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Assessing effectiveness of concept map as instructional tool in high school biology

Ritchie Adlaon

Louisiana State University and Agricultural and Mechanical College

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ASSESSING EFFECTIVENESS OF CONCEPT MAP AS INSTRUCTIONAL TOOL IN HIGH SCHOOL
BIOLOGY

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
In partial fulfillment of the
requirements for the degree of
Master of Natural Sciences

in

The Interdepartmental Program in Natural Sciences

by

Ritchie Bagcat Adlaon
B.S., La Salle University, 2002
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ABSTRACT

This thesis emphasizes on an alternate instructional tool called “Concept Map”. The goal of this study was to determine the effectiveness of using concept maps in improving the science achievement of 10th-grade students and compare it with a traditional approach for a Biology unit. Furthermore, the interaction of the student’s concept mapping ability and their learning gains was investigated. Both the control and the experimental groups were required to take a pre test before instruction and a posttest at the end of three weeks. The test consisting of 31 questions was used to assess learning gains on a Biology Unit about Balance in Nature. Student-constructed maps were scored using Novak’s scoring scheme. The first finding of the study was that concept map – exposed students did not perform much better than the same level students in the traditional group. The difference in the learning gains between the experimental and the control group in their unit test, though statistically significant, did not seem to be solely due to concept mapping. The second finding indicated that total scores in concept maps did not strongly predict student achievement in Science. Moreover, results showed that the levels of concept mapping ability were not associated with the concept- mapping students’ learning gains. Nevertheless, the study suggests that, when carefully integrated into the normal classroom procedure and when other contributing factors such as student motivation and preparedness, reading ability levels, time and classroom environment are considered, concept mapping has a potential to be an effective instructional strategy.

INTRODUCTION

Background of the Study. Biology is difficult to teach and to learn because it consists of unfamiliar concepts involving complex relations. The highly conceptual nature of Biology makes it particularly difficult for students and the strategies used in the classroom have not sufficiently eased the learning process. Edusoft data from last year was analyzed during collaborative planning and it was found out that the students struggled in making connections between and among concepts learned in units covered throughout the trimesters. Many students showed difficulty identifying the important concepts in a text, lecture or other form of presentation. Part of the problem stemmed from a pattern of passive learning that simply requires memorization of information, and no evaluation of the information is required. As a result, students failed to construct powerful concept and propositional frameworks, leading them to see learning as a blur of myriad facts, dates, names, equations, or procedural rules to be memorized. For these students, the subject matter is a cacophony of information to memorize, and they found it boring. Rote learning contributes very little at best to knowledge structures, and therefore cannot promote reflective thinking or novel problem solving. If students can see a clear organized picture of a broad unit covering various concepts, then they would build a deeper understanding and appreciation of these concepts. Concept Mapping would be an excellent strategy to enable the students to think about connections between science terms being learned, organize their thoughts, visualize relationships between key concepts in a systematic way and reflect on their understanding. If concept maps are used in instruction and students are required to construct concept maps as they are learning, unsuccessful students

can become successful in making sense out of science and any other discipline. Concept map stresses meaningful learning, and appears to be ideally suited to address biology content.

Concepts play a crucial role in guiding the production of knowledge and in meaningful (as distinct from rote) learning (Novak, 1979). Concepts are defined as regularities in events or objects designated by a sign or symbol. A concept is something conceived in the mind. It can be an idea, a general or abstract thought, or notion. Humans create concepts when they recognize some new regularity in events or objects and assign labels or signs to signify this regularity. Almost all words in English are concepts “signs”, and education is the process by which each of us comes to know these. Because concept meanings are not static; the understanding of the meaning of a given concept keeps changing over time at least in some small way (Novak, 1981). For instance, the meaning of one’s concepts of nucleotide, gene, love, peace, and pleasure continue to change. Moreover, each of us has had a unique sequence of experiences that led to acquiring set of concepts; but we share a common core of meaning for each concept that enables us to communicate. According to Novak, concepts grow and change in meaning as they become linked to other concepts in what psychologists call “propositions”. For example, “the sky is blue”. This is a proposition that gives meaning to a young child’s developing concept of sky and blue. However, this proposition takes on a significantly different meaning when the child learns later that the sky is air and air is colorless, but that the mass of air above earth scatters component colors of sunlight differentially giving the appearance that the sky is blue. This is new learning and it is primarily the extension of meanings of concepts that the student

has or the acquisition of new concept meaning, and each learner must construct these meanings from the framework of different concepts he/she holds. This can be achieved through the process of meaningful learning (Novak, 1981).

Teachers can facilitate the acquisition of shared meaning with their students regarding the concepts of Biology to produce meaningful learning by making explicit the framework of concepts that comprise our contemporary understanding of the regularities manifested by living things (Novak, 1981). It is best to begin with the most general, most inclusive concepts of discipline, so that these may later serve to anchor or subsume new concepts and new knowledge. The reason for this is that meaningful learning (as distinct from rote learning) requires that new knowledge to be learned is anchored or assimilated into concepts we already know. Novak and Gowin (1984) have developed a theory of instruction that is based on Ausubel's meaningful learning principles that incorporates "concept maps" to represent meaningful relationships between concepts and proposition. According to them "a cognitive map is a kind of visual road map showing some of the pathways we may take to connect meanings of concepts." Novak (1991) states that concept maps serve to clarify links between new and old knowledge and force the learner to externalize those links.

Concept Maps. Concept maps are two-dimensional graphical representations of one's knowledge of a domain (Novak & Gowin, 1984). The idea of concept mapping, as previously mentioned, is based on Ausubel's assimilation theory of cognitive learning (Ausubel et al., 1978). The underlying basis of the theory is that meaningful (as opposed to rote) human

learning occurs when new knowledge is consciously and purposively linked to an existing framework of prior knowledge. Furthermore, he mentioned that the mind organizes information in a hierarchical top-down fashion. Unlike meaningful learning, in rote (or memorized) learning, new concepts are added to the learner's framework in an arbitrary and verbatim way, producing a weak and unstable structure that quickly degenerates. The result of meaningful learning is a change in the way individuals experience the world; a conceptual change.

In a concept map, concepts are represented by nodes, usually enclosed in circles or boxes, and relationships between concepts are indicated by connecting lines that link them together. The label for most concepts is a single word, although sometimes symbols such as + or % are used. The core element of a concept map is a **proposition**, which consists of two or more concepts connected by a labeled link. *Propositions* are meaningful statements about some object or event. Figure 1 presents a Concept Map pertaining to Concept Maps. In a concept map, propositions are connected to each other to form a hierarchical and branching structure, with the most inclusive, most general concepts at the top of the map and the more specific, less general concepts arranged below, that represents the organization of knowledge in long-term memory.

The Concept Map may pertain to some situation or event that we are trying to understand through the organization of relevant knowledge, thus providing the context for the Concept Map.

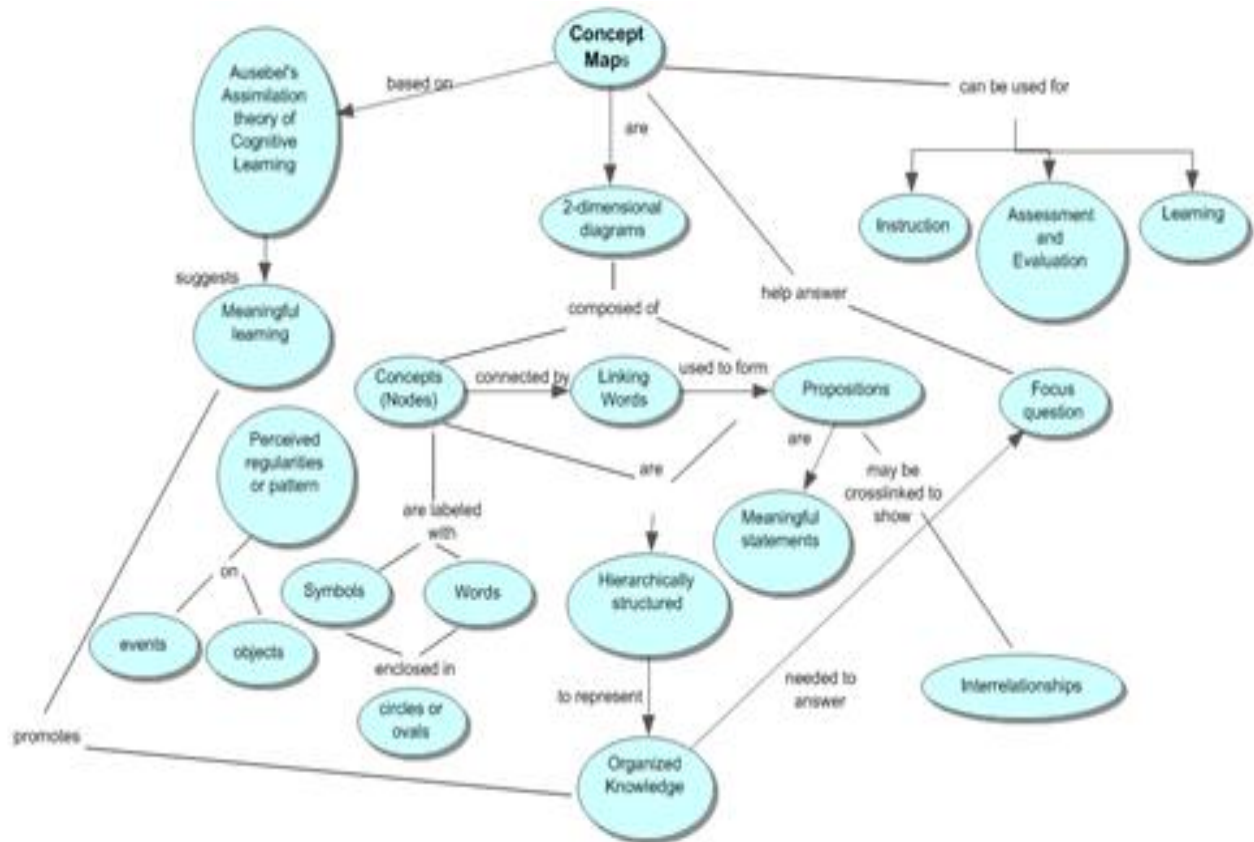


Figure 1. A Concept Map that describes Concept Maps

Thus, Concept Maps are often constructed with reference to some particular question we seek to answer, which is called a *focus question*. Another important and characteristic of Concept Maps is the inclusion of “*crosslinks*.” These make explicit relationships between or among concepts in different regions or domains within the Concept Map. Cross-links show how a concept in one domain of knowledge represented on the map is related to a concept in another domain shown on the map. In the creation of new knowledge, cross-links often represent creative leaps on the part of the knowledge producer. An example in Figure 2 is the proposition “Energy flows from Primary Producers to consumers in an Ecosystem” which is cross-linked

