received higher overall scores than paper-pencil concept mapping and that the use of *Post-it*™ notes was least effective as reflected by the rubric scores.

Focus Groups:

The three focus groups consisted of four students each. These were heterogeneous groups. Within each group the following themes emerged from each question that was discussed:

1. How do you like concept mapping activities in general?

Students in the first group discussed that concept mapping "describes stuff- helped you on the tests" and "helps you understand categorizing – this into that and all the details about it". This same group also discussed that it "helped you on the tests" and "homework stuff". Two of the groups noted that "It helps to make me learn more in Science" and "remember stuff".

2. How do you like the computer-based mapping using *Kidspiration*® as compared to other ways of concept mapping such as paper and pencil [mapping]?

Students again discussed the "categorizing and the details". Two groups noted that mapping assists students to "learn more in Science", "remember", and "know what I am writing and understand". Finally, one student added that "working together" was an advantage.

3. Have you felt that concept mapping has helped you to understand the scientific concepts and relations among the concepts? How?

One group discussed that concept mapping "helped…understand…when writing to know the vocabularies". Another group discussed how students "learn more about what you like doing… [The arrows] connecting to each other to understand both [concepts] of them. Two of

the groups again noted that it helped "to know the details" and "categorizing…tells how something can change into something else and examples of other things."

4. How do you like revising your concept maps regularly during learning a science unit?

One group discussed that concept mapping "helped me more" and "made me learn more because if you had something wrong you just go back and do the concept mapping and then you correct it". Another group emphasized that "as we were learning more we understand more so that helped us complete it" and "if you forgot…then you came back…you could have forgotten one so going back really helps". Finally, the last group emphasized that mapping helps "categorizing" and one student stated "I didn't like it but it helped me learn more because if you had something wrong you just go back and do the concept mapping and then you correct it".

5. What difficulties have you experienced with concept mapping?

One group admitted that "we sometimes argued over who was typing". A student in another group stated that "it's really a lot cause I really didn't sometimes I didn't understand how it goes- I mixed it up and all that". Finally, the last group discussed they "didn't really get it…how to find the answers". Another student added "I didn't know if you could write something even though it's not found there…like it's what we were writing about in concept mapping and you don't know if you can write that- if it will make sense with what you're putting on the computer."

6. You have been doing concept mapping in pairs/group. Have you found that working with other students is beneficial? In what way?

The first group discussed "you have someone to talk to and share" and "If you got an idea and your friend got an idea- you can have two ideas". In the same theme, the second group discussed "both of you can come up with new ideas and you know it and even more than two and you know somebody might have this idea that we never thought of" and "it's fun working with other people". The second group explained "it was better working in groups…to understand how other people's minds are working". Another theme was that "somebody is there to help you". In contrast, one student felt that "I think that it really didn't help me because some of them like if I said I was working with [someone] and one came by and she started helping us and then the next came by and starting helping us but one but like if another student came by and started helping us and we all had every single detail we needed and he added one more detail and we said that we think we had that detail but he added like something we think didn't really go with it – it like started a whole argument – I would…no".

7. If you had a choice to work alone, in pairs, or in groups of three for concept mapping, which would you prefer and why?

The basic opinion was that the majority of the students liked working in pairs because "I can have like a partner so we can share ideas with each other and get answers" and "we can share ideas". Student opinion regarding working in groups was that "some people think this is right

and some think this is right…and some people in our group just don't do work, they just copy". Another group agreed that in groups "each person has their own ideas and everybody's fighting".

8. Do you interact with your teacher during concept mapping? What would you like your teacher to do during concept mapping sessions?

One group discussed that "when we're doing concept mapping [we] get more help from the teacher" and "you tell us if we write the wrong thing or the right thing." One suggestion by the second group was "take some words out [of the bubble]…and go one by one at a time…take some time so I can understand better". Another group suggested that the teacher should "give [her] own ideas- like if you came up with the test that you give us you put your own ideas on it probably would help us because with your ideas and our details…sometimes I'm confused they use words that sometimes [you] don't understand…clarify it". Another student added "the teacher explain it to you…like telling you the story and then just explaining".

9. Would you like your teacher to continue concept mapping in your science teaching?

Most of the students responded positively that "we should do it in math, reading and different subjects" and "it helps you understand better, classify things and put them in categories and we can later use that skill in middle school". Also, another group discussed "mapping helps if you're doing a story" and "it could be kind of like a review" and finally "it helps you more and gets your grades up".

Overall the students liked electronic mapping more than *Post-it*™ notes mapping or paper-pencil mapping and they preferred working in pairs versus working individually or in

groups. Their opinions show that concept mapping was advantageous for the majority of this class of students.

Pre- and post-test

Table 5 provides a summary of all scores as well as a range or increase or decrease for each student from pre to post-test scores. The pre-test was administered after the science chapter had been taught but before the introduction and use of concept mapping. The pre-test results indicated an overall class percentage of 29% of knowledge for the concepts already taught with a range of scores from 73% to 9%. The class averaged of 37% on the benchmark assessment shows that the students know that common materials can be changed from one state to another by heating and cooling. They also scored 31% on the benchmark related to knowing that 75 percent of the surface of the Earth is covered by water. The lowest percentage of 24% on the benchmark was in relation to students knowing that the water cycle is influenced by temperature, pressure, and the topography of the land. The highest percentage (44%) was related to students understanding that people, alone or in groups, invent new tools to solve problems and do work that affects aspects of life outside of science.

Table 5: Scores of the pre- and post-test

Student	Pre-test	Post-test	Range
AF1	41	59	18
AF2	27	27	0
AM3	14	45	31
AF4	73	82	9
BM5	36	55	19
BM6	18	73	55
BM7	18	64	46
BF8	18	64	46
CM9	41	73	32
CM10	18	59	41
CF11	41	68	27
CF12	50	64	14
RANGE	59	55	55
MAXIMUM	73	82	55
MINIMUM	14	27	0
MEAN	33	61	28

Students scored highest on the test questions that entailed rote memorization. The test question regarding the formation of an iceberg that the students scored the lowest (17%) required higher level skill application because it was an open –ended response. Student's misconceptions

varied between an iceberg forming when ocean water freezes and when an ice sheet cracks at its base.

The post-test was administered after the science concepts were presented through the application of concept mapping. The post-test indicated an overall class percentage of 59% with a range of scores from 27% to 82%. The class averaged 57% on the benchmark that students knew that common materials can be changed from one state to another by heating and cooling. They scored 72% on the benchmark that students knew that 75 % of the surface of the Earth is covered by water. These test questions required lower level skill application because they were rote memorization responses. The lowest percentage of 53% was on the benchmark that students knew that the water cycle is influenced by temperature, pressure, and the topography of the land. This test question required higher level skill application because it covered multiple concepts. The highest percentage of 83% was received on the benchmark that students understood that people, alone or in groups, invent new tools to solve problems and do work that affects aspects of life. This test question required higher level skill application because it was an open-ended response.

Two questions received the lowest scores at 18% each. The first was the question regarding the salinity of cold water. As discussed in the previous paragraph, this outcome may be due to the use of words in the test that were not used in the text. The other low scoring question was “Dew forms during part of the water cycle”. Most of the students chose choice “A” (runoff); however, the science team felt that this may be due to the correct answer was not capitalized but all the other choices were and may have influenced the choice of the students. Most of the

students' percentages increased with the exceptions of the question "What carries warm water toward the poles?" The percentage decreased by 7%, from 72% to 65%. The other exception was the question regarding the formation of dew. The percentage decreased 4% from 22% to 18%. There was no obvious reason for this decrease. There were three questions that were omitted by one student each. These were the last three questions of the multiple choice section and that may be the reason for the omission.

