

**A TEACHER'S PERSPECTIVE ON CONCEPT MAPPING**

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## Abstract

There is a perception in education today that student learning needs to be improved but specific tools to do this seem lacking. From a teacher's perspective, learning can be improved only when students have been taught the skills or strategies that improve the way in which they learn. To this end, I undertook this study to investigate the educational value of concept mapping as a study skill/learning strategy. Research has shown that learning requires information to be encoded into memory using a variety of strategies and then retrieved as needed. Concept mapping creates a graphic representation of one's knowledge using a variety of methods, thereby, encoding the information into memory. This makes it a useful tool for studying and learning. The next step was to observe the effects of concept mapping in the classroom and determine its value to both student and teacher. Students in one of my senior high school biology classes were taught to map and encouraged to use maps in preparation for all chapter and unit tests. Observations of student behaviors were made and noted in a journal, along with personal comments as to the benefits and drawbacks for student learning and teacher workload. Finally, I evaluated what had been learned. The results demonstrated that concept mapping was good for learning and for the teacher. The positive benefits included more on-task student behaviors, less wasted class time, an overall improvement in the quality of assigned tasks, and interesting and enjoyable class discussions. Evaluating the maps using curricular criteria was quick and easy. Students who embraced the technique found the benefits to their liking and most students were at least able to make changes in their study techniques. The drawbacks to the use of mapping were the amount of time required for

students to master the technique and see measurable improvements in test results. This meant that one had to continually remind and encourage students to continue to use this “new” form of studying. Overall, I concluded that concept mapping is a useful tool to improve student learning and as such, it needs to be part of one’s teaching strategies.

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## Chapter 1: Introduction

Many of my colleagues in education have often expressed the need to improve the quality of learning that is taking place in their classrooms. I have always felt that it was my role as the teacher to help my students develop the skills and techniques needed to become better learners. Only then, would I be able to improve the quality of learning taking place in my classroom.

In my many years as a teacher, I have always tried to find ways to teach that helped my students learn and master the prescribed curriculum in the most efficient way. I always wonder how well my students are learning the material that I teach. After teaching a particular unit and feeling that students understood the material and were ready for the test, I would find myself surprised that the test results were not what I had anticipated. I began to wonder what techniques they used to prepare themselves for tests. Through casual questioning, I found that the majority of students merely read over the text book material that was to be tested the night before a test. To my dismay, the majority of students used such basic techniques as memorizing and rereading the text or their notes, to study for a test. Only a small number of students would write down any of the material to be tested as part of their study technique. For most students, these techniques did not seem to have the desired results in terms of positive test results, yet no one tried to change the way in which they studied. In my opinion, many students were reluctant to expend any extra energy or time to use more productive strategies to learn the course material despite consistently poor results on tests. To improve the quality of learning in my classes, I began to give more class time for review and encourage students

to use a variety of methods to become more involved in their own learning. I wanted them to do more than just read over the material that needed to be learned or memorize a list of terms.

I discovered concept mapping in one of the science texts I was using in a junior science program and tried it as a class review on the blackboard. Students were required to copy the map into their notebooks as we worked our way through the review. I found that with this treatment of the material to be learned, many students showed improvement on the next test. I believed that a better form of learning had taken place in my class and I wanted that to continue. As a result, I continued to experiment with the mapping process to see if the improvement in student achievement and learning that I had seen for this particular unit would continue with other units. Was it also possible to see these results when mapping was done in small groups or as part of an individual's study strategy? Over time, I have observed that concept mapping seemed to have merit, especially if used regularly to prepare for tests. Perhaps it was only my enthusiasm for the process that was influencing the outcomes that I had been noticing in my classes and not the mapping process itself, but I felt that I had found a technique that could enhance student learning. However, I needed more than my cursory observations and teaching instincts to prove the value of concept mapping to myself and to my students. I needed to know if there were specific study and learning skills or techniques that were more useful than others for the learning process, and whether or not concept mapping would meet any of the current educational criteria for good study or learning skills. This study is meant to provide a better perspective on the value of concept mapping to improve student learning and by extension, my teaching.

## Chapter 2: Background

### Defining Study Skills and Learning

To begin the discussion of concept mapping as a study skill or strategy requires the definition of the currently used vocabulary associated with studying, learning, and concept mapping. A skill is defined as “a capacity or ability developed through practice” (Schmeck, 1988, p. 5-6). Study skills would then be “the effective use of appropriate techniques to complete a learning task” (Gall, M.D., Gall, J.P., Jacobsen, Bullock, 1990, p. 10), which can be developed through practice. These skills or techniques may include outlining, networking, mapping, schematizing, underlining, paraphrasing, summarizing, comparing and contrasting, and drawing inferences (Anderson & Armbruster, 1984, Weinstein, Ridley, Dahl, & Weber, 1988-89). All of these techniques can be used as part of an overall learning strategy to improve the learning of any students who wish to improve. Learning strategies can be defined as “behaviors or thoughts that facilitate learning” (Weinstein, et al., 1988-89, p. 17). As an educator, I want to improve the effectiveness of student learning by teaching students the kinds of skills needed for learning to take place, and to teach them to recognize the learning situations in which these skills would be the most effective.

To understand study skills, we must look at the process of learning. Different kinds of learning require different kinds of study skills and strategies. Hegarty-Hazel and Prosser (1991) describe two basic types of study strategies: surface study and deep study. Each of these strategies is used for a particular kind of learning. Surface study strategies are used to learn or memorize new material. Deep study strategies are used to relate new



material to previously learned material as required in problem solving. Learning requires that one encodes information into memory and be able to retrieve it when needed. To encode information, students must be able to focus their attention, extract the relevant information, put it into memory with some degree of comprehension by connecting it to previous knowledge, and then retrieve it at a later date (Armbruster and Anderson, 1981). Those students who are most proficient at learning can also evaluate their comprehension and progress and take the required steps to remediate incorrect or incomplete knowledge as needed (Armbruster & Anderson, 1981). The goal of any learning strategy, according to Weinstein and Mayer (1986, p. 315), would be to “affect the way in which the learner selects, acquires, organizes, or integrates new knowledge.” Learners should be able to select and use the particular skills and strategies that will work in a given situation, to monitor their comprehension, and to initiate remediation as needed to maximize their learning. These are the skills that self-directed and self-motivated learners would exhibit.

Weinstein and Mayer (1986) name eight categories of learning strategies that deal with the particular kinds of encoding processes required for the particular kinds of learning to which students will be exposed. These include:

1. Basic rehearsal strategies
2. Complex rehearsal strategies
3. Basic elaboration strategies
4. Complex elaboration strategies
5. Basic organizational strategies
6. Complex organizational strategies
7. Comprehension monitoring strategies

## 8. Affective and motivational strategies

Basic rehearsal strategies are those strategies like reciting lists for the memorization of facts, which become part of short-term memory. Complex rehearsal strategies require that the learner select specific information to become part of memory by means of such techniques as repeating material out loud, underlining important points, and making verbatim notes. It is a slightly better form of memorization. Students preparing for short tests most frequently use these rehearsal strategies.

Basic elaboration strategies, such as imaging and paired-associations, are used to learn languages and vocabulary lists. These are the next step beyond rehearsal, but are still used to put information into short-term memory for quick recall. Complex elaboration strategies, such as paraphrasing, summarizing, question answering, and making analogies, tie new information to existing knowledge. These strategies are used in taking tests which employ the recall of facts, definitions, vocabulary, or spelling as is found in many multiple choice tests.

Basic organizational strategies, such as grouping and reordering on the basis of shared characteristics or meanings, require the active involvement of the learner. Complex organizational strategies such as outlining, creating hierarchies, or diagrams, require that selected information be placed into logical patterns to indicate their relationships within a knowledge framework. These last strategies require the conscious efforts of the student and a significant amount of dedicated time in order to benefit the student in problem solving and application of knowledge situations.