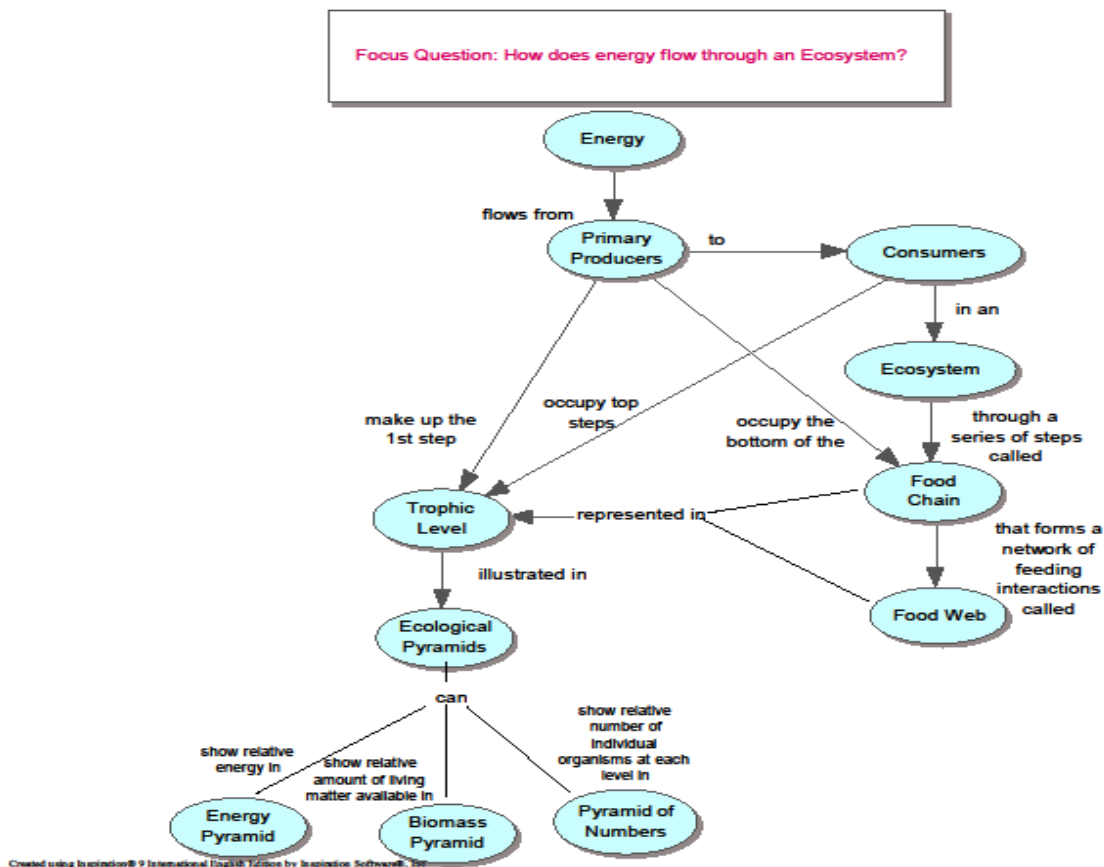


Figure 2. Example of a Concept Map

to the proposition “Primary producers occupy the bottom of the Food Chain.” A final aspect of the structure of Concept Maps is the inclusion of specific examples of events or objects. These can help to clarify the meaning of a given concept. Normally these are not included in ovals or boxes, since they are specific events or objects and do not represent concepts.

Concept maps have been used for over 25 years in research and classroom practice to reveal and assess the structure and complexity of knowledge held by students in the sciences and other disciplines (Novak and Gowin, 1984).

Uses of Concept Maps. According to Collette and Chiappetta (1989), concept learning is an active process that is fundamental to understanding science concepts, principles, rules, hypotheses, and theories. It is the responsibility of the teacher to organize learning experiences in a way that will facilitate student learning. As students are introduced to new science concepts, they embark on a cognitive process of constructing meaning and making sense by consciously or subconsciously integrating these new ideas with their existing knowledge. This is best facilitated by Concept Maps. In the view of Safdar (2010), "If teachers learn how to construct concept maps and use them for planning and assessing lessons, they will be able to teach students better how to make concept maps to organize their thoughts and ideas." Science teacher can use concept maps to determine the nature of students' existing ideas, and make evident the key concepts to be learned and suggest linkages between the new information to be learned and what the student already knows. To sum up, Concept maps can be used for; (1) knowledge construction: how students construct their knowledge (2) learning (3) assessment: used as a pre-post assessment of what students' prior knowledge and what they have learned (4) evaluation (to evaluate how students organize their knowledge) (5) record of understanding and misconceptions (6) and Instruction. (Mintzes, et al.1997 & Mintzes, et al.1998).

Concept maps are useful tools to help students learn about their knowledge structure and the process of knowledge construction. In this way, concept maps also help the student learn, how to learn (meta-learning). Concept mapping requires the learner to operate at all six levels; knowledge, comprehension, application, analysis, evaluation, and creation (synthesis) of

Bloom's educational objectives of cognitive domain. What conceptual understandings students achieve in a new learning activity is highly dependent on what they already know. Concept Maps have been used to examine students' prior knowledge, to track a student's progression of knowledge throughout a course, to compare students at different levels of knowledge and so forth (Hoz, Bowman & Kozminsky, 2001; Pearsall, Skipper & Mintzes, 1997).

Teachers and students are often able to more clearly identify misconceptions within the context of a Concept Map. According to Novak and Gowin, (1984) "concept maps can make clear to the student (and the instructor for curriculum development purposes) how small the number of truly important concepts they have to learn." They further say that concept maps externalize a person's knowledge structure and can serve to point out any conceptual misconceptions the person may have concerning the knowledge structure. This explicit evaluation of knowledge and subsequent recognition of misconceptions allows for finely targeted remediation. Since concept maps are visual images therefore they tend to be more easily remembered than text. Concept Maps have also been used to identify specific misconceptions in knowledge (e.g., Gonzalez, 1997; Regis & Albertazzi, 1996), and to identify alternative educational approaches to address misconceptions (Kinchin, 1998).

Another very powerful use of Concept Maps is as an evaluation tool, thus encouraging students to use meaningful-mode learning patterns (Novak & Gowin, 1984; Novak, 1998; Mintzes, Wandersee & Novak, 2000). Concept Maps have also been used in instruction such as advance organizers.

Concept Maps as “Advance Organizers.” In Ausubel’s (1960) view, to learn meaningfully, students must relate new knowledge (concepts, proposition, rule, principles) to what they already know. Ausubel believes that information /scientific concept is learned more easily if it is organized and sequenced logically. This gives rise to the term advance organizer. He proposes the notion of an advance organizer as a way to help students link their ideas with new material or concepts. Advance organizers are concepts given to students prior to the material actually to be learned to provide a stable cognitive structure directing attention to what is important in the coming material; highlighting relationships among ideas that will be presented; and reminding the students of relevant information already in memory.

These organizers are introduced in advance of learning itself, and are also presented at a higher level of abstraction, generality, and inclusiveness. Ausubel (1960) emphasizes that advance organizers are different from overviews and summaries which simply emphasize key ideas and are presented at the same level of abstraction and generality as the rest of the material.

Advance organizer Concept Maps might be constructed by teachers or other experts. The Concept Map advance organizers can then be used in various ways as part of the classroom experience. They might be presented at the beginning of a textbook chapter or other instructional unit, or used as a guide for a lecture that is presented in a class. They might be used to present an overview of multimedia, with links to instructional materials associated with different topics. In theory, advance organizers are most effective if they make explicit the relationship among learned concepts that learners already know, thus providing a structure into which the new concepts can be integrated.

Concept Mapping. Concept Maps created by students can be used in several ways to facilitate meaningful learning. Novak & Gowin (1984, Chapter 2) pointed out that Concept Maps are a kind of schematic summary of what students know. Concept maps provide a unique graphical view of how students organize, connect, and synthesize information. Novak and Gowin noted that the act of mapping is a creative activity, in which the learner must exert effort to clarify meanings, by identifying important concepts, relationships, and structure within a specified domain of knowledge. The activity fosters reflection on one's knowledge and understanding, providing a kind of feedback that helps students monitor their learning and, perhaps with assistance of teachers or peers, focus attention on learning needs.

Lambiotte and Dancereau (1991) state that the students that viewed or made concept maps would have a broader knowledge base and therefore be more able to solve problems compared to those students that learned by rote memorization. They also found that the students with low prior knowledge learned better with concept mapping than the other. Cognitive structure and concept mapping are highly personal as each individual's knowledge is unique. Hence, concept maps are idiosyncratic. There is no one "correct" concept map. However, this does not mean that all concept maps are correct: it is possible to identify errors, such as the absence essential concepts or inappropriate relationship between concepts.

Although concept mapping fosters learning and understanding, beginners are easily overwhelmed by the demands of mapping. In order to cope with beginners' difficulties in using concept maps for learning from texts, a few training studies have been read by the researcher. For example, Chang et al. (2002) compared students' learning outcomes after either correcting

worked-out concept maps with errors included, constructing their own concept maps after a training session, or constructing concept maps without training. The students learning by correcting concept maps achieved the best results in a learning test on text comprehension. Students learning by constructing a map without training performed worst. It is, however, noteworthy that even after training students could still not perform as well as the students who learned by correcting concept maps. Similar advantages of studying worked-out maps in comparison to map construction were reported by Hauser et al. (2006). Ebenezer and Connor (1998), produced a list to construct a concept map, which includes the following; choosing a passage from a science textbook, underlining the main concepts in this passage, listing all the concepts on paper, writing or printing the concepts on small cards or stickers so that the concepts can be moved around, placing the most general or all-inclusive concept on the top of the paper, arranging the concepts from top to bottom (from most general at the top to most specific at the bottom) so that a hierarchy is indicated, (in constructing this hierarchy) placing concepts next to each other horizontally if they are considered to have equal importance or value, relating concepts by positioning linking verbs and connecting words on directional arrows, supporting the concepts with examples, having members of a cooperative group critically analyze the concept map to improve on and further extend your ideas.

The teachers in this study applied this method in training the students on concept map construction. The students were allowed to correct concept maps as part of the guided practice activities before they turn in their own concept maps. They were given the nodes and the focus questions for the unit lesson that they had to make concept maps for.

Related Studies. More than two hundred studies in science education have employed concept mapping in one form or another (Novak, 1998; Mintzes, Wandersee and Novak, 1998). Several of these investigations have examined the reliability and validity of the technique as a way of representing knowledge in scientific disciplines (Markham, Mintzes and Jones, 1994; Ruiz-Primo and Shavelson, 1994). For example, in one study (Markham, et al., 1994) it was shown that the conceptual frameworks revealed by concept maps reflect essentially the same structure as that seen in much more time-consuming techniques, such as interviews and picture sorting tasks.

The effectiveness of concept mapping has also been compared to several other learning techniques. For example, learners who used concept mapping as a learning strategy performed better than learners who used underlining (Amer 1994), note-taking (Reader and Hammond 1994), or outlining (Robinson and Kiewra 1995). There has also been some research on worked-out concept maps. These are maps that have been constructed by a teacher or an expert and provided to students as a learning tool. In particular, students with low verbal abilities have been shown to benefit from studying such worked-out maps (O'Donnell et al. 2002; Rewey et al. 1998). In addition, learners with low prior knowledge of the content domain also profit in particular from learning from worked-out concept maps (Lambiotte and Dancereau 1991).

The following paragraphs report past studies designed to improve science achievement by using concept maps for knowledge construction, learning and assessment.

The goal of a study by Bascones & Novak (1985) was to test the effect of Concept Mapping on students' problem solving in physics. The teaching process used in this study was based on Ausubel's (1968) theory of meaningful learning. The course was a required physics course

taught throughout Venezuela. The design involved two groups. The treatment group had general-to-specific orderings of content and routine Concept Mapping exercises, while the control group had traditional instructional methods. The results showed large effects in favor of the treatment group on every test administration and at all ability levels. The results of this study clearly present a strong statement for the benefit of the instruction that was based on Ausubel's (1968) learning theory and some sort of utilization of Concept Maps.