The two short response questions scores increased significantly following the use of concept maps. The first question, "Evaporation and sublimation both occur during the water cycle. Explain how these two processes are alike and how they are different" increased from 44% to 83%. The second question, "Because of possible pollutants, water is treated before use. Name two ways that most communities treat water before it comes to your home" increased from 56% to 88%. The extended response scores of the essays requiring the identification of types of clouds, their description and altitude where they form increased from 31% to 88%. These scores illustrated an improvement in the summarization skills of the Earth Science concepts.

Overall, the teacher/researcher observed students becoming more aware of the vocabulary associated with the Earth Science concepts and were able to use the terms properly later during assessments. They were also better able to recognize relevant details and classify them into categories that assisted them in making connections presented in the text. The use of the concept mapping enabled the students to not only mentally visualize the relationships but to also commit them to memory. Students' understanding of the relationships between the concepts assisted in their overall understanding of the Earth Science benchmarks.

Item difficulty was assessed using the procedure described in Chapter 3. The item difficulty is the proportion of students who correctly answered the item. In order to obtain maximum spread of students' scores it is best to use items with moderate difficulties. Moderate difficulty can be defined as the point halfway between perfect score and chance score. For a four choice item, moderate difficulty level is .625, or a range between .50 and .75 (because 100% correct is perfect and 25% of the group would be expected to answer the correct item through blind guessing. Items that are too easy or too difficult cannot discriminate adequately between student performance levels. According to the pre-test results (see Table 6) three items were determined to have moderate difficulty. Two of these were covered by the benchmark that the student knows that the water cycle is influenced by temperature, pressure and topography of the land (SC.D.1.2.3). The other question had been covered by the benchmark that the student knows that common materials can be changed from one state to another by heating and cooling (SC.A.1.2.2). The post-test results indicated that eight items were determined to have moderate difficulty. These included all of the benchmarks which were indicated in Chapter 3 on Table 1: Sunshine State Standards: assessed by the Earth Science pre- and post-test Florida Sunshine State Standards except the benchmark that the students know that 75 % of the surface of the Earth is covered by water (SC.D.1.2.2). Items that are too easy or too difficult cannot discriminate adequately between student performances.

The science team, which analyzed the validity of the pre- and post-test, determined that the multiple choice questions were considered to be lower order questions when placed in Bloom's taxonomy; only the short and extended response questions were considered higher order

questions. When the pre- and post test results were being assessed by the science team four questions were found in the opinion of these professional experts to have the following issues related to validity:

- The third question stated “A liter of cold water with high salinity than a liter of warm water with low salinity.” used the words “heavier” and “lighter” as choices regarding the salinity of cold water; the text had used the word “denser.”
- The eighth question “Which process below does NOT involve water vapor?” was determined as too easy to eliminate the correct answer because the word “vapor” was present in the three incorrect choices.
- Finally, the thirteenth question “Frozen raindrops falling from the clouds are called” did not offer the correct answer in the choices.

Therefore, some issues of validity of the questions related to the responses were identified but were not teased out in this study. According to Ellis, test scores are enhanced by concept mapping in that:

> The graphics help students understand, learn the subject, and focus their energies on studying the essential information. The concept maps serve as effective devices for helping students focus on the relationships between main ideas and details, main ideas and other main ideas. The focus of study is how it all fits together rather than on just memorizing isolated, decontextualized bits of information (2004, p. 3).

This statement rang true in the increase in scores observed in this classroom by adding concept mapping to the class activities.

Table 6: Item Difficulty Analysis of the pre- and post-test

Pretest	Discrimination	Posttest	Discrimination	Benchmark Assessed
MC1	.20	MC1	.50	SC.A.1.2.2
MC2	.20	MC2	.50	SC.D.1.2.3
MC3	.00	MC3	.40	SC.A.1.2.2
MC4	-.40	MC4	.25	SC.D.1.2.2
MC5	-.25	MC5	1.00	SC.A.1.2.2
MC6	.75	MC6	.60	SC.D.1.2.3
MC7	.00	MC7	.20	SC.D.1.2.2
MC8	.50	MC8	.00	SC.A.1.2.2
MC9	.25	MC9	.60	SC.D.1.2.3
MC10	.40	MC10	.50	SC.D.1.2.3
MC11	.60	MC11	.75	SC.A.1.2.2
MC12	.40	MC12	.50	SC.D.1.2.3
MC13	.00	MC13	.50	SC.D.1.2.3
MC14	.00	MC14	.00	SC.D.1.2.3
SR15	.40	SR15	.75	SC.D.1.2.3
SR16	.40	SR16	.75	SC.H.3.2.1

MC= multiple choice item; SR=short response item

Summary of the Data

In reviewing the three measures concept maps, students' perceptions and pre-post test scores overall the concepts maps did impact student learning in this particular classroom for this unit of study. In relation to each of the research questions the following outcomes were observed. Question 1: How does my practice of using graphic organizers during instruction influence students' ability to summarize and comprehend significant fifth grade Earth Science content regarding the Earth's changing surface? After using the concept maps students in this classroom were better able to recognize relevant details and classify them into categories. The use of the concept maps seemed to assist them in summarizing of the main ideas presented in the text. Overall, students' understanding of the relationships between the concepts assisted in their comprehension of the Earth Science benchmarks. Student noted that they liked using electronic type of concept maps more than *Post It*™ notes. However, the combination of learning various ways of mapping collectively appeared to have a positive outcome on their learning in spite of the type of mapping the students preferred.

The second research question had some outcomes but more inference had to be made related to this question: How do using graphic organizers assist students in making connections to understand the fifth grade Earth Science content regarding the Earth's changing surface? Related to this question, the students appeared to become more aware of the vocabulary associated with the Earth Science concepts from implementing the various types of mapping. Overall they were able to use the science terms properly during the post-test and appeared to be

able to answer more complex questions. The use of the concept mapping appeared to allow students to go beyond rote memorization and to actually understand the meaning behind the various concepts introduced. During focus groups, one student stated “well it helped me understand it because like when I’m writing I know the vocabularies and I know like the details and when you’re writing just so different.” The students’ pre- and post-test contained extended response items that the students were to write details regarding the question using vocabulary and facts about the concepts (see appendices L). When orally discussing the responses with the students, most of them noticed that though they had written about the same amount but the difference was the amount of the scientific vocabulary had increased and they had correctly identified and described the clouds One student noticed that she wrote significantly more information as well as identifying and describing the clouds with accurate, scientific terms because she “could see the map in my mind when I answered the question”. The student scores consistently increased on the 0-4 rubric from an overall .25 on the pre-test to 2.75 on the post-test (see Table 7).

Table 7: Pre- and Post-test scores: extended response items

	AF1	AF2	AM3	AF4	BM5	BM6	BF7	BF8	CM9	CM10	CF11	CF12
Pre-	0	0	0	1	0	0	0	1	0	0	1	0
Post-	2	2.5	1	4	4	2	2	4	3	1	4	3.5

Validity and Reliability

The focus groups were audio taped; the tapes were then transcribed. A member check of the audio tape and transcripts from the focus groups were conducted by permitting the students to reflect upon the themes that developed during their dialogue. The students stated in the focus groups "that [concept mapping] describes and helps understand categorizing". They also agreed that "it helps memory and understanding".

Reliability of the reported pre- and post-test scores was established by administering the same test twice after an interval of time has elapsed. "Since the stability of scores over a two- or three- month periods is usually viewed as sufficient evidence of reliability" (Fraenkel and Wallen, 2006, p. 159). The testing interval during this study was five weeks, which is adequate time to intervene and to reassess students. However, the researcher acknowledges that some scores may have increased not just due to the concept mapping but due to the effect of administration of the same test.