Comprehension monitoring strategies such self-questioning and prereading text material, require learners to have and set goals for their learning, assess their degree of

success in attaining these goals, and to modify the strategies used in order to reach their goals. Affective and motivational strategies such as relaxation techniques, positive thinking, and time management are used to create a suitable learning environment. This allows the learner to be in charge of the conditions under which their learning is to take place; to control his or her own learning.

Each of these eight techniques is effective in encoding particular kinds of information into memory, singly or in various combinations. Learning cannot be limited to the use of only one or two of these strategies. The techniques should be used together in a variety of combinations to suit the testing or learning situation being faced. Therefore, if meaningful learning is to be the goal of education, it is important that students be taught the specific skills and strategies needed to deal with the many types of learning tasks that they will encounter. It has been my experience that too many students lack the skills or the will, to attain more meaningful learning and improved achievement. A simple device or tool that would aid in the development of more appropriate study and learning strategies to improve student learning would be of great use. Concept mapping could be this tool.

### Concept Mapping Explained

Concept mapping is a graphical or spatial representation of the structuring of knowledge about a particular set of concepts. Students constructing this graphic representation must select the key words, ideas, or concepts from a body of information, then organize and connect these concepts using lines and words to form a connected

hierarchy of the general and abstract concepts to the more specific and concrete concepts (Okebukola, 1992). By elaborating on this format using examples, definitions, and even simple diagrams, a student can create an individualized representation of his or her knowledge of a topic. Teachers can evaluate these maps based on the student's success in representing the required learning outcomes for each topic. The possible combinations that can be created by students to meet learning outcomes are infinitely varied especially when students are given the freedom to find their own connections and interconnections of meaning among the concepts. Concept mapping can be used for group work, as a class review, or as an individual study program. It can be changed or modified, until the "visual" representation of a set of concepts makes "sense" to the learner. The process of constructing the map allows the student to construct the "deeper meanings" of concepts, to make the connections between old and new knowledge and then to progress to higher levels of learning such as problem solving.

A concept map can be as simple or as complex as needed for a particular learning task (Adamczyk, Willson, & Williams, 1994). The starting point of the mapping process can be based on a given vocabulary list for any chapter or unit of study. Table 1 is a vocabulary list taken from an introductory unit on Ecology.

Table 1

A Sample Vocabulary List from an Ecology Unit.

Term	Definition
Environment	The interaction of living and nonliving things.
Ecology	The study of the interaction of living and nonliving things.
Ecosystem	All the living and nonliving things in a given area.
Community	All the living things in a given area.
Population	A group of one type or species of living thing.
Habitat	The place which provides the required resources for living things.

Figure 1 is an example of a simple concept map that could be developed, with student input, from this vocabulary list to illustrate the perceived relationships between the terms.

The terms are placed in boxes to denote that they have importance and arranged hierarchically to illustrate one's understanding of the relationships between the terms.

Arrows are used to represent the connections or relationships between the terms.

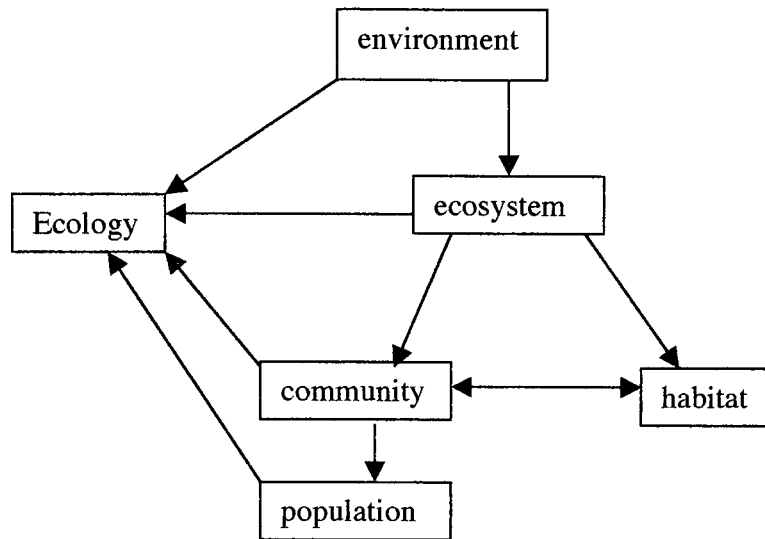


Figure 1. A simple concept map.

More complex concept maps, such as in Figure 2, would include definitions from our vocabulary list for each of the terms, which are then placed in a circle and connected to its respective term. The definition is simplified before being added to the map, which helps students to remember the terms and definitions more easily. These maps can be changed, modified, or added to as needed to demonstrate a student's improved understanding of a particular concept.

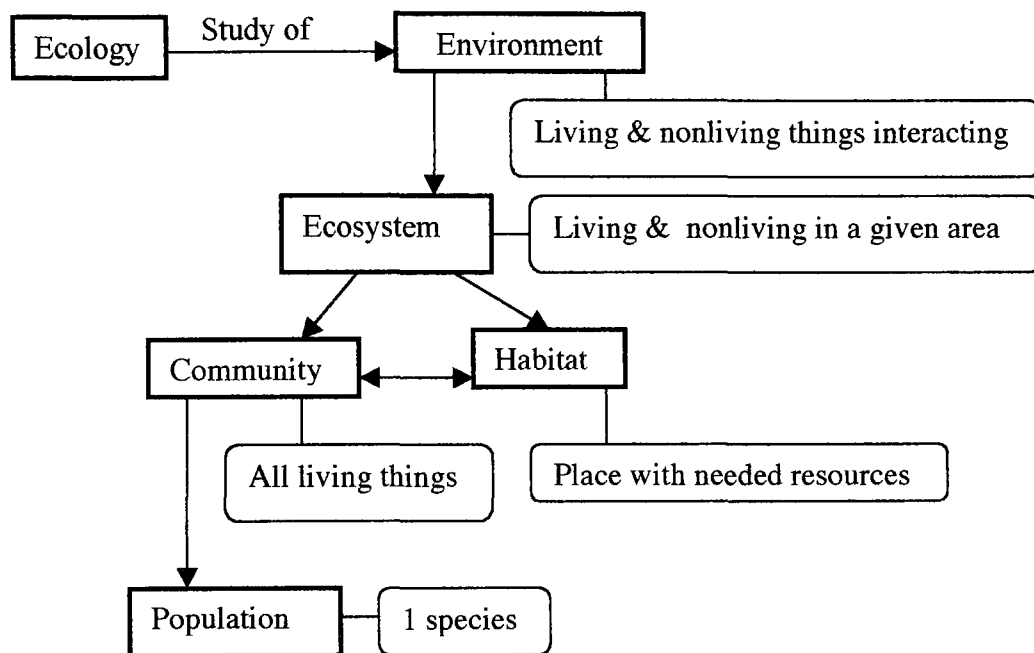


Figure 2. A complex concept map.

Concept maps can be handwritten or drafted on a computer. They can include diagrams and use color to create better meaning and understanding for the student. Concept mapping can be a learning strategy which allows students to manipulate information in order to make sense of it (Vaughan, 1984) which in turn leads to learning.

### Concept Mapping as a Technique for Studying and Learning

A good study technique helps to determine relationships, which can then lead to higher forms of learning and problem solving. Concept mapping requires the hierarchical arrangement of information and allows students to manipulate the information to make sense of it. Studying is considered effective when students process the “right information in the right way” (Armbruster & Armbruster, 1981, p. 665). Concept maps can allow students to represent the knowledge and understanding that they already have on a topic (Novak, 1991; Roth & Bowen, 1993; Dorrough & Rye, 1997), add to it, and even correct it. They are actively involved in finding relationships and meaning in the concepts being put into their maps (Dorrough & Rye, 1997). Concept mapping has even been found to be beneficial to the problem solving processes of science students (Okebukola, 1992). It offers a way for students to focus their attention and select the information to be processed into short-term memory. Then the material is reprocessed to create the meaningfulness that will put it into long-term memory where it can be retrieved and processed again for deeper meaning (Rafoth, Leal, & DeFabo, 1993). This type of “spatial learning strategy” is a valuable skill to aid comprehension (Breuker, 1984, p. 26). According to Breuker (1984), spatial learning strategies require key concepts, topics, or themes to be selected and the relevant attributes of these concepts noted. The relationships between these concepts are then determined by the arrangement in a hierarchy. Evaluations and comparisons can be made of the information presented in this format, leading to higher forms of learning and problem solving. The process of creating the concept map allows students to monitor their own progress and to make changes and



adjustments to improve their learning. This is the framework of knowledge acquisition. This is also the framework for concept mapping.