Richard Schmid of Concordia University assessed the concept mapping as an instructional strategy to use with high school students in learning Biology concepts. The concept mapping technique was compared with an established curriculum approach and tested in an interaction with learners of varying ability. The sample was drawn from students who had chosen Biology as an optional course at Montreal high school in Canada. The procedure involved administering SDRT to rank the students according to reading ability. The 1st instructional strategy was a traditional approach where the classroom teacher covered the Nervous system content and where the main method was lecturing, using teacher- and professionally prepared materials. The 2nd approach was concept mapping technique. The results also showed that there was significant differences between the high-reading-ability experimental and control groups and between the low- ability control group and the high ability control group. Individual comparisons of means indicated that the low-reading-ability concept mapping students performed significantly better statistically than did the low-ability control group. The students with high and medium ability showed no differences. It showed that concept mapping facilitated low ability learners' performance, but only higher level, relational knowledge.

The usefulness of the strategy was discussed in terms of its ability to individualize and raise the quality of learning with little extra effort or resource costs to the instructional system.

The effectiveness of concept maps as advance organizer in improving Science achievement of students was also assessed by Marvin Willerman in 1991 on 82 eighth-grade students in four physical science classes at a middle school in a north Chicago suburb with experimental group that had 40 students and the control group had 42 students with the SES of the students ranged from the poverty level to upper class and the ethnic breakdown of the sample was 42 black, 33 white, 4 Hispanic, and 3 Asian. The experimental group completed the concept map at the beginning of the science unit under the teacher's supervision while the control group was given an introductory lesson with questions. At the end of the two- week unit a science test was administered to the experimental and the control group. The results of a one-tailed t test indicated that there was a significant difference between the two groups. The effect size is 0.40. The effect size of 0.40 in this study is well within the range of other advance-organizer studies. The study confirmed the hypothesis that students who are presented with a concept map that is used as an advance organizer at the beginning of a physical science unit will score higher on a unit test than students who are not presented with the concept map.

Several studies suggest that concept map scores do not correlate significantly with traditional measures of learning such as multiple choice tests. Novak, Gowin, and Johansen (1983) showed that mapping scores were not significantly related to students' SAT scores. These findings suggest that a concept map taps into a substantially different dimension of learning than conventional classroom assessment techniques. It is likely that many techniques commonly

used in college science courses focus largely on rote aspects of learning. On the other hand, Schau and Mattern (1997) found that posttest scores on maps drawn by graduate students in introductory statistics correlated significantly with final course grades. The interpretation from this study is that traditional evaluation tools (quizzes, tests, final grades) capture some aspects of conceptual structure, and concept maps capture other aspects.

A study entitled “The Effect of Using Concept Maps as Study Tools on Achievement in Chemistry” by Saouma BouJaoude and May Attieh in 2007 examined whether or not the construction of concept maps by students improves their achievement and ability to solve higher order questions in chemistry. It also investigated the differential effect of the treatment by gender and achievement level, and explored the relationships between performance on concept maps and chemistry achievement. Participants in this study were sixty Grade 10 chemistry students from private high school in Lebanon who were randomly divided into two groups. The study spanned six weeks in a class that met five times a week. The material covered was acid-base titration and equilibrium in weak acids. The students were pre- and post-tested using a teacher-constructed chemistry test. In this study, the control group covered the chemistry content with regular exercises assigned as homework while the experimental group covered the same content and were trained to construct concept maps as homework. treatment period was divided into two parts. The first part consisted of one week during which the experimental group students were trained to construct concept maps and were accorded, towards the end of each session, some time to practice the construction of concept maps using a concept list provided by the teacher. The concept lists were related to the material taught in

class, they included chemistry concepts known to students in order to help them focus on learning the process of concept mapping. Students received feedback on their concept maps. During the second week, students in the experimental group were required to construct concept maps using concept lists identified in class. These concept maps were scored using the researcher scoring rubric developed by the researchers and turned back the next day to the students. The scored maps included detailed feedback to help students improve their concept mapping skills. At the end of the second week, the second part of the treatment started and the experimental and control groups started the acid-base titration chapter, which took four more weeks to complete. During this 4-week period students in the experimental group were required to submit twice per week a concept map constructed by using the concepts taught in class. The teacher did not provide the list of concepts to the students.

Students in the control group completed traditional homework assignments during the six weeks of the study. These assignments were scored and students were provided with detailed feedback. At the end of the treatment period, both the experimental and control group students took the post-test at the same time. Results showed that while there were no significant differences on the achievement total score, there were significant differences favoring the experimental group for scores on the knowledge level questions. Moreover, there were sex-achievement interactions at the knowledge and comprehension level questions favoring females and achievement level – achievement interactions favoring low achievers. Finally, there were significant correlations between students' scores on high level questions and the convergence and total concept map scores.

To sum up, various researches have already been conducted to assess the effectiveness of Concept Mapping as an instructional strategy. In this study, the researcher aimed to investigate the effect of Concept Mapping in the science achievement of 10th grade students and compare it with a traditional teaching method. Concept Maps were presented as advance organizers and used as assessment tool and students were trained in concept map construction.

Scope and Delimitation. The experimental design of this study involved the use of concept mapping as an instructional strategy particularly as an advance organizer and for guided practice on only one unit in a high school Biology. This unit, under the EBR curriculum, is originally taught within 5-6 weeks but was covered in this study for only 3 weeks to adapt to a trimester schedule. Due to time constraint, the study groups were not flipped to see if there were any differences in the attitudes and response to the instructional treatment. Also this study did not take into account other factors such as reading ability and IQ levels of the subjects prior to the implementation of the instructional treatment. Furthermore, the study was conducted in inclusion classes where a majority of the students were observed to be 1-2 grade levels below their current grade in reading or math.

MATERIALS AND METHODS

Overview. This study made use of an experimental research method. It utilized a pretest/posttest study with a control group design. The control group consisted of students who were taught the traditional teaching method while the experimental group was composed of students exposed to concept maps as advance organizer and was given training to construct concept maps on 3 sub-lessons.

The Science achievement was measured and analyzed using the Edusoft test on Unit 2: Balance in Nature in a Biology course. During this time, students are already acclimated to taking pretests and posttest since it is given before and every unit of the high school science curriculum. The pretest and posttest were the same. The test consisted of multiple choice questions selected from a pool of numerous objective questions from previous and this year's Unit 2 Edusoft test. These tests were administered before the unit lessons and after the unit ended respectively.

During the 3-week period, the experimental group was exposed to concept map as advance organizers and to the concept mapping technique. Two days in the beginning of the second week were allotted for teaching concept mapping which was first introduced as a cooperative group activity. Task analysis was employed for the students to construct their 1st concept map by giving them the concept bank and a list of linking words as well as visual clues on levels of hierarchy. Two additional concept maps were done by the students. Each concept map was graded using the Novak's scoring scheme. Students were allowed to correct their concept maps as the lesson progressed.

The total scores in the concept maps were used to define the concept mapping ability of the students in the experimental group and to divide them into two subgroups; high and low concept-mapping ability. It was later analyzed if students with high concept mapping ability scored significantly better than those with lower abilities.

Participants. The respondents in this study consisted of students at a public high school in East Baton Rouge Parish. The sample was taken from inclusion classes but data from the exceptional students were not collected due to nature of their disabilities, IEP accommodations and placement settings. Table 1 shows the distribution of the sampled respondents in terms of study groups and gender. The overall sample (including both the experimental and control groups) consisted of 64 students. The total sample is made up of 44% male and 56% female subjects. The control group consisted of 30 students while the experimental group was made up of 34 students. The sample is reflective of the demographics of the school which can be described as a high-needs population such that 99% of the students have African-American ethnic background and 98% were from a low socio-economic background (defined as qualifying for free or reduced lunch).

Table 1. Frequency and Distribution of the Respondents categorized by Gender

Study Group	Male		Female		Total	
	f	%	F	%	f	%
Control	14	22	16	25	30	47
Experimental	14	22	20	31	34	53
Total	28	44	36	56	64	100

At the beginning of the school year, distinct characteristics were noted between the two groups. First, the control group was a 1st period class when more interruptions were observed due to early morning announcements that could take as long as 10 minutes on the intercom everyday. Secondly, the control group was observed to be different in general class behavior. Students would come in less motivated and prepared. In addition, more students in this 1st period class were put out of class for disruptions and more students were suspended every now and then for behavior infractions. Based on the discipline report, there was an average of 2 referrals every week in this class during the 3-week period that the study was done, with referrals on class disturbance and disrespect for authority and 3 students were suspended alternately with suspension days that range from 2-3 days. Lastly, absences and tardies were another issue for this group. Students who came in tardy were sent to TOR for the whole period or half day, thus missing instructional time. On the other hand, the experimental group's general classroom behavior was observed to be more subtle, although there were also some students known for behavior problems in this class. This group was also observed to be more compliant and responsive.

PROCEDURE

Two instructional strategies were used. Both strategies were print-based. The experimental group received the concept map instructional treatment, while the control group received a traditional type of instruction by the same teachers (a regular and an inclusion teacher). The inclusion teacher shares the responsibilities of planning, instruction and evaluation aside from ensuring that the Individualized Education Plan (IEP) academic goals of the ESS (Exceptional Student Services) students with learning disabilities are addressed. The inclusion teacher was also responsible to teach the concept mapping technique. She was given careful training regarding the implementation of concept map as an instructional tool. The studies by Gowin and Novak were read in preparation and the teacher integrated the technique into the normal classroom procedure. Both study groups covered the content of a customary unit in the 10th grade Biology curriculum. The unit consists of sublessons on Biosphere, Ecosystems and Communities, Populations, Photosynthesis and Cellular Respiration. The groups were given three weeks to complete the unit.

In the traditional teaching method, the regular classroom teacher covered the content and the main methods used were lecture- note-taking sessions and teacher demonstrations using teacher and professionally-prepared materials, including the use of LCD projector and slides. The unit was complemented by having the students do a few standard practical laboratory and workbook exercises. Laboratory sessions were 30 minutes twice a week. The method derived its content chiefly from one main source- Biology textbook, by Miller and Levine (2010 edition).

The control group on the first day was given an introductory lesson that included the unit objectives and some interesting questions designed to instill motivation. The succeeding days consisted of regular class discussions, paper and pencil activities, lab sessions, informal assessments and textbook exercises.

In the concept mapping strategy, the teacher used concept maps as advance organizer to introduce the unit and to introduce each of the major lessons while integrating the concept mapping technique in the experimental design. The unit was also complemented with the same laboratory exercises with those in the traditional method.