Summary

The three processes used to collect data for this research were concept maps, focus groups and the pre- and post-test results. The themes that emerged were the ability to describe, categorize and classify details. The students stated that they preferred to work in pairs rather than individually or in groups. Another positive theme that emerged was the increased accuracy of the use of vocabulary and the memory of the concepts that occurred with the concept maps.

When student instruction was supported by concept maps their ability to recall information and understand the Earth Science concepts as evidence through summarization and comprehension through the pre- and post-test increased.

CHAPTER 5: CONCLUSION

Introduction

The purpose of this action research project was to determine the influence of graphic organizers on students' ability to summarize and comprehend science content regarding the Earth's changing surface. The focus questions that were investigated were:

1. How does my practice of using graphic organizers during instruction influence students' ability to summarize and comprehend fifth grade earth science content regarding the Earth's changing surface?

2. How do using graphic organizers assist students' in making connections to understand the fifth grade earth science content regarding the Earth's changing surface?

The research goal was to investigate the use of graphic organizers to enhance and organize the understanding of the science concepts and their relationships.

Literature Review

During this action-research study, the students used concept mapping to enhance their understanding of the surface of the Earth. According to Liu (2002) students may use concept mapping for evaluation of the changes in science. In their conclusions, the students found it

advantageous to create and revise concept maps regularly. The main advantage in both the study by Liu and this action-research study was that students were able to visualize how concepts were related. Additionally, this study concurred with Liu's findings that when given a choice, the students enjoyed working in pairs.

According to Lee, Baylor, and Nelson, (2005), mapping can support learning by constructing concept maps for representing student understanding in a domain, which in this action-research study was the changing of the surface of the Earth. The concept maps ease the recognition of patterns and relationships. Students reflect what they know and do not know to assemble important data in terms of propositions and links. Concept maps can be used as instructional notes. The students discussed in the focus groups how the mapping assisted them in completing homework and studying for assessments. Concept maps can also be used as a measurement of "internal knowledge structure in memory" (p. 119). The pre- and post-test results also support this work in that the students were able to answer higher level questions after using concept maps.

Despite the literature supporting the use of *Post-It™ notes* (Novak & Cañas, 2006) the students who participated in this study were not partial to their benefit. Unlike Novak and Canas who employed the use of *Post-it*s ™ and stressed the importance to acknowledge that a concept map is never completed students did not seem to find this method overly productive. Though I initially thought that the use of *Post-it*s™ would be advantageous my line of reasoning changed when there was not enough room for students to write their concepts on the *Post-it*s™. Students also did not use white boards due to their 8x11 size. Instead poster boards were used so that

though they were able to move the *Post-it*s™, they were not able to redirect the links that had been written. Also, another factor that may have contributed to student dislike was that when the students were first exposed to the concept mapping procedure, I emphasized writing the concept and then placing the circle or box around the words so that they would not need to erase and re-write the map.

The study by Liu (2002) concluded that understanding becomes more complicated and clearer as more concepts and relations are added. The concept maps produced in this action-research study seemed to become more confusing as each detail, though simplistic, was added to the map. The students were not always sure of the placement of the additional concepts to illustrate hierarchical formation. Therefore, the *Kidspiration*® type of map seemed to have the greatest impact and students preferred working in pairs versus individually or in cooperative groups.

Implications

McClure, Sonak, and Suen, (1999), found that the use of concept mapping assignments in classroom assessment will affect teachers in three ways. First, additional time needs to be allocated to guide students in concept mapping methods. Second, Teachers must take into account how the mandatory time to construct concept maps contrasts with conventional evaluation assignments. Third, teachers must reflect on the time necessary to grade, or otherwise assess the concept maps constructed by the students.

Related to time I found that during this action-research study, additional time was needed to scaffold the procedures required to teach students the concept of mapping. The creation of the computer mapping using *Kidspiration*® also required additional time because only one computer had been downloaded with the required software. In addition, scoring the concept maps that were created by individuals in the science notebooks and pairs on the computer required further evaluation and additional time.

Vanides, Yin, Tomita, and Ruiz-Primo, (2005) determined that benefits for teachers using concept mapping included providing information regarding the student's information of the concepts as well as providing means to examine the understanding of science exhibited by the concept map that was created by the student. The concept maps may also be evaluated to determine retention of the themes and verify interruptions in learning. Teachers may then apply information from students' concept maps to drive the future instruction within the classroom. After the pre-tests were given during this action-research study, I was able to evaluate the results to determine any gaps that may be evident. This guided the direction of the instruction that was applied and influenced that benchmarks needed to be clarified.

Vanides, Yin, Tomita, and Ruiz-Primo, (2005) also determined that the advantages for students using concept maps are that they reflect about the links between the science vocabulary and classify and connect those ideas in an organized way. Students also reflect more intensely about the science concepts through arranging what they have learned in a way that makes sense to the learner. Concept mapping assists students in gathering and retrieving information more effectively while communicating their thoughts about science. Concept mapping facilitates

students' integration of literacy and science. The concept maps give an opening point for writing about science. These outcomes were evident in the post-test short and extended response questions, the students were better able to recall and retrieve information necessary to answer higher order questions. These questions required students to summarize the text and concepts that had been presented as well as appropriately use vocabulary. The students discussed during the focus groups that the concept mapping helped them to envision the organizational pattern of the science concepts.

According to Ellis, (2004) concept maps are universal in nature. They may be applied to expand learning and success of many students, including those who may be intellectually gifted to those with mild learning problems. In my action-research study, the majority of the students benefited from the use of concept mapping. Most of the students showed improvement of the comprehension of the concepts when comparing the pre- and post test scores with an average range of 28%... The exception was one student who scored exactly same on both measures. Surprisingly, the student whose scores produced the greatest range of 55% was a student with an identified severe learning disability.

Limitations

The limitations of this action-research study were similar to those mentioned by Lee, Baylor, and Nelson, (2005), that the number of concepts that could be characterized on a computer screen or paper is restricted and that may have inhibited the learner from expressing his or her thoughts as fully as he or she could if adequate space were offered. Also, the strategy

using the *Post-it* Notes™ limited the amount of text that was written as the propositions the notes themselves.

Daley, (2004), also discussed the complexity of concept mapping that causes the format to be difficult for participants to comprehend if they unfamiliar with the strategy of concept maps. Additionally, the links become increasingly more difficult as the concept maps become more complicated requiring the use of other data analysis methods in combination with the concept maps.

Finally, McClure, Sonak and Suen (1999), maintained that science teachers should give thorough consideration to the precise nature of concept mapping tasks that they chose to use in classrooms. The primary expenditure to classroom teachers is the time required to instruct the students regarding how to produce concept maps and the time required for teachers to score and assess concept maps. Their recommendation was to keep the mapping procedure simple. Complicated mapping will inhibit the student's responses and may limit the information presented in the concept maps.

Other limitations were that research biased existed in relation to teaching to a particular assessment since the teacher and researcher were one in the same. However, as expected in an action research study the teacher taught to concepts critical to the assessment and used procedures to show reliability in score of the concept maps and assessments.

Conclusion

If I were to carry out this action-research study again, I would teach the concept mapping concurrently while presenting the text. While using the concept mapping to diagram the important concepts and their relationship, the students would also be provided with a copy of the organizer to use while learning the content. I would utilize the scaffolding strategy of enabling the students to co-construct graphic organizers with me depicting relevant ideas as the content is further explored. Next, the students would work in cooperative groups while I guided the mapping of the concepts. Finally, the students would independently construct individual concept maps.