The process of making the map also has a positive effect on the students themselves in terms of enhancing their self-esteem and calming their fears about being adequately prepared for tests. If students can be shown that this technique can be a positive means of improving their learning and by association, their level of achievement, perhaps more of them can be persuaded to incorporate it into their repertoire of learning strategies and skills. Concept mapping may be a positive means of empowering students to take charge of their learning.

### Concept Mapping and Studying

Studying is considered effective when students process the “right information in the right way” (Armbruster & Anderson, 1981, p.665). Concept mapping can be one of the right ways to accomplish this task. Teaching students to elaborate upon the mapping process can meet the eight categories of learning strategies of Weinstein and Mayer (1986). Maps can be used for rehearsal strategies, both basic and complex, where basic recall of factual information is all that is needed. “The conscious manipulation of concepts into a visual array improves recall performance of information” (Vaughan, 1984, p. 140). For basic and complex elaboration, information can be selected and summarized, and then organized on the map to show the interrelationships. Maps can allow students to represent the knowledge and understanding that they already have on a topic (Novak, 1991; Roth & Bowen, 1993; Dorrough & Rye, 1997), add to it, and even

correct any misconceptions. The process of creating the map allows students to monitor their own progress and to make changes and adjustments to improve their learning. They are actively involved in finding relationships and meaning in the concepts being put into their maps (Dorough & Rye, 1997). The process of making the map also has a positive effect on the students themselves in terms of enhancing their self-esteem and calming their fears about being adequately prepared for tests. Concept mapping has even been found to be beneficial to the problem solving processes of science students (Okebukola, 1992). A given topic can be represented in a variety of ways making it an ideal method to incorporate into individualized learning programs. The maps can also be a source of feedback for instructors (Schmid & Telaro, 1990). To have more meaningful learning taking place in the classroom, educators need to empower students to take charge of their learning (Novak, 1993). Concept mapping can be one of the ways to accomplish this empowering process. The appropriate time to introduce this process would be when study habits are first being formed (Santhanam, Leach, & Dawson, 1998) such as the upper elementary grade levels and even at the junior high school grade levels.

Concept mapping can offer a way for students to focus their attention and select the information to be processed into short-term memory. Then concept mapping allows students to reprocess the material to create the meaningfulness that will put it into long term memory where it can be retrieved and processed for deeper meaning (Rafoth, Leal, & DeFabo, 1993). This type of “spatial learning strategy” is a valuable process in aiding comprehension (Breuker, 1984, p. 26). According to Breuker (1984), spatial learning strategies require key concepts, topics, or themes to be selected, and the relevant attributes of these concepts noted. The arrangement in a hierarchy helps determine the

relationships between these concepts. Evaluations and comparisons can be made of the information presented in this format, leading to higher forms of learning and problem solving. This is the framework of knowledge acquisition. Concept maps can be the graphic organizers which aid in more complex forms of learning by relating “the acquisition and retention of new understanding to one’s background knowledge” (Barron & Schwartz, 1984, p. 285). Concept maps can be a positive addition to the studying and learning processes (Anderson-Inman & Zeitz, 1993) of students, empowering their learning.

## Chapter 3: Project Methodology

### Choice of Methodology

To determine the effectiveness of concept mapping, I decided to observe and record the effects found within my particular teaching situation in a journal and to make personal comments on my observations as I taught the process of concept mapping to my students. I teach in a small rural high school with small class sizes but a wide range of student abilities and degrees of interest in science. Any observations and conclusion made as a result of this project would be most relevant to my particular teaching situation, but hopefully, there will be components of this study that could be applicable to other teaching situations.

To determine the effects of concept mapping, I chose to observe certain student behaviors. In my many years of teaching experience, I have come to recognize that certain types of student behaviors are positive indicators of learning taking place in the classroom. Positive learning indicators would be on-task behaviors such as students being able to work on an assigned task for lengthy periods of time with minimal distractions such as talking off topic, or “doodling” in their notebooks. Good collaboration during group work, with all members of the group contributing to the selection of information and its presentation, attentiveness to the details of an assignment, the asking of questions to clarify understanding are all good indicators of on-task behaviors. Such behaviors are easily observed and recorded in a journal. In choosing to use a journal, I have the freedom to record my observations discreetly at any time, during a class or at the end, without drawing undue attention to the study I am carrying out. I wanted students to feel

that using and making concept maps was just another component of the course requirements in my classes with no particular need to “help” or “hinder” my study. Since I am always jotting down notes in my Day Planner, my jotting down notes in a journal would not seem out-of-place and would be a good way to record my observations. Journal writing would allow for factual recording as well as reflective and in depth commentary as needed to clarify my personal understanding of the events taking place within my classroom (Ozdoba, 1993). I wanted my observations to be as reflective of my everyday classroom as possible to give my study the most validity for my particular teaching reality. Journal writing would also provide a daily record of what was done and what was learned in order to better evaluate the events of the day (Kingen, 1995). The journal would allow me to have foremost in my observations and reflections (McCrindle and Christensen, 1995), the observed effects of concept mapping on student learning and my teaching. It would provide me with a physical record by which I could evaluate the value of concept mapping both as a study skill and learning strategy for my students and, as a teaching strategy for me.

### The Project

After obtaining permission from my school board, each of my senior biology classes was asked to participate in this project. I have purposely not identified the class level or grade so as to maintain the anonymity of my students. Students were given an information/permission letter (see Appendix A for a Sample Permission Letter) to be signed by their parents and returned. The return rate of permission letters was less than 1

had hoped – 22 out of 23 for Class 1 and 5 out of 13 for Class 2. As a result, my observations were based on Class 1. I chose to make my observations over a semester, using approximately 68 of the 88 classes. Some classes were “lost” to such things as school presentations, Parent-Teacher Interviews, Non-Instructional days, holidays, examination days, and sick days for myself. I made daily notations in my journal (Appendix B), describing the basic teaching or lesson plan for each class along as well as comments on observed student behaviors, specific student comments, and my personal interpretation of my observations and experiences. For the purpose of this study, I tried to limit my comments to those occasions during which concept mapping was being used. However, I found myself commenting in my journal on “other” situations or events that arose in the process of teaching the course. This proved to be a great way to “vent” one’s frustrations and to “see” classroom issues in a different light allowing me to make changes in my teaching and classroom management strategies.

### Introducing Concept Mapping to the Classroom

To begin introducing concept maps, I first needed to convince my students that concept mapping was a tool or technique worth adding to their study skills repertoire. I began by initiating a class discussion on the kinds of learning that would be needed to be successful in science or biology several days before their first test. I had students describe the various study techniques that they currently employ to prepare themselves for a test. As a class, we looked at the positive and negative attributes of each of the techniques named. For the most part, the preferred method of studying was to read over text or note

material once or twice the night before a test. Though none of the students could prove themselves to be in possession of a photographic memory, the students who employed this method could not justify its use, other than to say that it was easier and it was what they had always done. When questioned further, these same students would admit to losing track of what was being read through boredom and interruptions of various kinds. Most students would admit that just reading the material over before a test did not help very much to commit the material to memory. The class concluded that this was not the best way to study. I would then lead the discussion into determining the kinds of skills that they have found did help to learn and remember material. We would also discuss which types of study skills would be more useful for the different types of learning situations they might encounter. As a class, the students concluded that memorization was good for basic facts and that lots of repetition of the facts was needed to commit them to memory. For this process, some would make lists of the terms to be learned; others used their own version of flash cards; and friends or family would quiz many of them in preparation for a test. Beyond these few techniques, the students determined that the majority of them were using poor and ineffective study methods. They were also at a loss as to how to make changes in their study skills due to their admitted laziness and the lack of knowledge of better alternatives for studying. At this point in our class discussion, students were open to learning alternative methods by which they could improve their study skills. Even the students, who were judged by their peers to have good marks and by extension to be good at studying, were interested in finding simpler and less time-consuming ways to study and maintain their level of scholastic achievement.