A discussion of the meaning of 'concepts' and concept maps was used to begin the unit on the first day. On the same day, the experimental group received blank concept map with spaces assigned for the concepts in hierarchical fashion. Arrows showing the linkage between the concepts were included. The students complemented their concept maps by copying the teachers' example, which was on the board. The concept map was explained in the context of an advance organizer. The maps were also used as basis for discussion to emphasize the meaning of the concepts. Each student's concept map was checked for accuracy and completeness at the end of the activity. Students were also told they could modify their concept maps at any time. The same procedure was done for the succeeding lessons. Also embedded during the 3-week period were assignments that required students to preview the main ideas and chapter content using the concept map in their workbook and to use the concept map to review the chapter once they are done reading. Furthermore, concept maps were used for guided practice by requiring students; to determine the relationship between

the vocabulary terms in the lesson by placing the terms from the box in their correct location in the concept map, to complete the linear concept maps by adding texts to the circles to show the most important parts of the concept and to fill in the details missing from the concept map. At the beginning of the second week, the experimental group students were introduced to concept mapping and given instruction on constructing concept maps followed by guided practice which included the following steps: giving the students a focus question; then requiring them to choose a passage from a science textbook; underline the main concepts, list all the concepts on paper, write the concepts on small cards or stickers so that the concepts could be moved around, place the most general or all-inclusive concept on the top of the paper, arrange the concepts from top to bottom (from most general at the top to most specific at the bottom); (in constructing the hierarchy) place concepts next to each other horizontally if they are considered to have equal importance or value; guiding the students in relating concepts by positioning linking verbs and connecting words on directional arrows, supporting the concepts with examples; and requiring members in the cooperative groups analyze the concept map to improve on. For the rest of the week students in the experimental group were given, towards the end of each session, some time to practice the construction of concept maps using a concept list provided by the teacher. The concept lists were related to the material taught in class. Students received feedback on their concept maps. The students constructed the 1st concept map on Ecological relationships using concept list provided by the teacher. On the third week, the students constructed 2 more concept maps on Photosynthesis and Cellular respiration using concepts identified in the class.

Data Gathering. The data gathered in this study were obtained from the students' Edusoft Unit 2 test scores. **Edusoft** tests are part of the East Baton Rouge Parish School System's Benchmark Assessment Program in which high school students are assessed in English, Algebra, Geometry, Biology and American History. Edusoft Unit tests are LEAP-like tests following curriculum units gauge mastery of content throughout the year. Test content is aligned to Grade Level Expectations (GLE's) from the Louisiana comprehensive curriculum and the East Baton Rouge Parish curriculum. The tests are developed by East Baton Rouge faculty and staff and supplemented with commercial products as well as Louisiana released test items. Each unit test has both multiple choice and open-ended items. Teachers are provided scoring rubrics for short answer items, constructed responses, and essays. Benchmark Assessments are paper and pencil tests administered using the Edusoft scan and score platform from Riverside Publishing (www.edusoft.com). Reports at various levels: student, teacher/classroom, school, and district aid the teachers and administrators in making decisions regarding classroom instruction and in giving students timely and detailed feedback.

In order to measure the effectiveness of Concept Mapping in increasing the science achievement of the 10th- grade students in Biology, the raw and normalized learning gain from the pretest and the posttest scores of both groups were obtained. The Raw Learning gain is calculated by subtracting the pretest score to the posttest score.

The normalized gain is determined using the formula below:

$$\text{Normalized Gain} = \frac{\text{Posttest score} - \text{Pretest score}}{1 - \text{Pretest}}$$

Hake (1998) developed normalized learning gains because his research showed that absolute learning gains (posttest – pretest) provide unfair advantage to classes with low pretest score.

Method of Scoring Concept Maps. Reliability and validity of concept maps as assessment tools are integrally related to the concept map task and to the scoring system used (Ruiz-Primo & Shavelson, 1996). The traditional method of Concept Map scoring was proposed by Novak and Gowin (1984). This is shown in figure 3. This method is based on the components and structure of the Concept Map.

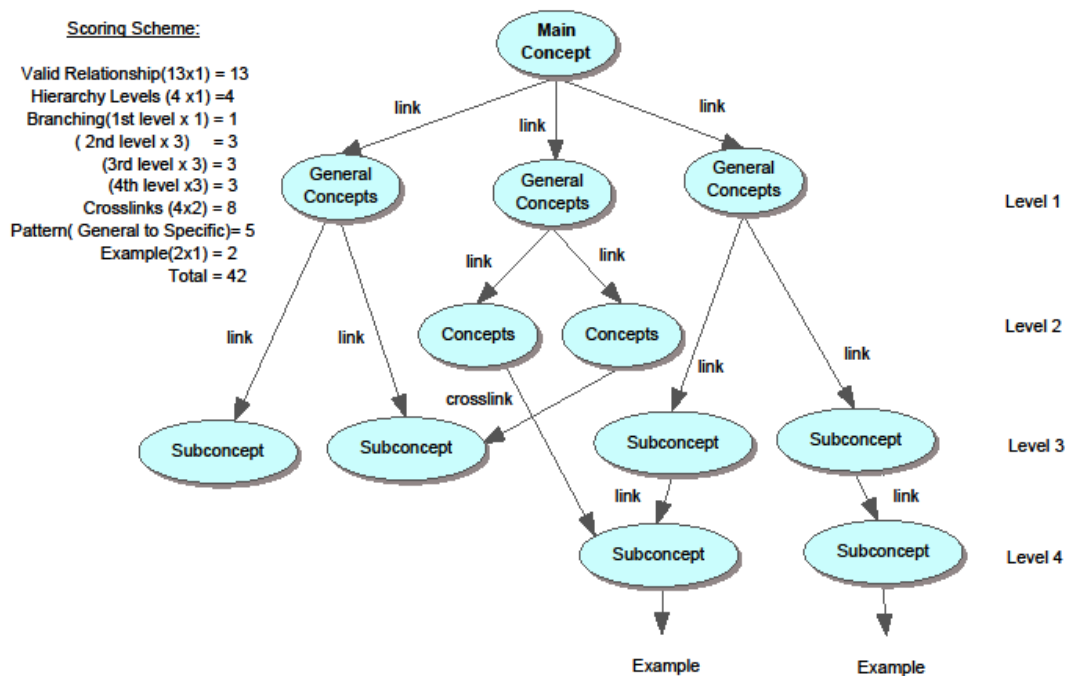


Figure 3. Scoring Scheme (Novak and Gowin, 1984)

Novak and Gowin's system assigns points for valid propositions (1 point each), levels of hierarchy (1 point for each level), branchings (1 point for the first branching where two or more concepts are connected to the main concept and 3 points for any subsequent branching where there are two or more concepts connected to the preceeding concept), pattern (maximum 5 points if the map shows general to specific pattern), crosslinks (1 point for each valid cross-link), and specific examples (1 point for each example). The number of hierarchical levels addresses the degree of subsumption, the number of branchings indicates progressive differentiation, and the number of cross-links indicates the degree of integration of knowledge. This scoring technique has proven to be time-consuming, but it does give a great deal of information about the creator's knowledge structure.

Although Liu & Hinchey (1996), found relatively low correlations among different component scores in Novak and Gowin's (1984) scoring system, the component scores for propositions, levels of hierarchy, cross-links, and examples may actually be measurements of different aspects of the structure and organization of knowledge. Studies on reliability and validity measures indicate that Concept Maps fall within acceptable ranges from the viewpoint of psychometrics (e.g., West et al; 2000; Shavelson & Ruiz-Primo, 2000).

The teachers in this study employed the same scoring scheme as proposed by Novak and Gowin in all the concept maps created by the students. The total score in all 3 concept maps was used to assign ability level to the students in the experimental group.

Statistical Treatment. T- test was employed to validate the significant difference in the raw gains between the control and the experimental groups. Statistical tests were set to 95%

confidence level. In determining the correlation between concept mapping scores and learning gain, the Pearson r correlation was used. To determine if high concept mapping ability students performed equally with the low ability students in the experimental group, Fisher's Exact test was used. Fisher's exact test is a statistical significance test used for small sample sizes like the sample in this research study. Fisher's exact test calculates deviance from the null hypothesis, which holds that there is no bias in the data, or that the two categorical variables have no correlation with each other. In the case of this study, the null hypothesis is that the association between concept mapping ability and learning gain is not statistically significant. The null hypothesis was tested at 0.05 level of significance.

Student–Constructed Concept Map Examples. Concept maps are also valuable tools for teachers because they provide information about students' understanding. Concept maps are effective in identifying both valid and invalid ideas held by students. They can be as effective as more time-consuming clinical interviews for identifying the relevant knowledge a learner possesses before or after instruction (Edwards & Fraser, 1983). Teachers can examine how well a student understands science by observing the sophistication of their concept map. When an expert creates a concept map, it is typically an elaborate, highly integrated framework of related concepts (Chi 1988). Highly sophisticated maps show highly integrated knowledge structures, which are important because they facilitate cognitive activities such as problem solving. A closer look at the propositions in a concept map also reveals students' level of understanding. For instance, linkages drawn between two unrelated concepts expose students' alternative or naïve conceptions in science. Likewise, the absence of a link between two closely

related concepts can reveal that a student has not yet developed a strong understanding of the relationship between the concepts. Figure 4 shows an example of a student-constructed concept map which demonstrates the knowledge structure of the student. The teacher-made concept map that was used as basis for grading this student work was on Appendix A. The concept map below displays most of the components of a concept map structure. The concepts were correctly enclosed in ovals and the words on the linking lines provided accurate relationships between and among the concepts. Examples of organism for each type of consumer were also included in the map. However, it failed to provide all the required examples and to show a general-to-specific pattern.

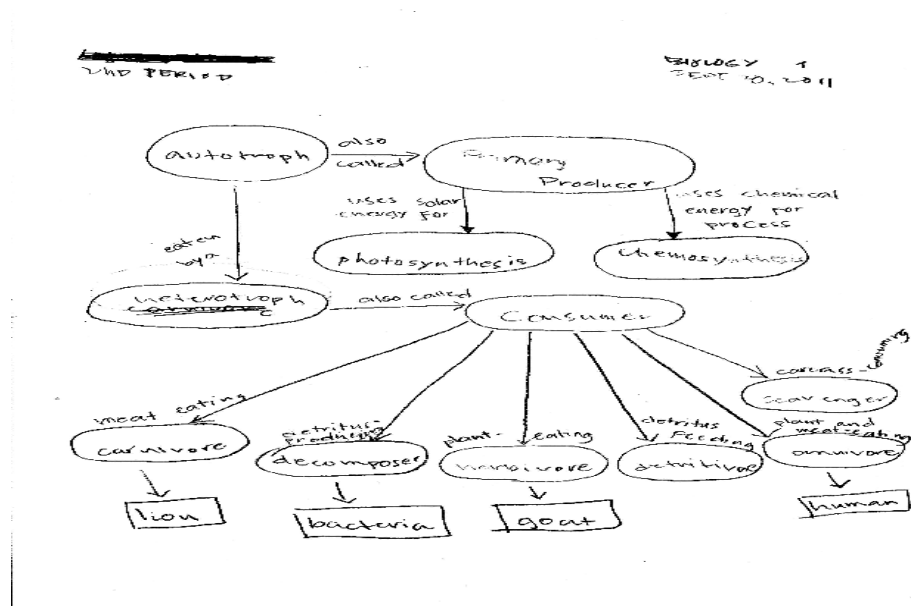


Figure 4 . Student-constructed Concept Map

RESULTS AND DISCUSSION

The results are divided into 3 sections. The first section describes and analyzes the science pre and posttest scores of the students in both groups. The second section compares the raw gains and the normalized gains. Finally, the third section explains the correlation of concept map scores and learning gains of the students in the experimental group. Furthermore, this section analyzes the association between the levels of concept mapping ability and the raw gains.

Comparing Pretest Scores. Before instruction, both the control and the experimental group were administered an Edusoft Unit 2 pretest. Figure 5 shows the distribution of pretest scores. The scores of the control group range from 3-17 while those of the experimental group are from 3-25. As seen from figure 5, only 1 student (3%) in the control group scored its highest (17) while 5 out of 34 (15%) students in the experimental group scored above 17. The control group had a mean score of $12.0 \pm .6$ while the experimental group scored a mean of $12.4 \pm .5$.