I would also like to expand the concept mapping into other themes within the fifth grade science curriculum. There are currently four units in the science instruction consisting of Earth Science, Physical Science, Life Science and Space Science. The research that I have found defends the use of concept mapping in Earth Science. However, there were not sufficient studies to support the use of mapping within the other subject matter. Students also suggested that concept mapping should be completed during other subject areas such as math, social studies, and reading.

Finally, I would like to determine the effects of concept mapping by comparing and contrasting students that were exposed to concept mapping and those who were not. In this study, I would like to establish the value of concept mapping throughout the classroom. It would

be necessary to finance the Kidspiration™ software so that it could be available more than just one computer in the classroom. It would also be advantageous to have the capabilities to print the concept maps from the computers that the software had been downloaded.

According to De Simone, (2007),

> "It is more likely that they will retain and apply the information…students are better able to detect and correct gaps and inconsistencies in their knowledge…However, drawing the map is time consuming. Making revisions to it, while helpful, often requires that the whole mapping process be restarted almost from scratch" (p. 34).

While using the electronic concept mapping, students were able to diminish the lengthy procedure of erasing, revising and starting over. It also permitted additional independence to alter abstract thinking and mapped demonstrations; and encouraged students to concentrate on discrepancies and gaps in their understanding. Therefore, my future choice for mapping would be if available the use of a computerized tool to assist students in the timely and most effective creation of concept maps.

Final Summary

The purpose of this action research project was to determine the influence of graphic organizers on students' ability to summarize and comprehend science content regarding the Earth's changing surface. Concept mapping was used as an instructional tool used to arrange curriculum subject matter, plan precise instructions, and present the material to the students. It was also a student learning tool used to understand facts, and combine chapters as well as the

essential benchmarks across the Earth science unit. The concept mapping served as an assessment tool to evaluate student learning and measure growth. Concepts were used as a way to organize the various sources, and most importantly promoted collaboration with peers to better understand the concepts in the unit. This outcome is the ultimate goal of my teaching and I will use this tool in the future.

APPENDIX A: PRINCIPAL'S LETTER

To Whom It May Concern:

I, [redacted] principal at Palmetto Elementary School, give Patricia Goss, a K-8 Science and Math Masters' student in the UCF/Lockheed Martin program and fifth grade teacher at this facility, permission to conduct her thesis research regarding Earth Science at this school during the 2008-2009 school year.

Sincerely,

[redacted]

APPENDIX B: INSTITUTIONAL REVIEW BOARD

University of Central Florida

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

Notice of Expedited Initial Review and Approval

From : **UCF Institutional Review Board**
FWA00000351, Exp. 6/24/11, IRB00001138

To : **Patricia Goss**

Date : **September 30, 2008**

IRB Number: **SBE-08-05787**

Study Title: **How does my practice of using concept mapping during instruction affect my student's ability to summarize and comprehend significant earth science topics?**

Dear Researcher:

Your research protocol noted above was approved by **expedited** review by the UCF IRB Chair on 9/29/2008. **The expiration date is 9/28/2009.** Your study was determined to be minimal risk for human subjects and expeditable per federal regulations, 45 CFR 46.110. The categories for which this study qualifies as expeditable research are as follows:

6. Collection of data from voice, video, digital, or image recordings made for research purposes.

7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

The IRB has approved a **consent procedure which requires participants to sign consent forms.** Use of the approved, stamped consent document(s) is required. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Subjects or their representatives must receive a copy of the consent form(s).

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

To continue this research beyond the expiration date, a Continuing Review Form must be submitted 2 – 4 weeks prior to the expiration date. Advise the IRB if you receive a subpoena for the release of this information, or if a breach of confidentiality occurs. Also report any unanticipated problems or serious adverse events (within 5 working days). Do not make changes to the protocol methodology or consent form before obtaining IRB approval. Changes can be submitted for IRB review using the Addendum/Modification Request Form. An Addendum/Modification Request Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at http://iris.research.ucf.edu .

Failure to provide a continuing review report could lead to study suspension, a loss of funding and/or publication possibilities, or reporting of noncompliance to sponsors or funding agencies. The IRB maintains the authority under 45 CFR 46.110(e) to observe or have a third party observe the consent process and the research.

On behalf of Tracy Dietz, Ph.D., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 09/30/2008 09:11:30 AM EDT

Joanne Muratori

APPENDIX C: RESEARCH REQUEST

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

RESEARCH REQUEST FORM

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

Requester's Name Patricia A. Goss Date 7/11/08

Address: Home_ Phone_

Business_ Phone_____

Project Director or Advisor Dr. Enrique Ortiz Phone 407-823-5222

Address UCF Main Campus, 4000 Central Fla. Blvd. Orlando 32816
(Lockheed Martin/UCF K-8 Math and Science Program)

Degree Sought: (check one) ☐ Associate ☐ Bachelor's ☑ Master's ☐ Specialist ☐ Doctorate ☐ None

Project Title_____

ESTIMATED INVOLVEMENT

PERSONNEL/CENTERS	NUMBER	AMOUNT OF TIME (DAYS, HOURS, ETC.)	SPECIFY/DESCRIBE GRADES, SCHOOLS, SPECIAL NEEDS, ETC.
Students	±23	35 day • 45 m/day = ±26 hrs. / ±42 hours	
Teachers	1		
Administrators			
Schools/Centers	1	.45 min of 7.5 hr. /dy	
Others (specify)			

Specify possible benefits to students/school system: Students will use concept mapping to comprehend and summarize Earth Science concepts. It will assist them in "connecting" the ideas and organizational skills.

ASSURANCE

RECEIVED JUL 15 2008

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

Requester's Signature Patricia Goss

Approval Granted: ☒ Yes ☐ No Date: 7-21-08

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

APPENDIX D: INFORMED CONSENT

Informed Consent from a Parent for a Child in a Non-medical Research Study

Researchers at the University of Central Florida (UCF) study many topics. To do this we need the help of people who agree to take part in a research study. You are being asked to allow your child to take part in a research study which will include about 24 people. You can ask questions about the research. You can read this form and agree right now for your child to take part, or take the form home with you to study before you decide. You will be told if any new information is learned which may affect your willingness to allow your child to continue taking part in this study. Your child is being invited to take part in this research study because he or she is a student at You must be an emancipated minor according to the laws of the State of Florida or an adult 18 years of age or older to be able to give this permission and sign this form for your child to take part in this research study.

The person doing this research is Patricia A. Goss of the UCF Lockheed/Martin program.

Because the researcher is a master's student, she is being guided by Dr. Enrique Ortiz, a UCF faculty supervisor in the College of Education.

Study title: How does my practice of using concept mapping during earth science instruction affect students' ability to summarize and comprehend significant topics?

Purpose of the research study: The purpose of this study is to research the affect of concept mapping on fifth grade students' ability to summarize and comprehend earth science.

What your child will be asked to do in the study: The student's will be required to read concept maps, complete partial concept maps and then construct concepts maps given concepts and relational links. Finally, students' will determine the key concepts and relational links from the text to construct individual maps. Students will also work with partners in small groups to find similarities and differences to reconcile their maps. Each small group will present their propositions and explain their choices focusing in what is relevant within the lesson. Students will record their concept maps in their scientific notebooks.

Students will also participate in focus groups in which they will discuss the effects of the concept map strategy on learning and interest of the members of the class. The focus groups will consist of five randomly selected members.

Pre- and post-tests will be given to the students using the *Scott Foresman Unit B Earth Science* assessment.

If you chose not to allow your student to participate in the study, they will still be required to complete the concept mapping, Earth Science unit assignments, and pre/post-tests. However, their data will not be included in the study.

Voluntary participation: You should allow your child to take part in this study only because you want to. There is no penalty for you or your child for not taking part, and neither you nor your child will lose any benefits. You have the right to stop your child from taking part at any time. Just tell the researcher or a member of the research team that you want your child to stop. You will be told if any new information is learned which may affect your willingness to allow your child to continue taking part in this study.