Now I could present the values to be found in using concept maps. The mapping format is simple with the flexibility to meet individual styles of learning. It can be adapted to suit most, if not all subjects. I point out that using the mapping process allows students to read, summarize, and record in a concrete form, all the information deemed to be important to a particular topic. Since the mapping process requires that information be written down, the information to be learned will be read and reread in order to be included in the concept map. This is the repetition of information we had discussed in class, which is required to commit information to memory. Organizing the information into meaningful groups will also help commit the information to memory. These are positive points to sway students toward the use of concept maps.

The next step in persuading students to use concept maps, is to show how the evaluative criteria by which I will grade their maps is also simple guide for them to use in creating their maps. All concept maps are required to have three basic components in common. First, all the terms and definitions on a topic must be present in a simplified form with the wording of definitions chosen to clarify meaning for each student. Second, the terms and concepts chosen must be connected using lines and arrows. Using arrows within their maps to show the connectivity of the terms and concepts will aid their understanding and help to place this information into a level of learning beyond the basic recall of facts. It is being committed to memory in a new and better way. Third, all maps must show organization of the concepts. Organizing the information on their maps into relevant categories or groupings then allows the progression of learning into the higher thinking realms where new information can be associated with previously learned information. Students can make the connections between pieces of information and note



the interrelationships, which is a necessary skill for problem solving. Where and whenever possible, maps should include diagrams to clarify understanding of the concepts to be learned. Color coding the terms and definitions or the interrelationships is encouraged as it helps students to make sense of what is to be learned. The concept maps should be simple, yet include enough information to give a particular topic thorough coverage. The concept maps created by the students should become a means of organizing and reviewing the required information on any topic. It may also serve as a means of determining how completely one has learned that particular topic. If one is consulting one's text or notes too often in constructing the map, perhaps, one has not really learned what should be known. Information can be added to the map or corrected as needed especially when preparing for unit tests or final examinations. I emphasize that the repetition of information, which is built into the mapping process, allows information to be clarified and understood before it is committed to memory. I remind students that the process of concept mapping is a skill or tool that can be used for more productive learning. Factual information is retained more completely due to the number of times the information has been read, reread and written down in the process of creating the map. The mapping process will give students a means to move beyond the mere memorization of terms and definitions into looking at causes and effects, making useful predictions, and being able to evaluate new information for its relevance to previously learned concepts. Students will find that they are able to retain the information learned long after a specific test, an important component of long-term learning.

The next step was to model concept mapping on the blackboard for students. Since I have been teaching and encouraging the use of concept maps in my classes for

several years, most of my senior students had already had some experience with concept mapping in my Junior Science classes. This made it a little easier to have students use concept mapping and see it as a normal part of the class. “Building” a map on the board to review before an exam was a good way to show students who have never created a map the characteristics of a concept map and how useful they can be to the study process. For those who have done maps previously, the board map was a good reminder of the details that needed to be included. I started with a vocabulary list for a chapter or unit of work, building a map showing connections and the interrelationship of terms, and adding the definitions of the required vocabulary until the chapter or unit to be tested had been thoroughly covered. In a class period, the class and I can build a concept map using key terms, definitions, examples to illustrate the key concepts of a chapter or unit, and even diagrams. For those students who are linear thinkers and who need lists to organize and remember information, a radiating map such as that in Figure 3 on Viruses can include these lists. Others may choose to build a map around a diagram such as in Figure 4 creating a thorough summary of the required knowledge for the topic of Digestion.

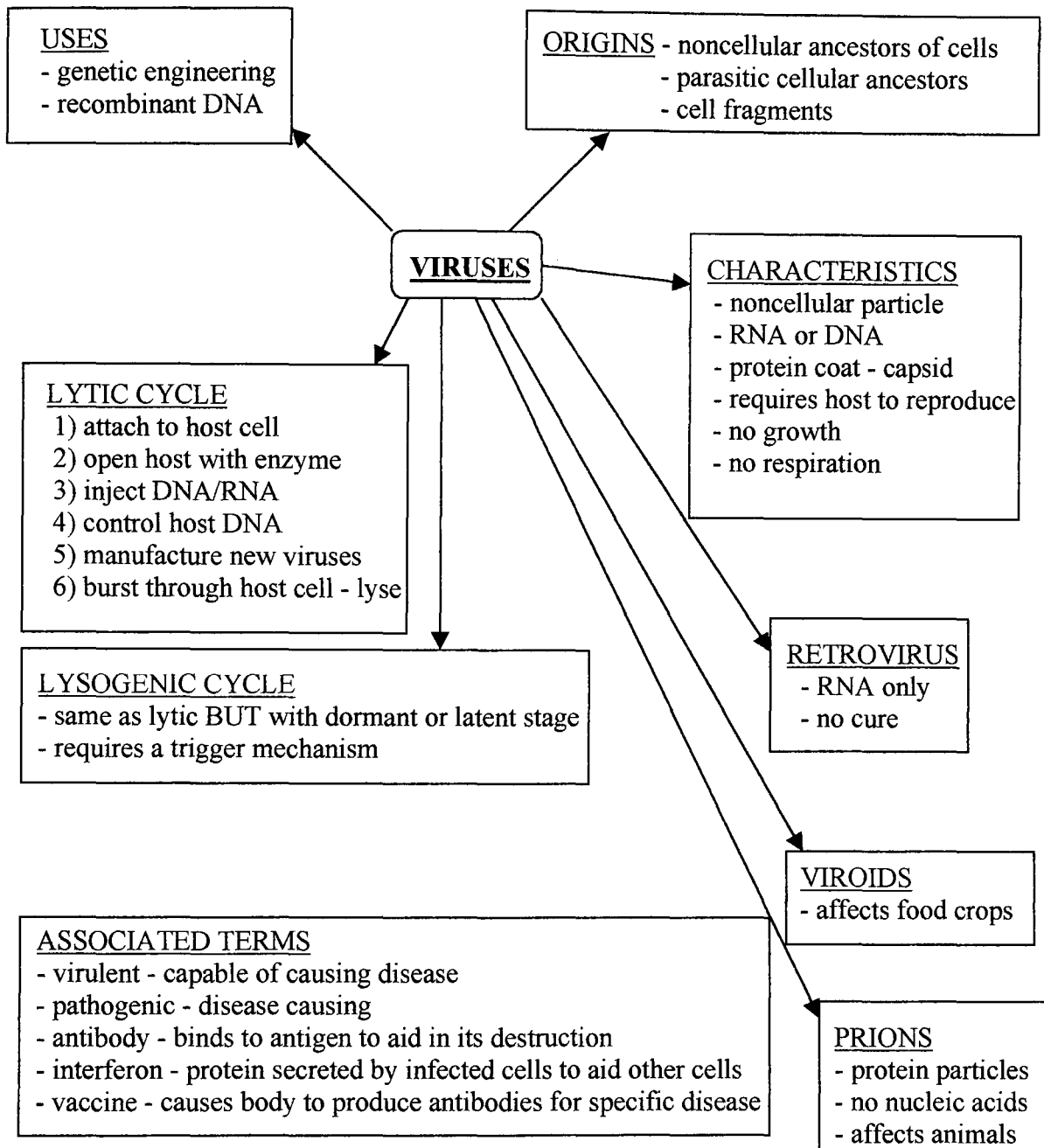


Figure 3. A radiating concept map on viruses with lists of pertinent information.