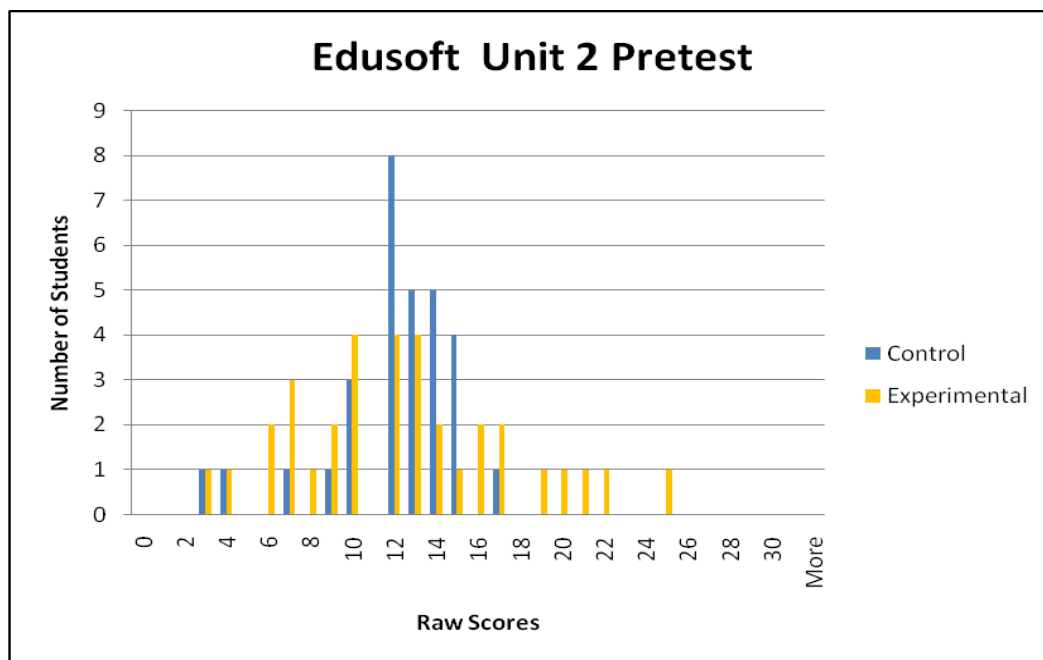


Figure 5. Frequency and Distribution of Pretest Scores Between Two Groups

To compare and verify if the pretest scores of the control and the experimental group were statistically the same, a two-tailed t-test was run. The result of the test is shown on Table 2. Since the p-value is 0.72, there is no statistical difference in the Science pretest scores of both groups. This establishes that all participants had the same prior knowledge of the grade level expectations covered in the Edusoft Unit 2 science assessment.

Table 2. Summary of the Statistics on the Pretest Scores of Both Groups

	Control (n=30)	Experimental (n=34)
Mean	12.0	12.4
Standard Deviation	3.1	5.2
Variance	9.6	27.3
Two-tailed p	0.72	
Decision	There is no statistical difference	

Comparing Posttest Scores. After 3 weeks of instruction, a posttest was given to both groups. Figure 6 shows the distribution of the posttest scores. It can be seen on this figure that the scores of the control group are more clustered towards the mean; whereas those of the experimental group are widely distributed.

Figure 7 shows the comparison of the two group's mean pretest and posttest scores. The control group attained a mean posttest score of 12.4 ± 5 while the experimental group's mean score was 14.0 ± 9 . Based on this figure, it can be observed that students in both groups seem to display a very modest improvement in their Science achievement from pretest to posttest.

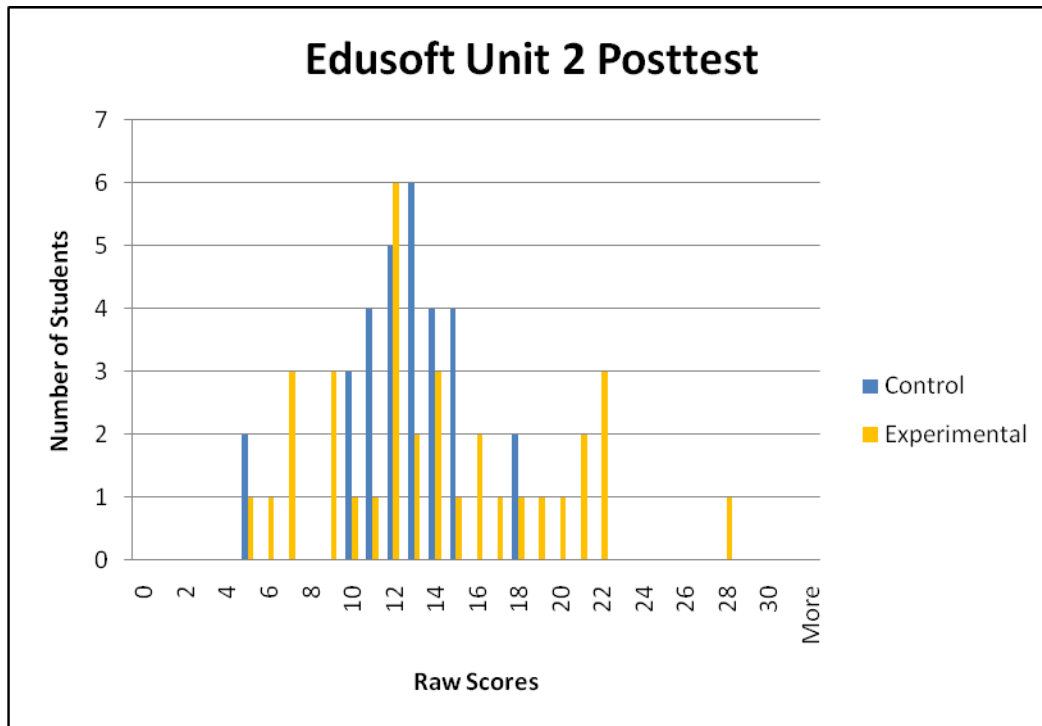


Figure 6. Frequency and distribution of Raw Scores of Both Groups

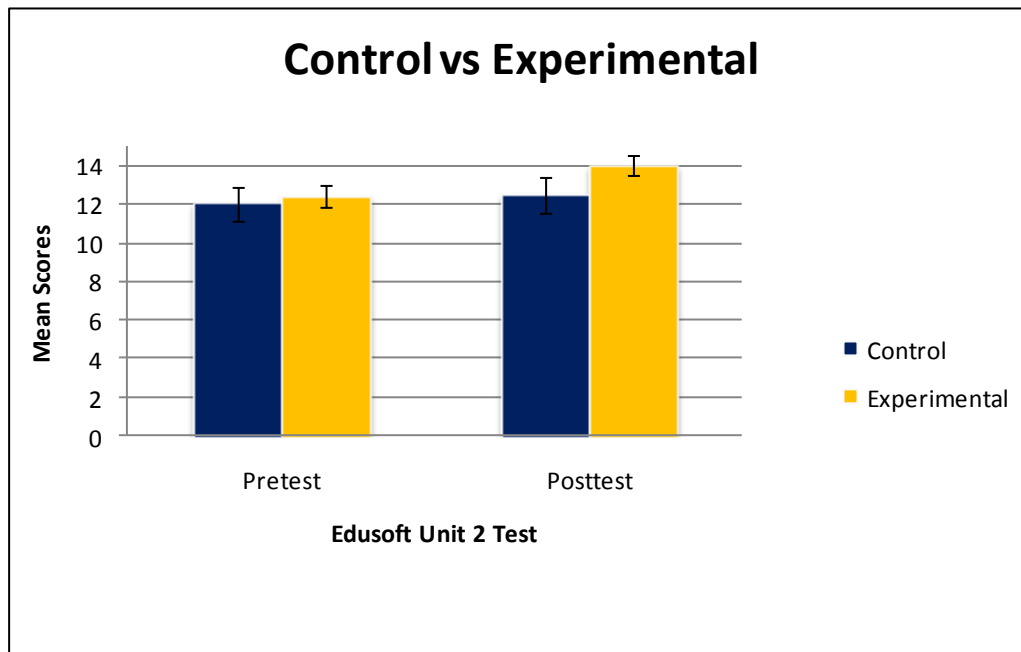


Figure 7. Comparison of Pretest and Posttest Mean Scores Between the Two Groups

To determine if the difference in the posttest scores of the control and the experimental group is statistically significant, a t-test was employed. Table 3 shows a summary of the analysis conducted. A p- value of 0.15 renders a decision that the difference is not statistically significant. One possible reason could be that the learners were not yet facile with constructing Concept Maps which gave an indication that the cognitive load of creating maps from scratch might have hindered learning. Students got caught up with the concept mapping process that less time was devoted on actually using the concept maps for its intended purposes of organizing thoughts and visualizing concepts. On the other hand, students who have developed a strong facility for rote learning of verbal knowledge may have found the concept maps intimidating resulting to decreased participation and motivation in learning.

Table 3. Summary of the Statistics for the Posttest Scores of Both Groups

	Control (n=30)	Experimental (n=34)
Mean	12.4	14.0
Standard Deviation	2.9	5.5
Variance	8.2	30.3
Two-tailed p	0.15	
Decision	There is no statistical difference	

Comparing Raw Gains. To quantify the improvement of both groups in their science achievement with the application of the two teaching methods, the raw gains of both groups were calculated and compared. The mean learning gain of the control group is $.43 \pm .4$ while that of the experimental group was $1.6 \pm .4$. Figure 7 shows the distribution of raw gains of both

groups. 11 out of 30 (37%) students in the control group had negative learning gains while 3 out of 34 (9%) students in the experimental group had negative learning gains. While there are more experimental group students who had zero learning gains than their traditional counterparts, there are more experimental group students (58%) who had positive gains.

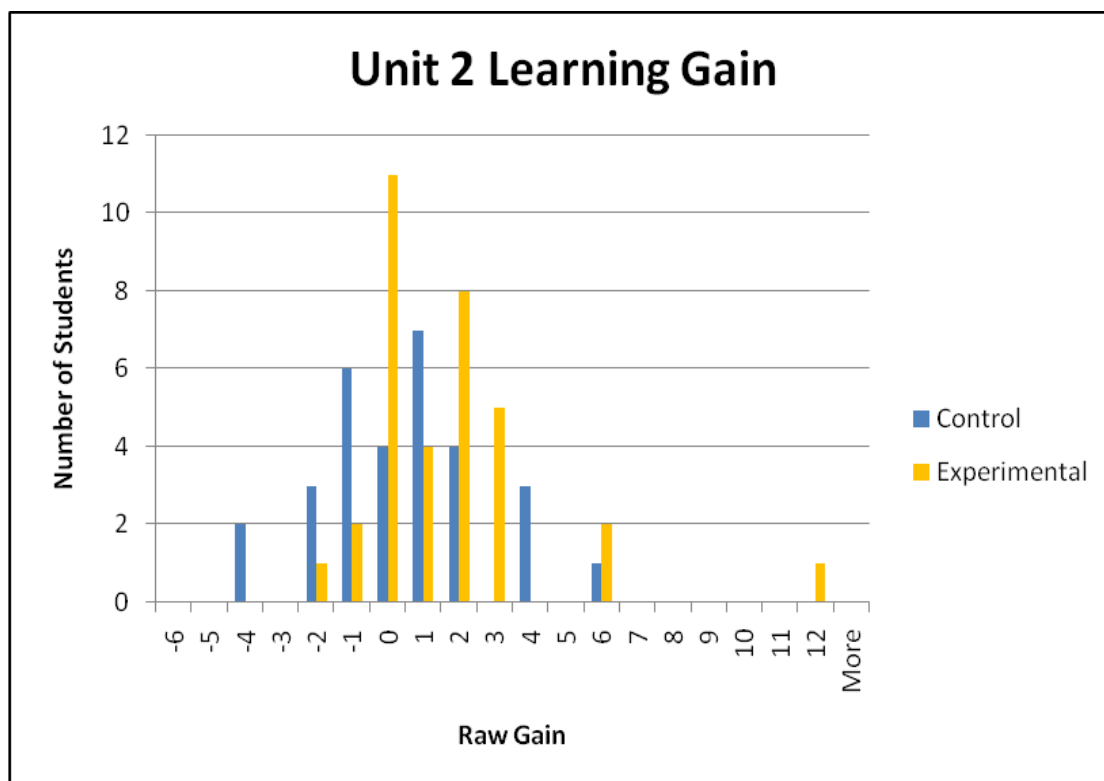


Figure 8. Frequency and Distribution of the Raw Gains of Students in Both Groups

To examine if the difference in the learning gains between the two groups is statistically significant, a two-tailed t-test was employed. Table 4 displays the result of the t-test. T- test results show that with a p-value of .05 at 95% confidence level, there is a significant difference in the learning gains of the control and experimental group. This finding suggests that Concept Mapping students had slightly higher learning gains than their traditional counterparts.