Location: The research will take place in the fifth grade classroom

Time required: Each session will be conducted during the normal science time clock of the classroom schedule. This study will take place during the first and second nine weeks of the 2008-2009 school year.

Audio taping:

Your child will be audio taped during this study. If you do not want your child to be audio taped, he or she may not be able to be in the study. Discuss this with the researcher or a research team member. Audio taping of the students will take place in focus groups. These focus groups will take place during one of the scheduled special area classes. Students who are not in a particular focus group or not participating in the study will not be in the classroom during the taping. If your child is audio taped, the tape will be kept in a locked, safe place until what your child says has been written down. Once it is written down, the tape will be erased or destroyed.

Risks:

There may be minimal risks for taking part in this study such as embarrassment, humiliation, loss of confidence, emotional trauma, etc. due to how a student might feel or react to whole group discussions or focus group questions. Breach of confidentiality is also a risk. The student's names will be deleted on the data, and no actual names will be used within the research itself.

Your child does not have to answer every question or complete every task. Neither you nor your child will lose any benefits if your child skips questions or tasks.

Benefits: There are no expected benefits to your child for taking part in this study.

Compensation or payment:

There is no compensation, payment or extra credit for your child's part in this study.

Confidentiality: Your child's identity will be kept confidential The researcher will make every effort to prevent anyone who is not on the research team from knowing that your child gave us information, or what that information is. For example, your child's name will be kept separate from the information he or she gives, and these two things will be stored in different places.

Your child's information will be assigned a code number. The list connecting your child's name to this number will be kept in a password protected computer. When the study is done and the data have been analyzed, the list will be destroyed. Your child's information will be combined with information from other children who took part in this study. When the researcher writes about this study to share what was learned with other researchers, she will write about this combined information. Your child's name will not be used in any report, so people will not know how he or she answered or what he or she did.

There are times when the researcher may have to show your child's information to other people. For example, the law may require the researcher to show your child's information to a court or to tell authorities if the researcher believes a child abuse situation exists or your child is in danger to himself, herself or to someone else. Also, the researcher may have to show your child's identity to people who check to be sure the research was done right. These may be people from the University of Central Florida or state, federal or local agencies or others who pay to have the research done.

Study contact for questions about the study or to report a problem: Patricia Goss, Graduate Student, Lockheed Martin/UCF Academy, College of Education, (407) 858-3150 or Dr. Enrique Ortiz, Faculty Supervisor, Department of Mathematics Education at (407) 823-5222 or by email at Ortiz@mail.ucf.edu.

IRB contact about you and your child's rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901.

How to return this consent form to the researcher: Please sign and return this consent form in the enclosed envelope. A second copy is provided for your records. By signing this letter, you give me permission to report your responses anonymously in the final manuscript to be submitted to my faculty supervisor as part of my course work.

☐ I have read the procedure described above

☐ I voluntarily agree for my child to take part in the research

☐ I am at least 18 years of age

☐ I am an emancipated minor per Florida state law

☐ I agree to have my child audio taped

☐ I agree to have my child video taped

☐ I do not agree to have my child participate in this study

_____	_____	_____
Signature of parent	Printed name of parent	Date
_____	_____	_____
Signature of parent	Printed name of parent	Date

_____

Printed name of child

_____	_____
Principal Investigator	Date

APPENDIX E: STUDENT ASSENT

I am doing a project on fifth graders using graphic organizers to summarize what you learn during science. I am interested in how students like you learn and grow in their use of these maps. I am completing this research as part of my classes at the University of Central Florida.

Prior to the science unit, you will be taking a pre-test to help to see what you already know about what we will be studying. During the science unit, you will be making concept maps in your science notebooks. At the end of the unit, you will again take a test to see how much you have learned. Also, at the end of the science unit, I may talk with you in a small group and use an audio tape to ask questions like how you like using and changing concept mapping including how they helped you learn or problems which you came across when using them. Also, we will discuss if you liked working with computers and/or individually, in pairs or in groups if you had the chance. Only Dr. Ortiz, my professor at UCF, and I will hear the audio tapes. I will destroy the tapes at the end of the study. I will not use your real names so that nobody will know it was you in my study. It will not affect your grade if you decide you don't want to do this. You can stop taking part in the study at any time. If you don't want to be audio taped, you cannot be in the study. You will not be paid for doing this. Would you like to take part in this research project?

____ I want to take part in Ms. Goss' research project.

____ **I** do not want to take part in Ms. Goss' research project.

_____ _____

Student's Signature Date

_____

Student's Printed Name

APPENDIX F: PEARSON APPROVAL LETTER PRE- AND POST-TESTS

PEARSON

PEARSON SCHOOL
RIGHTS & PERMISSIONS
ONE LAKE STREET
UPPER SADDLE RIVER, NJ 07458
TEL: (201) 236-6716
FAX (201) 236-3625

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Contract No. 139723

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Bind date of dissertation:	8/1/08
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Location where print dissertation will be stored:	University of Central Florida
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PATRICIA GOSS
PALMETO ELEMENTARY
2015 Dutkin Avenue
Orlando, FL 32839

August 12, 2008

Grace Mensah
Assistant Rights Administrator
(201) 236-6716

APPENDIX G: PERMISSION TO USE RUBRIC FOR GRAPHIC ORGANIZERS-INSPIRATION DIAGRAMS/CONCEPT MAPS

RE: Rubric for Graphic Organizers - Inspiration Diagrams/Concept Maps

Franker, Karen [frankerk@uwstout.edu]

Sent: Friday, April 03, 2009 11:29 AM

To: Goss, Patricia

Patricia,

Thanks for your interest in my Graphic Organizers rubric.
You have my permission to use the rubric if the credit line reads as below and includes the URL to the original website:

"Adapted and used with permission from Karen Franker
Original at: http://www.uwstout.edu/soe/profdev/inspirationrubric.html
<http://www.uwstout.edu/soe/profdev/inspirationrubric.html> "

Please add that information if you are placing the rubric on a web page, in a PowerPoint or other presentation, as well as in documents, booklets or handouts.

Good luck with your thesis. It sounds like a very focused and interesting topic!

Karen Franker
frankerk@uwstout.edu <mailto:frankerk@uwstout.edu>
Instructor & Course Developer
Inspiration & Kidspiration: K-12 Strategies to Build Study Skills and Comprehension
http://www.uwstout.edu/soe/profdev/conceptmap/
<http://www.uwstout.edu/soe/profdev/conceptmap/>
Online Professional Development
School of Education
University of Wisconsin-Stout
Wisconsin's Polytechnic University

Life isn't about waiting for the storm to pass...
It's about learning to dance in the rain.

From: Goss, Patricia [mailto:patricia.goss@ocps.net]
Sent: Thu 4/2/2009 7:04 PM
To: Franker, Karen
Subject: Rubric for Graphic Organizers - Inspiration Diagrams/Concept Maps

Dear Ms. Frank

I am a graduate student at the University of Central Florida. I am conducting my thesis on THE INFLUENCE OF GRAPHIC ORGANIZERS ON STUDENTS' ABILITY TO SUMMARIZE AND COMPREHEND SCIENCE CONTENT REGARDING THE EARTH'S CHANGING SURFACE. I am requesting your permission to use the rubric which you had posted on the internet with a copyright dated 2004-2007. I am attaching the rubric for your convenience.
I appreciate your assistance and response.