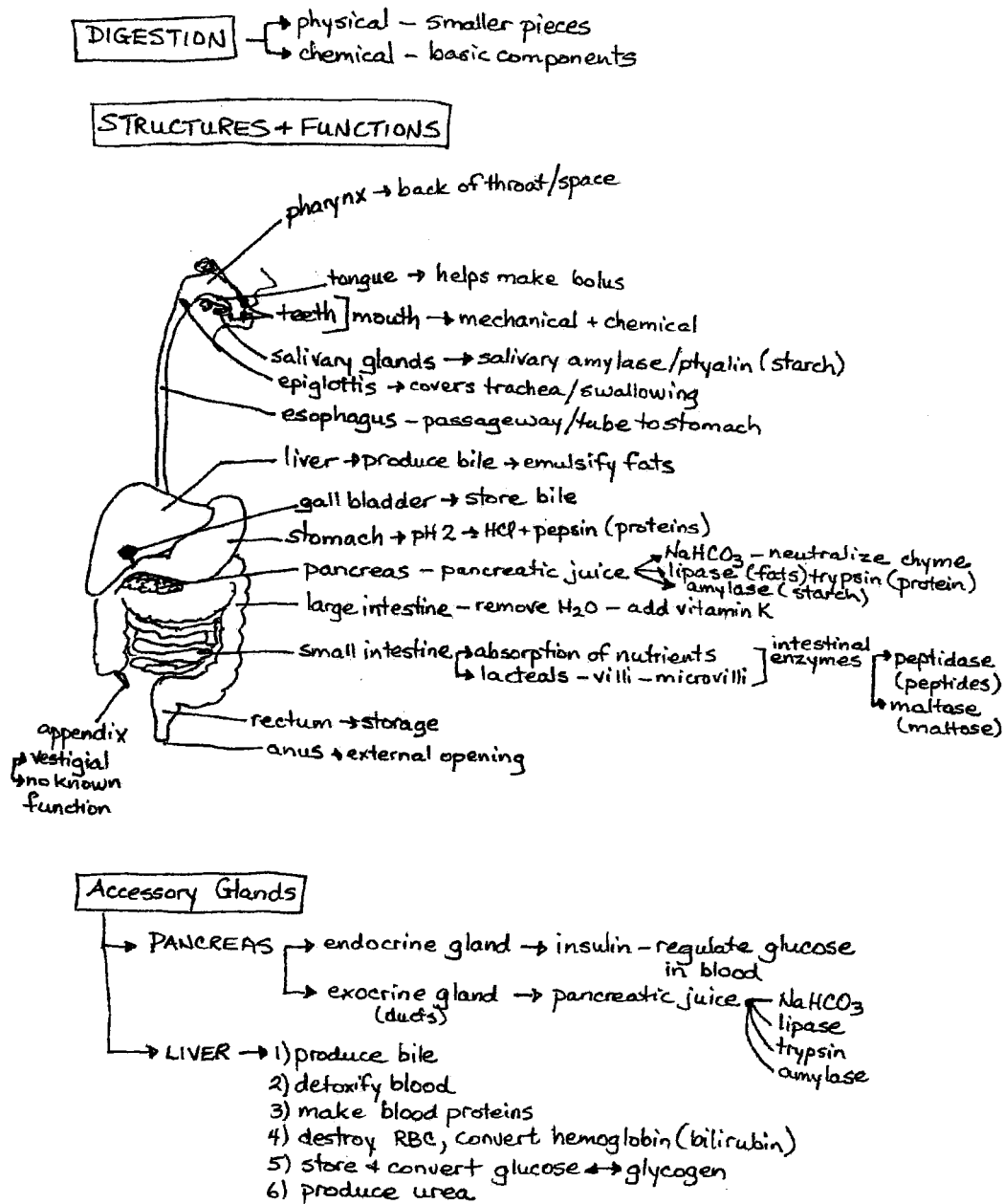


Figure 4. A handwritten concept map structured around a diagram of the digestive tract.

We have reviewed and presented our knowledge and understanding of a topic in a new way. The map we have created on the board is not the only way to represent the particular unit being studied. Students are encouraged to create their own pen and paper maps and to work and rework their maps until they are personally satisfied that all the material to be tested is represented. I remind the students that each map should be reflective of their individual learning style and that no two maps will be exactly the same. However, each map should share certain characteristics in common: all the terms and definitions of the chapter or unit being studied, visible connections between concepts and terms, and visible organization of the concepts and terms. I encourage students to create pen and paper maps rather than computer generated maps as it has more immediacy for them and is less time consuming. The map can be worked on at any time and be “built” over a period of time. The map can and should be personalized to better reflect each individual’s particular learning style using colored words or lines, diagrams, and boxes, anything that helps them to make better sense of the information to be learned. I remind students that creating a good concept map is work, but it is productive work that will help their learning. A cautionary note is given to students concerning the improvements sought in their grades. It will take some time. Students will need to become adept and comfortable at creating the concept maps, but with patience and practice, the results can be satisfying.

For me as the teacher, the concept maps created by the students readily indicate whether or not all the required terms and concepts have been noted and to some degree, give an indication of a student’s thought processes as he or she works through and organizes the required information. The actual learning or grasp of the required terms and concepts is more difficult to ascertain and can only be partially assessed in testing.

Students are required to submit their concept maps for marking before the start of each test period. I grade them using a simple criterion-referenced scale of 0 to 3 based on the prescribed learning outcomes for the course. Zero represented no attempt to map; 1, some map work attempted; 2, average with most terms and concepts included; and 3, was an excellent representation of mapping with all required terms, concepts, and interrelationships represented. It was easy to see if all the relevant or important terms were present, if the terms or concepts have been defined, and what connections have been made through the groupings of the terms and concepts. On several occasions when dealing with a particularly difficult unit, I would allow students to use their maps as a “cheat sheet” while writing the test. Incentives such as giving marks for their maps or allowing maps as cheat sheets in a test helped to encourage the use of concept maps and helped to insure that more students actually prepared for the tests. From my perspective as the teacher, it was important to have the majority of students doing some form of preparation for the test. These were my attempts to encourage students to use concept mapping to help them study. Though this study focused on concept mapping, other concrete representations of student efforts to study such as study notes or cards were also accepted for grading.

### The Effects of Concept Mapping in the Classroom

Teaching students to map is not difficult, getting them to do it consistently was a time consuming and frustrating process. A great deal of time was spent during the first two months just trying to convince students to use the process as part of their study skills

repertoire. Most students have a degree of comfort with whatever methods they have been using to study and learn up to this point in their schooling, and learning a new way to study was definitely not high on their list of priorities. As creatures of habit, students would prefer to continue using their old methods or techniques, even if these did not improve their success rate on tests. It was easier for them to continue to do what they had always done, rather than try to embrace a new technique. I found myself continually trying to encourage students to use the technique by expounding on the “built-in” benefits of concept mapping to their learning. I would remind them of the built-in value of the repetition of information through reading, rereading, and writing down the information. The visual representations and organization of the information on their concept maps had value in helping them to remember and connect ideas and concepts. The concept map could become a complete package of the knowledge that needs to be learned and retained for a particular unit or topic of study. Perhaps the best selling point was that each student could individualize the concept map to represent his or her personal style of learning so that there is no wrong way to create a concept map. Concept maps should be as individual as the person who creates them, yet contain the basic characteristics of a good concept map to represent and organize the required information on a topic. Despite my best efforts to sell concept mapping, it was difficult to get many of the students to take ownership of the process and to put genuine and consistent effort into the mapping process. Even though many of these same students had had previous exposure to the mapping process in the junior sciences, I was disappointed that I was unable to find any means of overcoming their reluctance to work with the mapping process.