Table 4. Summary of the Statistics on the Raw Gains of Students in Both Study Groups

	Control (n=30)	Experimental (n=34)
Mean	0.4	1.6
Standard Deviation	2.3	2.6
Variance	5.2	6.5
Two-tailed p	0.05	
Decision	There is a significant difference	

Comparing Mean Normalized Gains. To quantify and focus on student learning in the classroom, regardless of prior knowledge, normalized gain scores were used. The normalized gain measures the fraction of the available improvement realized. The average normalized gain for the control group was calculated to be 0.015 ± 0.02 while that of the experimental group was found to be 0.09 ± 0.02 . The two-tailed t-test yielded a p-value of 0.02. The result ($p < 0.05$) suggests that there is statistically significant difference between the two groups based on the 95% confidence level.

Table 5. Summary of the Statistics of the Normalized Gain scores of Students in Both Groups

	Control (n=30)	Experimental (n=34)
Mean	0.015	0.09
Standard Deviation	0.12	0.14
Variance	0.015	0.02
Two-tailed p	0.02	
Decision	There is a significant difference	

These results seem to suggest that Concept mapping may have slightly improved the science achievement of the experimental group students. One possible reason would be the

opportunity Concept Map gives the students in thinking about the connections between the science terms being learned, organizing their thoughts and visualizing the relationships between key concepts in a systematic way, and reflecting on their understanding. Being able to think deeply about science by helping them to better understand and organize what they learn, and to store and retrieve information more efficiently, enabled the concept map-exposed students to gain slightly more than the students who were taught the traditional method.

The result is consistent with the findings of Kinchin (2000) and Lewis (1987) that the Ausubel's teaching strategy enhance significantly the conceptual understanding of the students.

However, the fact that the result showed no significant difference in the posttest scores of both groups, the researcher suspects that some factors other than the concept mapping treatment can be attributed to.

To further investigate this result, the correlation between pretest and posttest scores were determined. Figure 9 shows the correlation between pretest and posttest scores of both group. Based on the data in Figure 9.a, we can see that there is a high positive correlation of the control group's pretest and posttest scores; however, a closer look at the clustered data points appears that the control group's posttest scores did not change much from their pretest scores. It also seems to suggest that the control group students were more likely sticking to their answers in the pretest. On the other hand, the data points on figure 9.b show a linear trend and a positive correlation between the pretest and posttest scores. But a closer look at the widely distributed data points suggest that this group had students of varied abilities. This observation also reveals an apparent indication that these two groups are characteristically different. As

previously mentioned, the control group is very much in contrast to the experimental group in several aspects such as general classroom behavior, motivation, preparedness and attendance. These differences must have played a crucial role in producing these strange results. Data from the School's Attendance office showed more tardies and suspensions in the first period class for behavior issues.

When students miss class due to tardies and suspensions, they missed very important concepts and learning opportunities. Based on the weekly progress report, there were more students in the control group who had failing grades due to failure in turning in classwork and making up assignments. The great number of disruptive, unmotivated and less prepared students in the control group must have impacted the learning environment of the class, thus producing a very small gain. In contrast, the experimental group was observed to have lesser discipline issues than the control group. Nevertheless, the experimental group's learning gain still appears very modest to say that Concept mapping made a strong impact on their science achievement.

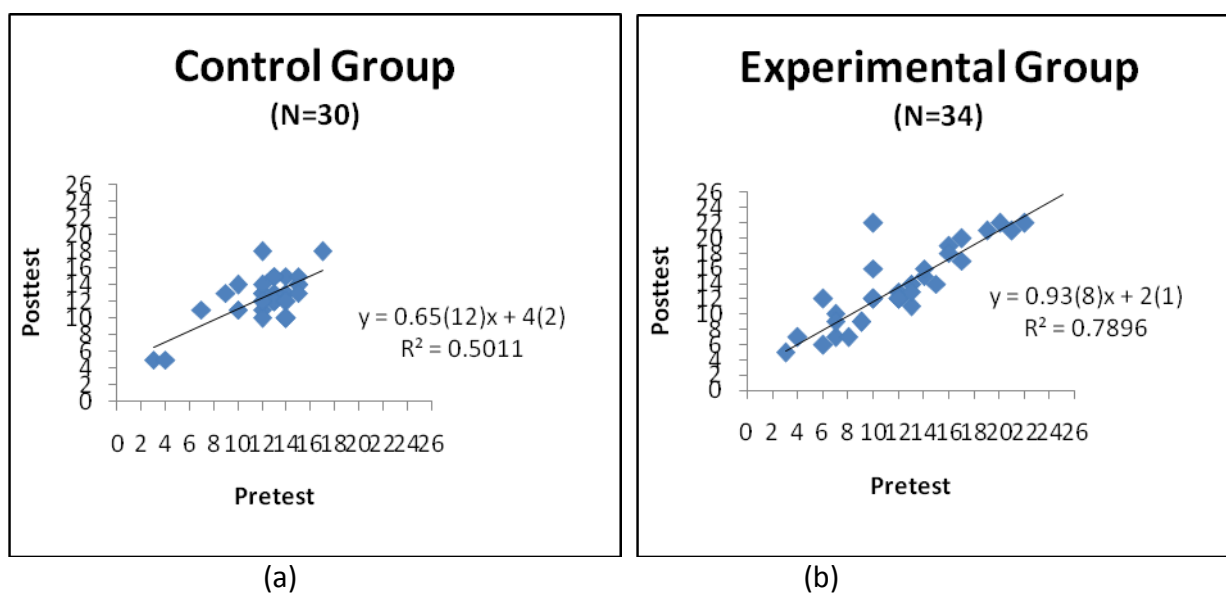


Figure 9. Correlation Between the pretest and posttest scores of a) Control Group and b) Experimental Group

Correlation of Concept Map Scores and Learning Gains. The students in the experimental group were not only presented with concept map as advance organizer, they were also made to construct 3 concept maps during the 3- week period. As mentioned earlier, the concept maps were scored using Novak’s scoring scheme. Each map was assigned 20 points for a total of 60.

Figure 10 shows the map score distribution of the experimental group students in all three maps. It can be noted that students scored higher on Map 3 than on Map 1. This could be due to the ease and familiarity with the process that came after several practice of map construction. This also suggests that had there been enough time allocated for concept mapping

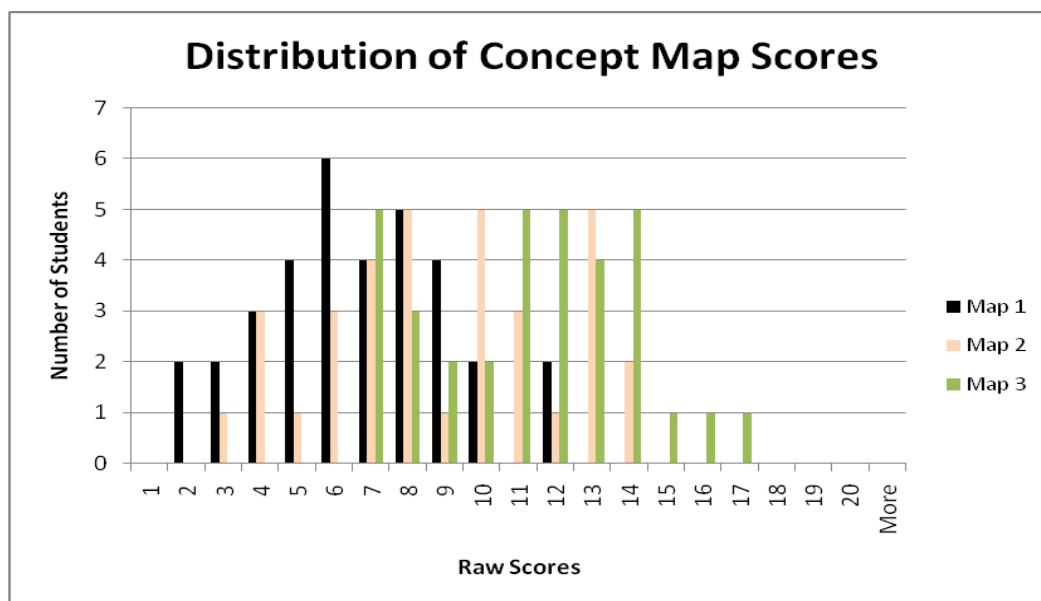


Figure 10. Distribution of Concept Map Scores of Experimental Group students in all 3 Maps

The researcher wanted to see if the concept map scores can be used to predict the performance of students in the Unit 2 test. Thus, to determine if there is correlation between concept map scores and learning gains of the students, total concept map scores are obtained

and PEARSON correlation calculation is employed. Figure 11 shows a scatterplot of the total concept map scores and the raw gains. The graph displays scattered points and shows a linear pattern. The slope of the line (0.13 ± 0.05) gives an indication of a positive slope but the r^2 value ($.2 \pm 1$) suggests a low positive correlation between concept map scores and raw gains. Linear regression was performed and a p value ($0.02 < \alpha$) suggests that this result is statistically significant. Table 6 shows the summary of the analysis conducted. The results suggest that Concept Map scores do not strongly determine the learning gains.