Sincerely,
Patti

APPENDIX H: UNIVERSITY OF MINNESOTA PERMISSION LETTER

Goss, Patricia

From: Kimerly J Wilcox [wilco001@umn.edu]
Sent: Tuesday, July 15, 2008 10:37 AM
To: Goss, Patricia
Subject: Rubric permission

Follow Up Flag: Follow up
Flag Status: Red

Hi, Patricia - you are welcome to use the rubric as is or adapt it to suit your (noncommercial, educational) purpose. Should you publish or present anything involving the rubric, we would appreciate appropriate citation, and the inclusion of the copyright language below:

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Good luck with your research!

Kim Wilcox

Goss, Patricia wrote:
> I am a graduate student at the University of Central Florida. I am conducting my Master's thesis research on the affect concept mapping will have on fifth grade earth science summarization and comprehension.
I am requesting permission to use the rubric which you have created. For your convenience, I have attached the example which had been posted on the internet. I appreciate your assistance. > Sincerely, > > Patricia Goss > NBCT, McGen '06 > Palmetto Elementary > 407-858-3159 x2249

--
Kimerly J. Wilcox, Ph.D.
Senior Instructional Multimedia Consultant Office of Information Technology, Digital Media Center University of Minnesota Room 212 Walter Library
117 Pleasant Street SE
Minneapolis, MN 55455
612-624-3528 fax 612-625-9302
Visit the DMC Web site: http://dmc.umn.edu

APPENDIX I: UNNIVERSITY OF MINNESOTA- CONCEPT MAPPING RUBRIC

UNIVERSITY OF MINNESOTA

Concept Map [Assessment Rubric]

criteria	Excellent	Good	Adequate	Marginal	no credit; is unacceptable to review
structure	non-linear structure that provides a very complete picture of your ideas	non-linear structure that provides a complete picture of your ideas	non-linear structure that provides a picture of your ideas	non-linear structure that shows some relationships between ideas	inappropriate structure
relationships	relative importance of ideas is indicated and both simple and complex relationships are very effectively mapped	relative importance of ideas is indicated and relationships are very effectively mapped	relative importance of ideas is indicated relationships are mapped	importance is evident but not very distinctive; relations are somewhat clear but lacking	no differentiation between ideas; no evidence of meaningful relationships
exploratory	map shows complex thinking about the meaningful relationships between ideas, themes, and the framework	map shows effective thinking about the meaningful relationships between ideas, themes, and the framework	map shows definite thinking about relationships between ideas, themes, and the framework	map shows some thinking about relationships between ideas, themes, and the framework	thinking process is not clear
communication	information is presented clearly and allows for a high level of understanding	information is presented clearly and allows for a good level of understanding	information is presented clearly and allows for a basic level of understanding	information is presented and some understanding can be gained	information is not clear, very difficult to understand

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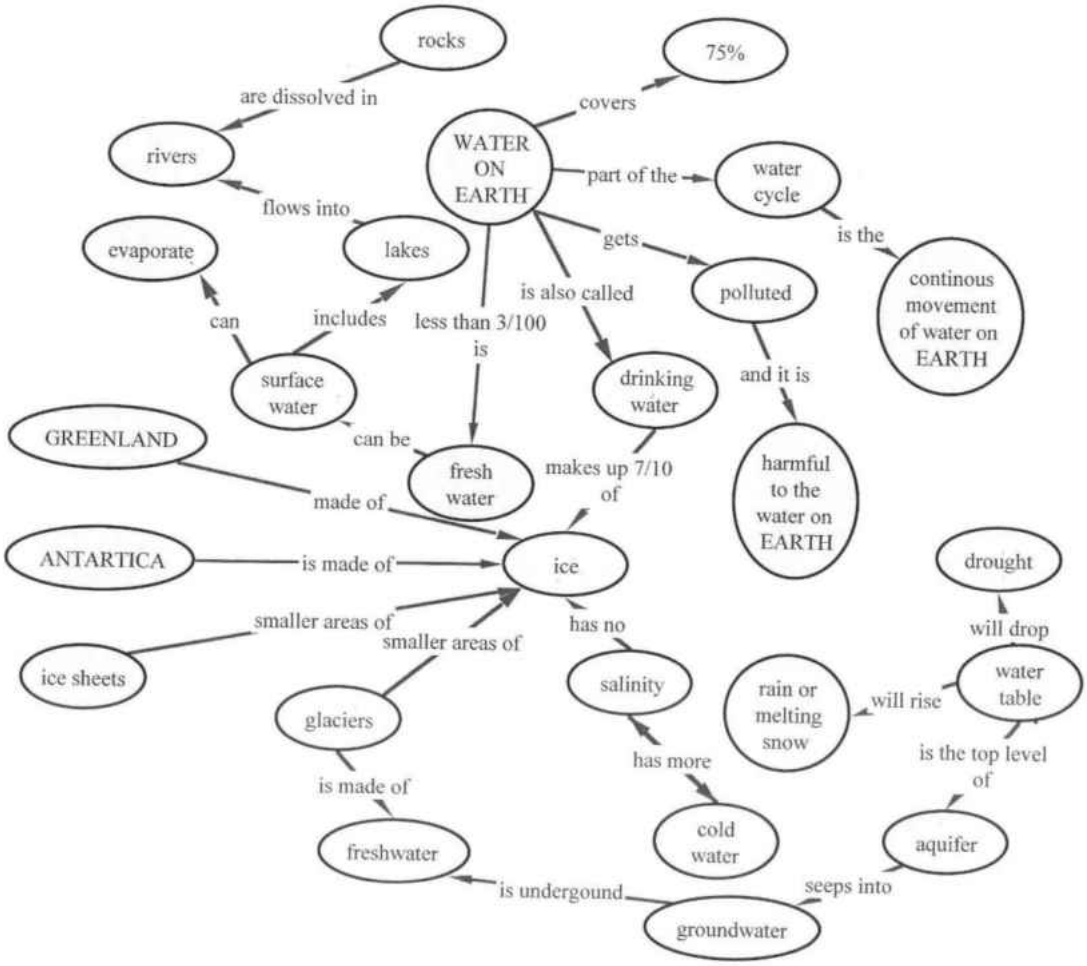
APPENDIX J: INSPIRATION CONCEPT MAPPING RUBRIC

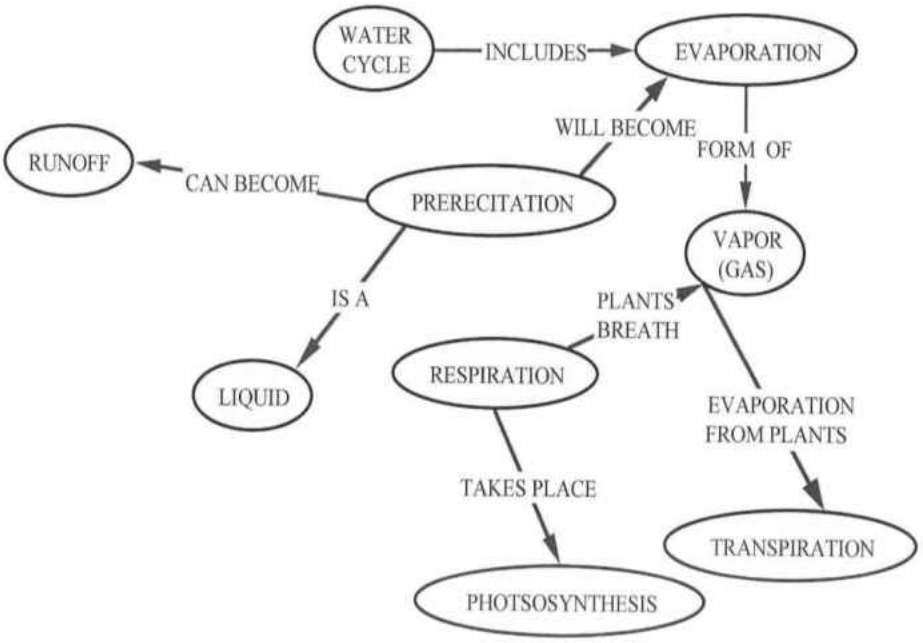
Rubric for Graphic Organizers - Inspiration Diagrams/Concept Maps