Developing a degree of competency with the mapping technique required a significant investment in time by students. It took most of a semester, about 16 weeks, before those students working consistently with the process, noticed any real benefits to their learning and to their grades. It also took a considerable portion of my teaching time in the beginning of the semester, to continually review the steps and to encourage the use of the mapping process. I began to feel like a salesman “selling” the mapping process. However, I believed so strongly in the value of concept mapping to student learning that I continued to encourage my students to use this study technique. Students, in their last two years of classes, seemed to be the most reluctant to invest any significant amount of time in a process that could not guarantee immediate benefits to their grades. For many of these senior students, the need for good marks was paramount to gain entry into their chosen post-secondary schools and to obtain various scholarships. Learning a new technique for studying with uncertain results was not looked on with much favor. I found that offering incentives in the form of marks was necessary in order to insure some degree of participation in the concept mapping process. Even though one may feel that this “colors” the value of this study, it is one of the unfortunate realities that I personally must face in my teaching situation everyday. Few students are willing to do anything in a class, from reading a chapter in the text in preparation for a quiz or assignment, to completing an assignment, without the benefit of marks being awarded. As a result, I could not get students in my teaching situation to change their learning strategies without offering the incentive of marks. I included the concept map marks along with marks for quizzes and laboratory investigations, in a special grading category worth fifteen percent of their overall mark. After checking the calculations, I found that this percentage would



only minimally affect overall student grades. However, I did find this category of grading to be an indicator of the quality and regularity of homework being done by a student. Students who chose not to participate in the concept mapping could provide other evidence of their studying such as their study notes, and still receive marks for their efforts. This gave everyone the same opportunity to earn marks. Only those students who did nothing to participate in the class, such as not studying for quizzes or completing laboratory investigations, had their grades affected to any degree by the marks awarded in this grading category. Even so, the effect was marginal. I found that it was actually a useful category to demonstrate student work habits to parents during discussions in Parent-Teacher interviews. For those students who were active participants in the class, this became an incentive or bonus category that actually helped to improve their overall grades, especially if they were on the borderline between two grade categories.

For the first two or three tests given in a class, most students appeared to participate willingly and to put effort into their concept maps. However, after the novelty of mapping wore off, and the improvements expected in their test results were not immediately forthcoming, some students showed great reluctance to continue making the concept maps. Getting these students to continue to use the process was difficult and at times impossible, regardless of the incentives. Despite all my efforts and the incentives offered, some students reverted to using the old study and learning techniques that had had some measure of success for them in the past. Even when the benefits of concept mapping were demonstrated to them, they would not be persuaded to change their study and learning techniques. Another disappointment was that a number of students would insist on completing their concept maps after the test. They viewed the mapping as a

means of gaining extra marks and not as a study tool. This was disappointing in that the process became secondary to the marks that could be earned. I knew how beneficial the mapping process could be for learning and yet, found myself helpless to persuade many students to try it.

The positive side of the study was those few students who took ownership of the process of concept mapping and used it on a regular basis. They demonstrated to me the improvement in the learning of Biology that I had been seeking. When they had developed a degree of comfort with the process, the improvements in their overall learning were demonstrated through the use of new terms and concepts in class discussions and in their written assignments, and in the improved quality of their answers on assignments and on tests. While working on their maps, I would query students about the differences they had found when they used mapping to prepare for tests as compared to whatever methods they had used previously. Most students liked the way that they could focus on a specific topic and create a simple concrete representation of a body of knowledge. They also liked being able to leave the work and come back to it, picking up where they left off, without having to reread pages of text or notes. They seemed to enjoy the flexibility of concept mapping to meet their style of learning and still have the security of being required to meet specific criteria. This was a perfect blend of the freedom to be different than everyone else and yet be “right” as long as the criteria were met. The improvements to student work habits and their learning were heartening and gave me hope that continued work with concept maps would bring more benefits and more converts. Despite the improvement in the quality of student work, it was

disappointing for me and for the students that it took almost an entire semester before the positive results were noted.

As the teacher, I liked the on-task behaviors that I would see with the mapping process. Students were working to accomplish the tasks set before them with accuracy. Work periods were being used more productively. When working on concept maps, singly or in small groups, students were focussed on the task and actively involved in meeting the requirements of a good concept map. Less class time was being wasted during the work periods with “off-topic” and personal discussions. It may be that the more concrete nature of concept mapping contributed to the positive efforts being made by students to accomplish the task. They could see the physical representation of their progress matched by their degree of efforts in their maps. I observed more positive sharing of ideas between students and with myself during the process of building concept maps. Class discussions became more interesting as students began connecting previously learned concepts with the new material to be learned. They began to remember what information they had put onto their maps. With this particular group of students, however, the class discussions did not really begin to work until almost the end of the semester. I am not sure if that was due to the concept mapping or just an overall maturing of the students over the length of the course. With group work, the sharing process and the positive on-task behaviors continued just as effectively. There were fewer of the distracting “side” conversations that tend to plague group work. Students working on regular class assignments were more focussed and wasted less class time. There were fewer discipline problems and classroom management was a non-issue. Students appeared to be more actively involved in the process of acquiring knowledge for

themselves. Now I could become a guide to learning rather than a dictator of learning. I could circulate more among the students answering their questions, encouraging their efforts, directing their learning. This is the teaching role that I prefer and concept mapping was helping me to carry out that preferred role.

Teaching students how to make concept maps and then convincing them to use the maps on a regular basis, was the hardest part of the process. One has to take the student's current study skills and show them how to incorporate these skills into the concept mapping process. This required time to be able to oversee and direct individual students while they were creating their personal concept maps. It also required time in the beginning of the semester, to show students through demonstrations, examples of concept maps, and discussions, how different learning styles can be incorporated into the mapping process creating different types of concept maps and then, reassure them that all the different concept maps are acceptable. In time, some of the students actually began to adopt concept mapping to prepare for their tests. Students would comment on how mapping helped them to make sense of the concepts to be learned. Student preparation for a test became more focussed and many found it to be less stressful. Mapping became a more productive use of everyone's time and a positive means to improve student study habits and study skills. With some of the more difficult Biology units, I would allow students to use their concept maps as cheat sheets during the test. These maps would then be submitted for grading after the test. Those students who submitted the most complete maps actually referred to their maps the least often during the test. They appeared to work calmly and efficiently through the test. The students who appeared to be more distressed and continually consulted their maps with each question were those who submitted

incomplete or poorly done maps. An interesting study, for future consideration, could be made on the effects of using concept maps during testing. This aspect of concept map use during testing also offers possibilities as a positive learning strategy to aid learning disabled students integrated into academic classes.

Students creating and using concept maps were demonstrating a positive learning strategy and a positive study skill. Teaching concept maps as a study skill naturally progresses into a learning strategy. This is a positive tool to improve overall student learning. The use of concept mapping does not mean that students will only focus on the task at hand, and that there are never distractions, or that they will suddenly become master learners and demonstrate great success in their studies. Mapping does not work every time or in every learning situation. It is, in my opinion, a positive addition to a student's study skills and learning strategies repertoire. It has the potential to benefit all students regardless of their abilities. I have found that Biology is a subject uniquely suited to the use of concept maps. The very structure and inherent organization of Biology makes it easier to convert students to the process of mapping. Though the effects of mapping are not always directly observable or measurable, the effects that I did see were encouraging. Positive student behaviors in class and improved student learning have encouraged me to continue the use of concept mapping in all my science and biology classes. Concept mapping is a good "fit" within the context of my teaching situation and my teaching style.