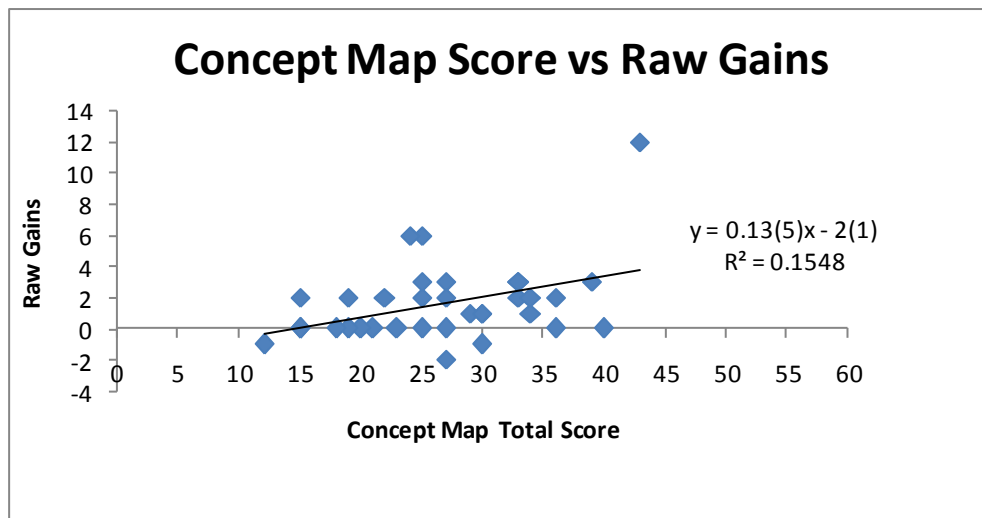


Figure 11. Scatterplot of Raw gains and Concept Map score

Table 6. Correlation Between Concept Map Scores and Learning Gains

Concept Map Scores and Learning Gain				
	Map 1	Map 2	Map 3	Total Map Score
Pearson r	0.30	0.33	0.44	0.39
r squared	0.09	0.11	0.20	0.15
Interpretation	low positive	low positive	moderate positive	low positive

Comparison of Learning Gains between the two Levels of Concept Mapping ability. Students who constructed concept maps varied in their concept mapping ability. High-level concept mapping ability students have concept map scores that range from 30-60 while the low-level concept mapping ability students' score range from 0-29. Figure 12 presents a distribution of the learning of the two groups of concept mapping ability; high and low.

Based on this figure, there is equal number of positive gains (10) between the low and high-level concept mapping ability students. However, the low-level group had more negative (2) and zero gain (9) compared with the high-level group which had 1 and 2, respectively.

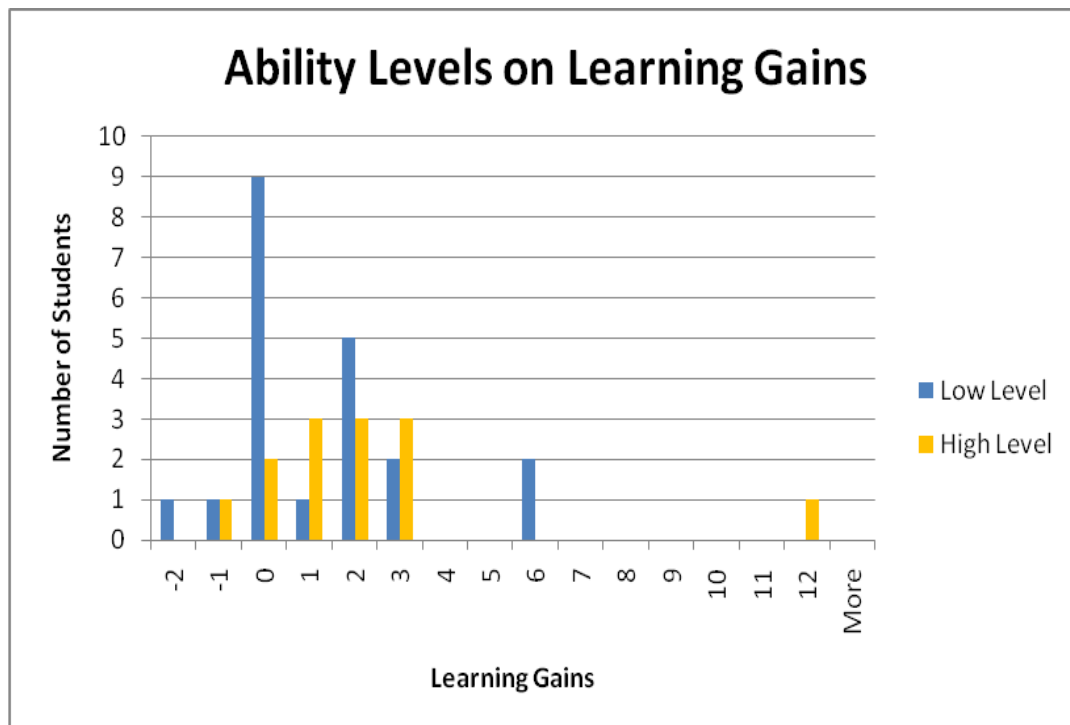


Figure 12. Distribution of Learning Gains of Two Levels of Concept Mapping Ability in the Experimental Group

To see if there is a difference in the learning gains between the two groups, a null hypothesis that “there is no significant association between the 2 levels of concept mapping ability and the

number of learning gains” was then formulated and tested at 0.05 level of significance using Fisher’s Exact Test. Data Analysis was done using Microsoft Excel and the result is presented and interpreted in table 7.

The contingency table used for this test is presented in Appendix D. The result of Fisher’s Test leads to the conclusion that indeed, there is no significant association between the number of learning gains and the levels of concept mapping ability.

Table 7. Result of Fisher’s Exact Test of Association Between the Number of Learning Gains and the Levels of Concept Mapping Ability

2-tailed p	Level of Significance	Result	Decision
0.15	0.05	$p > 0.05$	Do not reject null

SUMMARY AND CONCLUSIONS

Summary. This study assessed the effectiveness of concept mapping in improving science achievement of 10th grade students in Biology and compared it with a traditional method of instruction. It also analyzed the relationship between concept mapping ability and learning gains. In this study, concept mapping was used as an instructional strategy specifically as advance organizer and as guided practice.

The results of the present study showed that the pretest mean score of the students in the experimental group was not significantly different from that of the students in the control group. This indicated that the two groups used in the study exhibited comparable characteristics. Hence, they both entered the instruction/experiment on equal strength. This goes to show that the two groups were suitable for the study when comparing the effects of concept mapping strategy with the traditional teaching method on Biology Unit 2. Moreover, this is a confirmation that if any observable significant difference is seen in the post test mean scores of the two groups then such difference would not be attributed to chance but the effect of the intervention which is the concept mapping strategy.

But the results upon comparing the posttest scores of the two study groups suggest that the difference is not statistically significant- that is, the experimental group of this research study did not perform much better than the control group in their Edusoft Unit 2 test. Difficulty with the concept mapping technique by the students, given the constraint of time to master the process and to use the concept maps to its full potential which could have led to frustration, was cited as the possible reason. The amount of time spent to master the concept mapping

process was insufficient that it hindered the student's opportunity to use it to its advantage. On the contrary, students may have spent a great deal of time mastering the concept mapping process but left a miniscule for other learning processes such practice and reflection which are as essential as those that are tapped by the concept mapping strategy. Moreover, the volume of concepts that were covered in such a short span of time (3 weeks) with the whole course being compressed plus the cognitive load of the concept mapping technique might have been intimidating and frustrating to students whose ability levels are below their current grade. However, the raw gains and normalized gains of both groups are found to be statistically significant. The learning gain by the concept mapping students may have been due to the use of concept map as advance organizer which was presented to the student as a visual tool for organizing content in a logical way. The students in this study were probably helped by the organization and visual relationships of the advance organizer in a way which differs from the assistance provided by only an oral explanation. Another reason for its effectiveness may be attributed to it being constructed by a teacher rather than a student. Since the concept map was more complete and accurate than a student- constructed map, it probably became a better anchor for new information. All of these things support the possibility that students actually benefitted from concept mapping strategy. There are, however, other factors that cast doubt on the positive gains and differences in gain scores. The sample size used in this study makes results difficult to trust for the same reason that a possible outcome is much more likely to occur five times in a row than it is to occur 100 times in a row. The possibility that the positive gains are due to chance can only be proven or ruled out with more experimentation or

experimentation with more subjects. The difficulty the researcher faced in extending the study by flipping the two groups proved to be another barrier in eliminating possible biased assumptions that character differences were the main factor for not having statistically significant differences in the two group's science achievement. The researcher was constrained on being in the classes for only in that 3-week period of study due to the nature of her teaching position; as an inclusion and an IEP teacher of authority.

Aside from comparing the effectiveness of concept mapping with the traditional method of instruction, this study also aimed to see if concept maps scores could be used to determine learning gains. The results showed that there is low positive correlation between concept map scores and the learning gains. This could suggest that the concept mapping technique as an assessment tool probably provides a different measure of abilities and knowledge than traditional assessment techniques. Lastly, this study examined the levels of concept mapping ability and compared them with the experimental group's learning gains. It was determined that there is no significant association between concept mapping ability levels and the learning gains; the students who have higher ability in constructing concept maps do not significantly differ from those with lower abilities. Thus, the ability of students to construct concept maps was found to be not a strong predictor of their learning gains. These results have been reported by other similar research studies.

Conclusions . Based on the findings of this study, the following conclusions are drawn:

1. Although the difference in learning gains between the control and experimental group was statistically significant, the minimal improvement does not appear to be entirely due to Concept

Mapping as an instructional strategy. There seems to be other stronger factors at play that affected student achievement.

2. There is low positive correlation between concept mapping scores and learning gains.

($r = 0.39$)

3. There is no significant association between the levels of concept mapping ability and learning gains ($p=0.15$).

Recommendations. In light of these findings, the researcher recommends that:

1. Sufficient time must be allotted to teach the concept mapping technique with consideration to the students' physiological reactions to increasing levels of difficulty and demands of complexity,

2. Teachers assess levels of student motivation and preparation as well as reading ability before introducing any instructional strategies,

3. Teachers must flip the study groups to provide fair evaluation of attitudes and responses towards the concept mapping methodology

4. Teachers practice caution in incorporating concept mapping in instruction and in using proposition-based scoring methods as they can be time-consuming and require human judgement; and

5. Teachers use concept map as instructional strategy when the subject matter of a unit is hierarchical and basically conceptual; and that this strategy be used for one unit at a time to lessen the cognitive load and demands of the concept mapping technique