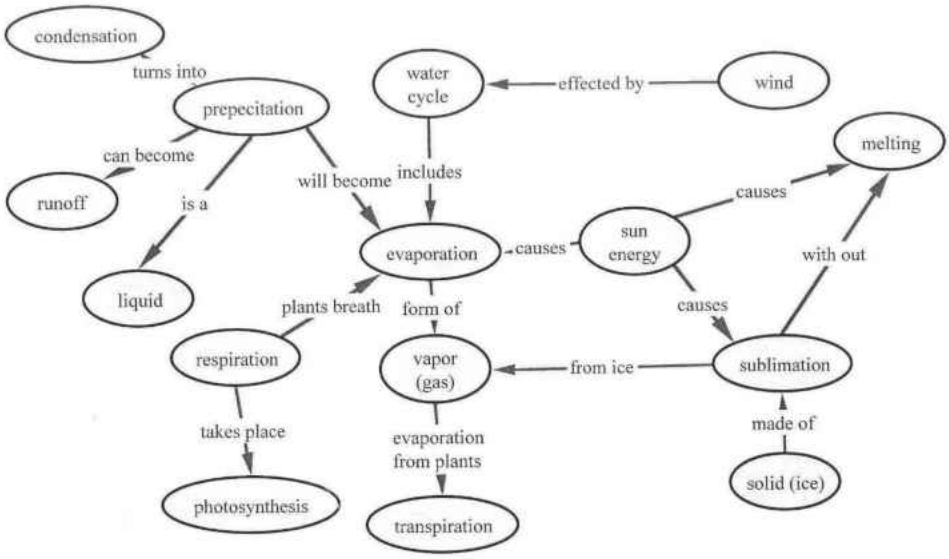
CATEGORY	Exemplary	Proficient	Developing
Arrangement of Concepts	Main concept easily identified; subconcepts branch appropriately from main idea	Main concept easily identified; most subconcepts branch from main idea.	Main concept not clearly identified; subconcepts don't consistently branch from main idea.
Links and Linking Lines	Linking lines connect related terms/point in correct direction; linking words accurately describe relationship between concepts; hyperlinks effectively used	Most linking lines connect properly; most linking words accurately describe the relationship between concepts; most hyperlinks effectively used.	Linking lines not always pointing in correct direction; linking words don't clarify relationships between concepts; hyperlinks don't function or fail to enhance the topic.
Graphics	Graphics used appropriately; greatly enhance the topic and aid in comprehension; are clear, crisp and well situated on the page.	Graphics used appropriately most of the time; most graphics selected enhance the topic, are of good quality, and are situated in logical places on the page.	Graphics used inappropriately and excessively; graphics poorly selected and don't enhance the topic; some graphics are blurry and ill-placed.
Content	Reflects essential information; is logically arranged; concepts succinctly presented; no misspellings or grammatical errors	Reflects most of the essential information; is generally logically arranged; concepts presented without too many excess words; fewer than three misspellings or grammatical errors.	Contains extraneous information; is not logically arranged; contains numerous spelling and grammatical errors.
Text	Easy to read/ appropriately sized; no more than three different fonts; amount of text is appropriate for intended audience; boldface used for emphasis.	Most text is easy to read; uses no more than four different fonts; amount of text generally fits intended audience.	Font too small to read easily; more than four different fonts used; text amount is excessive for intended audience.
Design	Clean design; high visual appeal; four or fewer symbol shapes; fits page without a lot of scrolling; color used effectively for emphasis.	Design is fairly clean, with a few exceptions; diagram has visual appeal; four or fewer symbol shapes; fits page well; uses color effectively most of time.	Cluttered design; low in visual appeal; requires a lot of scrolling to view entire diagram; choice of colors lacks visual appeal and impedes comprehension.

Adapted and used with permission from Karen Franker
Original at: http://www.uwstout.edu/soe/profdev/inspirationrubric.html

APPENDIX K: ELECTRONIC CONCEPT MAPPING

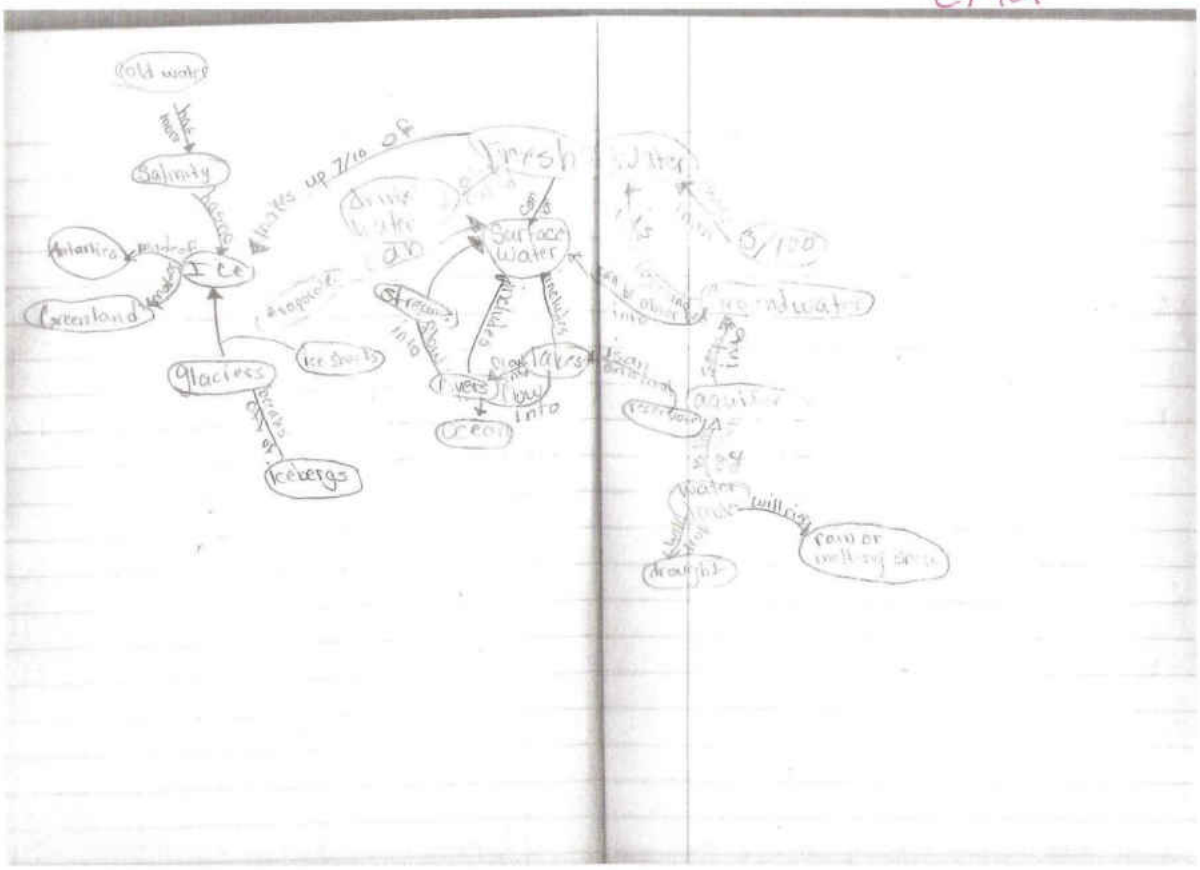

rocks
are dissolved in
rivers
flows into
lakes
evaporate
can
includes
surface water
can be
fresh water
WATER ON EARTH
covers
75%
part of the
water cycle
is the
continous movement of water on EARTH
gets
polluted
and it is
harmful to the water on EARTH
less than 3/100 is
is also called
drinking water
makes up 7/10 of
GREENLAND
made of
ANTARTICA
is made of
ice
smaller areas of
ice sheets
smaller areas of
glaciers
has no
salinity
has more
cold water
is made of
freshwater
is undergound
groundwater
seeps into
aquifer
is the top level of
water table
will rise
rain or melting snow
drought
will drop