## Chapter 4: Conclusion

### What Was Learned About Concept Mapping?

Concept mapping is work. It is work for the students to learn and use. It is work for the teacher in training students how and when to make a map, and in encouraging the use of the mapping process on a regular basis. One has to become mentor, coach, and salesman, in order to have students continue to use and work with concept maps. The teaching of the process must be done step by step over time with lots of encouragement and opportunities to model and practice. I feel that it is important for students to learn this form of “studying” and incorporate it into their learning strategies. It is a better way to learn. Concept mapping is both a study skill and a learning strategy. According to Schmeck (1988), practice is needed to perfect and develop skills and perfecting the process of creating a good concept map takes time and practice. The process of creating a concept map is also a good learning strategy and fits nicely with the effective learning strategies put forth by Weinstein and Mayer (1986). It is an effective technique in the completion of learning tasks as suggested by Gall et al. (1990). The process more than the map itself is important in creating usable and retrievable information that can be retained for long periods of time in memory. Putting information into long term memory to be retrieved and redirected into new situations becomes that valuable and desired commodity educators have termed higher level thinking skills or deep study strategies (Hegarty-Hazel and Prosser, 1990). The mapping process helps students to recognize the essence of information, to be selective in choosing what is important, and as shown by Rafoth et al. (1993), to find ways to organize the chosen information in meaningful ways.

They are able to process the right information in the right way (Armbruster & Anderson, 1981). This is the essence of learning. This is the essence of a good study skill (Weinstein et al., 1988-89). This is one way for me as the teacher to see that positive studying and learning are taking place within my classes. I can feel more confident that I have provided my students a useful tool for more effective studying and learning.

Marking the maps is easy and does not require a great deal of time. Even allowing for individual differences in the arrangement and presentation of the information, one can quickly determine the completeness of the map and mark it accordingly. A definite bonus to ease one's marking load. The maps can also indicate when students have not acquired certain required concepts. These errors in learning can then be redressed individually, or if a large number of students have missed an important concept or there is some misinterpretation of information, I can easily review or re-teach that concept. Students can then make the necessary changes or additions to their maps.

Good students, who have experienced a measure of success in school and already have a repertoire of study skills, were most easily converted to the use of concept mapping. For these students it seemed that simplifying their workload became the best selling point of concept mapping. The poor to midrange students, that I most wanted to help and have adopt this technique, were the most difficult to convert. I believe that it was the fear of change and the fear of failure that kept them from truly investing in the change to a new study/learning technique. Perhaps in time and with more practice, they can see and experience for themselves the benefits of concept mapping. All of the students required a great deal of reassurance, encouragement, and regular help to keep working with concept mapping. As they became more comfortable with the process, less

specific help was required from me. I would only need to offer words of encouragement with each set of maps and some small reminders of the essentials that would need to be included on the maps.

The task of teaching and encouraging the use of mapping at times seems daunting as it takes so long to see positive results. When the students use this learning strategy on a regular basis the results are the best reward. The results, from my perspective, were improved test results and improved quality in assignments, especially in the applied knowledge questions. Students began to reason their way through more complex questions. They were beginning to picture the connections between information that they had learned previously to what they were currently learning. I saw my students become more actively involved in the process of learning, and more independent of me, the teacher. Classes were becoming more interesting, more enjoyable, and less stressful for both the students and myself. We could enjoy the class and better appreciate the knowledge being shared. Learning biology became a positive experience for students and teacher.

Although this particular biology class may not have been the best choice for a study on concept mapping and student learning, I was able to obtain enough feedback to determine its value to my teaching. The process of concept mapping as it relates to studying and learning has enough benefits for students and teachers, that I am encouraged to continue teaching the use of concept mapping in my classes. It also demonstrated to me quite dramatically that converting students to a new and different method of studying and learning requires more than one teacher's belief and enthusiasm.



### A Final Perspective

Studying is the concrete application of skills to aid memory and learning.

Concept mapping is both a study skill and a learning strategy. I am so convinced of the value of concept mapping that I will continue to teach and use it in all my classes. I like the concrete nature and physical requirements of map construction. It gives me some assurance that at least some studying and learning is taking place when concept mapping is being used. An interesting and informative study could be made of the benefits of concept mapping to student learning over an entire school career from the elementary grades to high school and even beyond. However, I leave that to others to carry out.

This study has led me in a slightly different direction in my teaching strategies. I am currently trying to develop the use of concept mapping as a replacement or improvement on traditional note making. I can envision its potential to save time and improve the quality of learning taking place by simplifying the way in which students assimilate information and convert it to knowledge. As a result, I have begun to teach students how to read science and biology text material and to convert the information derived from their reading directly into maps. Students could develop their maps as they do required reading, skipping the usual note making and making their work time more productive. Then, in preparation for a test, or during class discussions, they could make alterations and even add to the map as part of their review process. I encourage students to “talk” their way through their maps as part of the review for a test. This gives them some indication of what they have already learned and what parts of the required concepts need to be clarified or relearned. This is another positive way to help students

use concept mapping to improve their learning. For me, this is another challenge to keep my teaching interesting and to improve what I do for students in my classroom.

I would like to encourage my fellow teachers, to teach their students this useful study skill and learning strategy. If concept mapping were taught to students in the elementary grades as they begin to experience the testing process, by the time they reach the high school where testing is continuous, they will have a degree of mastery of the technique of concept mapping. It would be wonderful if all students could acquire this useful tool to improve the quality of their learning.

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## Appendix A

### Sample Information/Permission Letter

#### **Information Letter**

Dear Parent or Guardian:

I would like to inform you of the study that I am conducting in my Biology 11 and Biology 12 classes this year to complete the final requirements for my Masters of Education degree through the University of Lethbridge.

I am looking at the process of Concept Mapping in Biology from the teacher's viewpoint. Through this study, I would like to determine 1) what benefits there are to teaching and using concept mapping in a class for the teacher, and 2) if this is a process that I would wish to continue to use in my classes in the future.

Please note that all information will be handled in a confidential and professional manner. All names, locations and other identifying information will not be included in any discussion of my observations. Students are free to choose not to participate in this study. Those who are not study participants are encouraged to choose alternate learning strategies.

Please indicate that you are aware of my study and your support for me by signing this letter in the space provided below, and returning the letter to the school as soon as possible.

If you have any questions, please feel free to call me at Elkford Secondary School at 865-4674 or, you may contact the supervisor of my study, Dr. Rick Mrazek at the University of Lethbridge at 403-329-2452, or Dr. Richard Butt, Chair of the Faculty of Education Human Subjects Research Committee at 403-329-2434, if you wish any additional information or reassurances.

Thank you for your assistance and support in this study.

Sincerely,

Ms. Linda Malesza  
Biology Teacher  
Elkford Secondary School

**Please sign and return this letter to Ms. Malesza at E.S.S.**

**Project Title: A Teacher's Perspective on Concept Mapping**

I, (Parent/Guardian's Name) \_\_\_\_\_ have been informed of  
(Please Print)

Ms. Malesza's study and I agree to allow my son/daughter, \_\_\_\_\_  
(Please Print)

to participate in this study.

Signature \_\_\_\_\_ Date \_\_\_\_\_  
(Parent/Guardian)

## Appendix B

Project JournalDAY 1

Lesson Plan: Introduce terms and concepts for Evolution, Chapter 13. Have students read chapter and begin a vocabulary list with terms and definitions.

Comment: I want students to have a working list of terms and definitions before beginning the process of building a concept map.

DAY 2

Lesson Plan: Have students build a concept map. May work with a partner.  
1) students are to organize terms into meaningful groups.  
2) add short meaningful definitions to terms.  
3) box or highlight terms and complete connections using arrows.  
Assign half of the chapter questions for homework.

Comment: It is important to keep encouraging students to group or arrange words in meaningful ways – that help them to make sense of the information. Students appear to be more focussed on the task at hand. There was good discussion taking place concerning connectivity of terms and the relationship between terms and definitions.

DAY 3

Lesson Plan: Begin next chapter by discussing with the students how to choose appropriate terms when doing required reading and how to take the meanings from context. Let students begin working on the chapter.

Comment: During the work period, more students seem to be putting effort into selecting the key words from their reading. Definitions are being taken from context of the reading rather than from the glossary or dictionary. One student noticed that 2 words from the previous list had different meanings in this second list. I told her to add the new meaning to her previous list in order to have a complete definition of the term in both lists.