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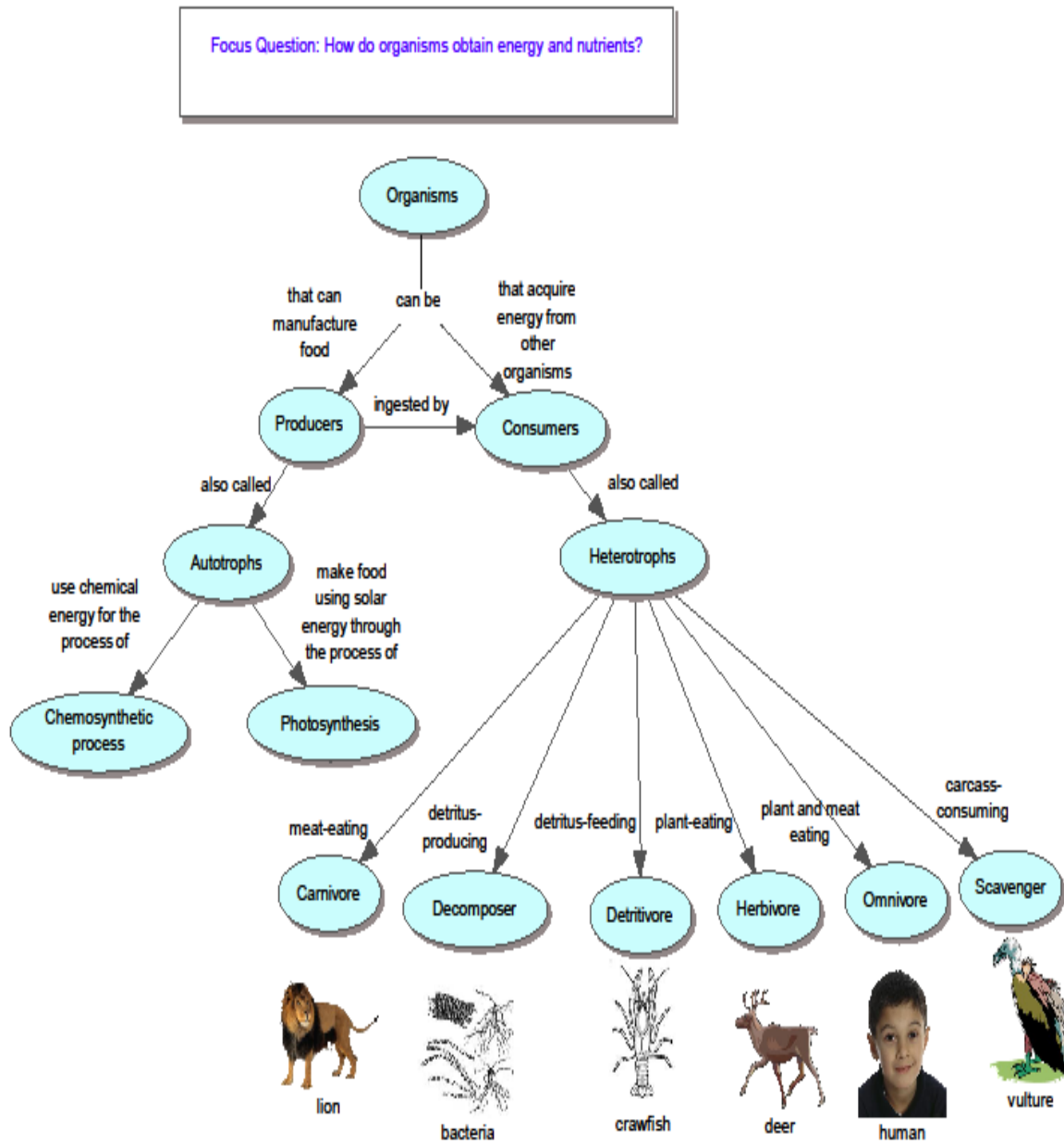
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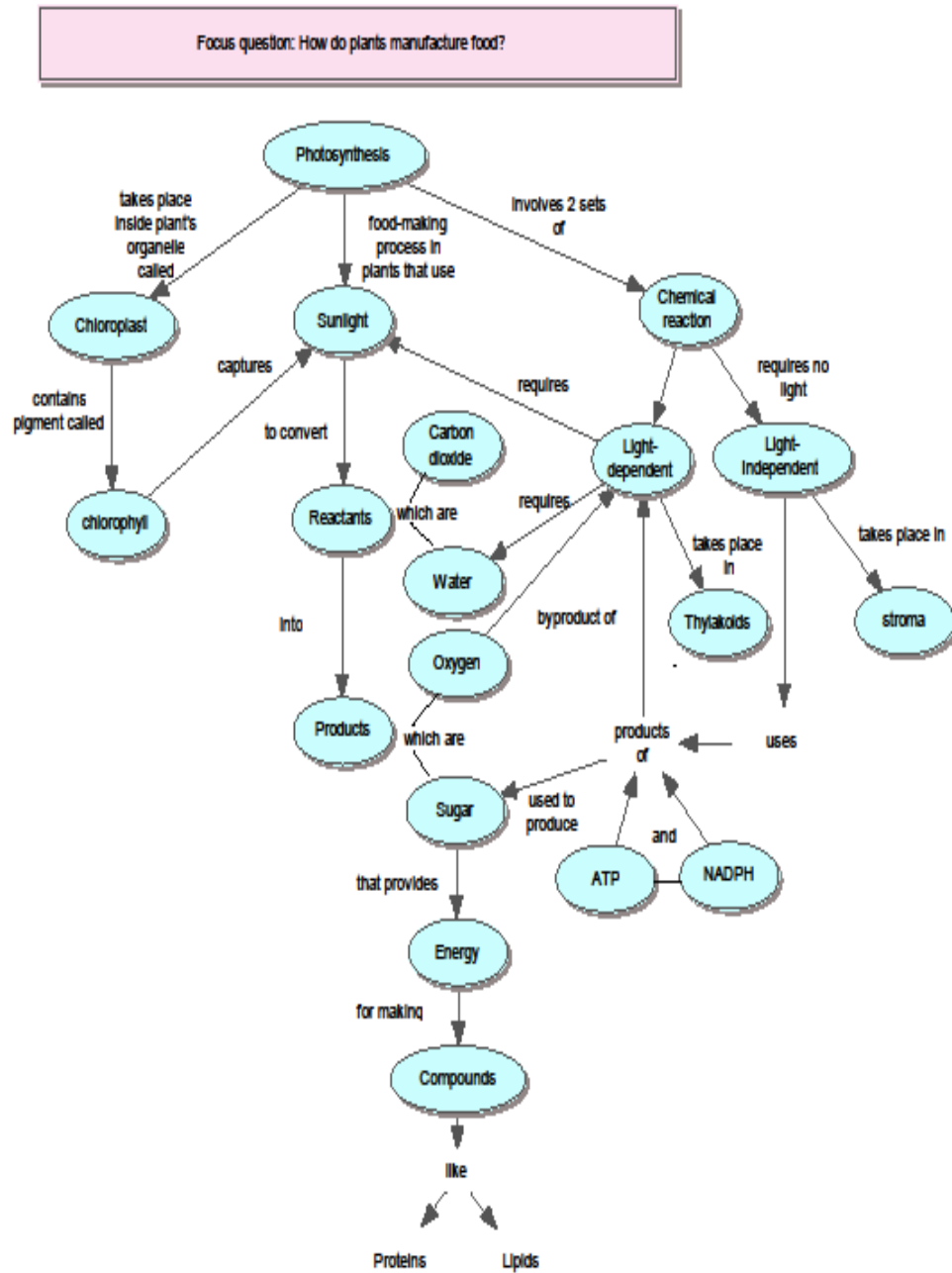
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APPENDIX A. TEACHER-CONSTRUCTED CONCEPT MAP FOR CONCEPT MAPPING ACTIVITY 1



Created using Inspiration® 9 International English Edition by Inspiration Software®, Inc.

APPENDIX B. TEACHER-CONSTRUCTED CONCEPT MAP FOR CONCEPT MAPPING ACTIVITY 2



Created using Inspiration® 9 International English Edition by Inspiration Software®, Inc.

APPENDIX C. APPLICATION FOR EXEMPTION FROM INSTITUTIONAL OVERSIGHT

Application for Exemption from Institutional Oversight

Unless qualified as meeting the specific criteria for exemption from Institutional Review Board (IRB) oversight, ALL LSU research/ projects using living humans as subjects, or samples, or data obtained from humans, directly or indirectly, with or without their consent, must be approved or exempted in advance by the LSU IRB. This Form helps the PI determine if a project may be exempted, and is used to request an exemption.

-- Applicant, Please fill out the application in its entirety and include the completed application as well as parts A-E, listed below, when submitting to the IRB. Once the application is completed, please submit two copies of the completed application to the IRB Office or to a member of the Human Subjects Screening Committee. Members of this committee can be found at <http://www.lsu.edu/screeningmembers.shtml>

-- A Complete Application Includes All of the Following:

- (A) Two copies of this completed form and two copies of part B thru E.
- (B) A brief project description (adequate to evaluate risks to subjects and to explain your responses to Parts 1&2)
- (C) Copies of all instruments to be used.
- *If this proposal is part of a grant proposal, include a copy of the proposal and all recruitment material.
- (D) The consent form that you will use in the study (see part 3 for more information.)
- (E) Certificate of Completion of Human Subjects Protection Training for all personnel involved in the project, including students who are involved with testing or handling data, unless already on file with the IRB. Training link: (<http://phrp.nihtraining.com/users/login.php>.)
- (F) IRB Security of Data Agreement: (<http://www.lsu.edu/irb/IRB%20Security%20of%20Data.pdf>)



Institutional Review Board
Dr. Robert Mathews, Chair
131 David Boyd Hall
Baton Rouge, LA 70803
P: 225.578.8692
F: 225.578.6792
irb@lsu.edu
lsu.edu/irb

1) Principal Investigator: Dana Browne Rank: Professor
Dept: Physics & Astronomy Ph: (225) 578-6843 E-mail: phowne@lsu.edu

2) Co Investigator(s): please include department, rank, phone and e-mail for each

Ritchie B. Adlaon, Graduate Student
Science Teacher, ESS & Science Department
Istrouma High School (225) 302-4471
radlaon@ebrpss.k12.la.us

IRB#	ES601	LSU Proposal #
<input checked="" type="checkbox"/>	Complete Application	
<input checked="" type="checkbox"/>	Human Subjects Training	

3) Project Title: Concept Mapping: Assessing Effectiveness as Instructional Tool in High School Biology

Study Exempted By:
Dr. Robert C. Mathews, Chairman
Institutional Review Board
Louisiana State University
203 B-1 David Boyd Hall
225-578-8692 | www.lsu.edu/irb
Exemption Expires: 8-17-2014

4) Proposal? (yes or no) ☒ NO If Yes, LSU Proposal Number

Also, if YES, either
☐ This application completely matches the scope of work in the grant
OR
☐ More IRB Applications will be filed later

5) Subject pool (e.g. Psychology students) High School Biology Students at Istrouma High

*Circle any "vulnerable populations" to be used: (children <18; the mentally impaired, pregnant women, the aged, other). Projects with incarcerated persons cannot be exempted.

6) PI Signature Dana Browne Date 6/30/11 (no per signatures)

** I certify my responses are accurate and complete. If the project scope or design is later changes, I will resubmit for review. I will obtain written approval from the Authorized Representative of all non-LSU institutions in which the study is conducted. I also understand that it is my responsibility to maintain copies of all consent forms at LSU for three years after completion of the study. If I leave LSU before that time the consent forms should be preserved in the Departmental Office.

Screening Committee Action: Exempted <input checked="" type="checkbox"/> Not Exempted <input type="checkbox"/>	Category/Paragraph <u>1</u>
Reviewer <u>Mathews</u>	Signature <u>Robert Mathews</u> Date <u>8/18/11</u>

APPENDIX D. CONTINGENCY TABLES FOR FISHER'S EXACT TEST

A) H_0 : There is no significant association between the number of learning gains and the levels of concept mapping ability in the Experimental group of students.

Fisher's test on Association between Concept Mapping Ability Level and Learning Gain

Contingency Table			
	Raw Gains		
Concept Mapping Ability Level	Negative or Zero	Positive	Total
Low (0-29)	11	10	21
High (30-60)	3	10	13
Total	13	20	34

Result: 2-tailed $p = 0.15$

2-tailed $p > 0.05$

Decision : Do not reject H_0

VITA

Ritchie Bagcat Adlaon- Jatico was born in 1981 in the Philippines. She earned her Bachelor of Science in Secondary Education with a major in General Science in 2002 from La Salle University in Ozamiz City, Philippines. She started teaching science in the Philippines in the school year following her graduation. After three years of consecutive teaching experience, she went back to school to earn her certificate in teaching Special Education in 2005 and her Bachelor of Science in Nursing in 2008. In October 2008, she moved to Baton Rouge, Louisiana, to embark on a more challenging teaching career as an inclusion teacher at Istrouma High School. She started her graduate degree at Louisiana State University in summer 2009 and aimed to earn her Master's in Natural Science in 2012. She is employed by the East Baton Rouge Parish School System and is currently assigned as a science teacher at Glasgow Middle School.