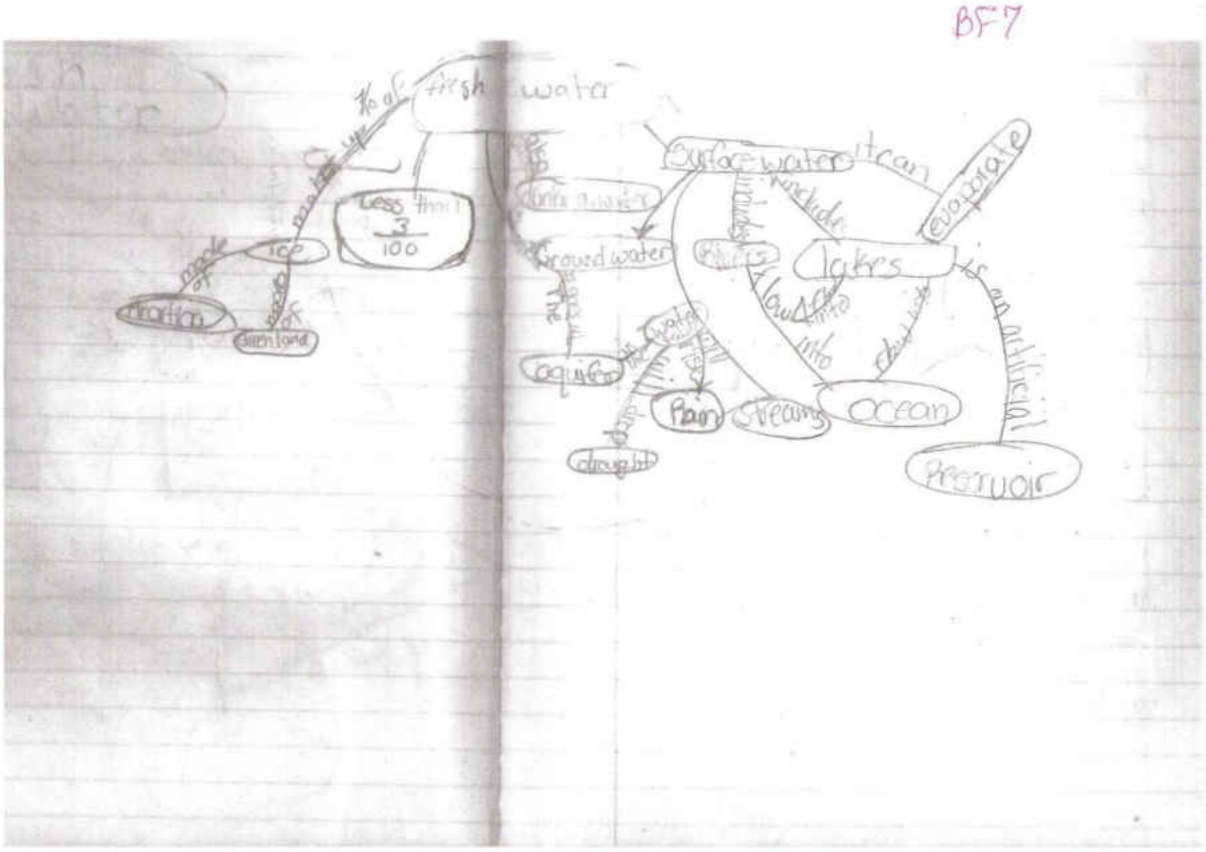

WATER CYCLE
INCLUDES
EVAPORATION
WILL BECOME
FORM OF
RUNOFF
CAN BECOME
PRERECITATION
VAPOR (GAS)
IS A
PLANTS BREATH
LIQUID
RESPIRATION
EVAPORATION FROM PLANTS
TAKES PLACE
TRANSPIRATION
PHOTSOSYNTHESIS


condensation
turns into
prepecitation
water cycle
effected by
wind
can become
runoff
is a
liquid
will become
includes
evaporation
causes
sun energy
causes
melting
with out
causes
plants breath
form of
respiration
vapor (gas)
from ice
sublimation
takes place
photosynthesis
evaporation from plants
transpiration
made of
solid (ice)

APPENDIX L: PAPER-PENCIL CONCEPT MAPPING IN NOTEBOOKS

CF12


Cold water
Salinity
makes up 7/10 of
Antartica
Ice
Greenland
Glaciers
Icebergs
Surface water
Streams
Rivers
Lakes
Ocean
into
Groundwater
aquifer
water
drought
rain or melting snow


BF7
fresh water
Less than
3
100
ice
Surface water
it can
evaporate
lakes
ocean
Reservoir
Rain
Streams
aquifer
drought

APPENDIX M: PRE- AND POST-TEST EXTENDED RESPONSES

The first Picture is ~~X~~umulus, Cause the first picture the cloud is high in the sky and kind of darky. The third picture is ~~S~~tratus and low. The second Picture is Cumulus and half way in the sky. Also the second picture is kind of fogy.

3. Look at the pictures below:

Identify each type of clouds shown above as *cirrus, cumulus or stratus*. Also **describe** each type of cloud and identify at what **altitude** each cloud generally forms.

x4 Cirrus is the second Picture, and the altitude is 6,000 m above, and it is wispy, thin and white. stratus is the first picture, and the altitude is less than 2,000 m above, and it look dark and little sunlight. cumulus is the third picture, and the altitude is between 2,000 m and 7,000 m above, and it have small fluffy balls.

The first picture is the cirrus cloud and the clouds look a little bit low and it looks like the clouds are below the tree and they are going to hit the ground. It most likely looks like that but it's not going to happen. And it is a light cloud.
The second one is ~~cirrus~~ and it looks like the altitude of the clouds are really high in the air and higher than high trees and other high things.
The third one is ~~stratus~~ it looks in the middle and it's really puffy and it looks like as tall as a big tree. They also look like puffy balls.

Identify each type of clouds shown above as *cirrus, cumulus or stratus*. Also **describe** each type of cloud and identify at what **altitude** each cloud generally forms.

x4

The first picture is cirrus and cirrus has a high altitude and they look like thin and wispy clouds in the air. The second picture is cumuls clouds and they are mid altitude and they look like big puffy balls in the sky. And the third cloud is stratus and it is at low altitude and they look like anvil clouds and they look pretty dark in the sky and they are dangerous sometimes so they are not good clouds in the sky.

The first one is a cirrus cloud and the altitude is low. The second one is cumulus and the altitude is high also a cumulus is a rain cloud. The third one is stratus is lik in the middle and is very puffy.

Identify each type of clouds shown above as *cirrus, cumulus or stratus*. Also **describe** each type of cloud and identify at what **altitude** each cloud generally forms.

+35

The first picture is cirrus because they are thin, wispy, and white, the altitude for cirrus are really form at 6,000m above the ground. The second picture is cumulus because they look like puffy balls, the altitude for cumulus is between 2,000m and 7,000m above the ground. The third picture is stratus because they are dark and they are dark because the sun is reflecting off them, the altitude is 2,000m above the ground.

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