DAY 4

Lesson Plan: Work Period. Students are to map Chapter 14 Vocabulary, may add or incorporate into Chapter 13 map, or do separately.

Quiz on both chapters' terms next class.

Comment: Wonderful on-task behaviors exhibited. Students appear to be very involved in working on their maps. Few, if any, distracting conversations. Discussions and conversations were centered on the mapping work.

DAY 5

Lesson Plan: Quiz on Chapter 13 and 14 Vocabulary. Mark in class.

Comment: None.

DAY 6

Lesson Plan: Reviewed terms and the background of information that leads to the definitions of Chapter 13.

Comment: Important to go over the background and history that leads up to the unit, to give context to the terms and help with the memory of the terms.

DAY 7

Lesson Plan: Continue background for terms in Chapter 14.  
Review of important terms in context of the material, which should have been pre-read by students. Assigned a chapter from a handout to read to establish more background for the various evolutionary theories and hypotheses.

Comment: Lecture format today. Made several assumptions today:  
1) students have read the text material and have completed a vocabulary list from the reading.  
2) students have put an "honest" effort into their concept maps.  
3) students will be reading the assigned homework and can put together in their own context the history of evolutionary theories.  
I'm not terribly happy with the lecture format since so many students appear to "tune out". I need to get the students more involved and interested in this material.  
I wonder how to excite my students with the many evolutionary theories.



DAY 8

Lesson Plan: Discussed Evolution of the 5 Kingdoms, Endosymbiotic Hypothesis, Biochemical Evolution, Mitochondrial DNA.  
Assigned Notes to be made from the Reading of “Human Evolution”.

Comments: None.

DAY 9

Lesson Plan: Discussed Human Evolution and Vertebrate Evolution.  
Assigned “thinking” question on the evolution unit – requires accessing more than 1 source of information and the inclusion of personal opinions.

Comments: Discussion – I talk, students “listen”. I can’t get a discussion going. No one volunteers anything. There is some reluctance to try new questions where the exact answers are not always possible. I am trying to get some thinking, organization, and application of knowledge skills going with this assignment.

DAY 10

Lesson Plan: Completion of “thinking” questions.  
Start Unit Concept Maps include Chapters 13, 14, and the information on Human Evolution. Allow work in small groups – 2 or 3 people or may work alone.

Comment: There are problems with “thinking” questions, which require students to join several points of discussion together to synthesize an appropriate response to the questions asked. Another concept map seems to be “bothering” some students. They’ve done 2 chapter maps and are reluctant to make a unit one incorporating the previous maps. I feel that practice and repetition are important to the process.

DAY 11

Lesson Plan: Oral Review of assignment questions and the unit.  
Time to be given to complete work due or to work on concept maps.

Comment: Most students on-task most of the time. Hard to judge how much they are taking in since I get very little feedback in terms of questions, answers, points of view expressed. This will be a difficult class to lead through Biology.

DAY 12

Lesson Plan: Test on Evolution – Multiple choice and short answer.  
Took most of the double block. Unit concept maps handed in.  
Assigned next chapter on Classification to read and to make their own notes.

Comment: 1 student complained about having to be tested on 2 chapters at the same time. I felt that the Test took longer than necessary for students to complete.

DAY 13

Lesson Plan: Assigned completion of reading and note making for homework.  
May also make a vocabulary list and map the terms.  
In class, students are to work on the 2 activities on Classification from the lab manual. May work in pairs. Afterwards, to complete in point form, the 5 concept mastery questions at the end of the chapter.

Comment: This is a good work period. Good on-task behavior.

DAY 14

Lesson Plan: Continuation of work on Activities and Concept Mastery questions.

Comments: Activity work is rather slow going. It is taking far longer than I thought it should. However, it is important to the understanding of the principles of classifying organisms. Some students seem to be caught up in the details not the process of the assignment. Many are not reading the directions of the activities carefully enough.

DAY 15

Lesson Plan: Work Period. Students are to complete all of the assigned tasks today – activities and review questions.

Comments: Slow going. Everything is taking far too long to complete, even the simple tasks.

DAY 16

Lesson Plan: Review Corrections for Chapter 16 – Spontaneous Generation.  
 Marked in class and recorded the grades.  
 Begin new chapter on Viruses. Gave notes on the overhead.  
 Assigned for homework: 1) drawing and labelling a bacteriophage  
 2) reading on Viruses from both texts

Comments: Some improvement noted for some students in doing review questions from the text. Still room for improvement in question interpretation and in providing shorter yet complete answers to assigned questions.

TOC Days

Lesson Plan: Complete notes Viruses.  
 Assigned Virus questions to work on and to complete for homework.

Comments: due to illness a teacher-on-call had to cover classes for 3 days.

DAY 17

Lesson Plan: Hand in Virus Questions. Give notes on the overhead on Bacteria.  
 Assigned Bacteria Questions for homework.  
 Give some class time to work.

Comments: A Work period. Quiet but slow progress.

DAY 18

Lesson Plan: Show video on Bacteria.  
 Complete Bacteria questions. Work on Concept Maps.

Comment: A Work Period. Answer specific student questions on Bacteria. Very little interaction with the subject matter. I miss the back-and-forth questions and answers when students are involved and interested. Curiosity is lacking in this group.

DAY 19

Lesson Plan: Correct Virus and Bacteria Questions in class.  
Remainder of class (15-20 minutes) to be used on Concept Maps.

Comment: Marking questions was very slow. Lots of questions about answers given. Had to collect and remark the questions myself. Students did a very poor job of marking each other's work. A waste of time to mark in class since they are not interested in learning from the process. They are only interested in the mark. Very disheartening for me to see this.

DAY 20

Lesson Plan: Chapter Review and Concept Mastery questions to be done orally in class.  
Discuss how to use the process of elimination to answer Multiple Choice type questions.  
Finish concept maps for coming test.  
Begin Chapter 18 Protists – read. Draw diagrams and label of Paramecium, Euglena, Ameba.  
Remind students that the process of mapping is a good way to study.

Comments: Hopefully I was able to give students enough hints on how to read questions and to come up with appropriate answers. This review process went relatively well – rate as OK to good. The test will tell.

DAY 21

Lesson Plan: Test on Viruses and Bacteria.  
After test, 1) to complete drawings of Protists  
2) Homework – to make a chart to compare characteristics of Euglena, Paramecia, Ameba – include form, locomotion & speed, food getting, digestion, absorption, respiration, excretion, sensitivities, and reproduction.  
3) Lab Assignment ( if time) – Viewing and drawing examples of Protists.

Comments: Some chart work was started.

DAY 22

Lesson Plan: Go over comparison chart on the overhead.  
Watch video on Protists.  
Work on Lab – Drawing Protists.

Comments: Charts were incomplete, some were not done at all.  
I question the level of commitment of these students to this course.  
Students need to practice using microscopes and how to draw detailed drawings based on what they see with the microscope.

DAY 23

Lesson Plan: Continue Lab work. Work on Protist questions.

Comments: Everyone busy completing Lab drawings.

DAY 24

Lesson Plan: Preserved Specimens of Protists arrive – do a Lab on preparing slides to view and locating specimens worth drawing.

Comments: I thought these were supposed to be live specimens – must have made a mistake in my order. This lab activity was very time consuming – but it was good practice in searching water samples for viable and viewable specimens.

DAY 25

Lesson Plan: Give overhead notes on Protists – to provide more of the needed information not found in the text.  
For homework: Hand out Protist diagrams to label.  
Chapter questions to be completed.

Comments: Some students worked ahead and completed the questions; others worked on color coding their structure labels on the diagrams.  
Some students don't know how to take notes – I must work on their note making skills. Also need to encourage the use of diagrams in the concept maps.

DAY 26

Lesson Plan: Review procedures for learning the labels of diagrams.  
Review chapter on Protists – phyla characteristics, examples, etc., role of protists.  
Work on Concept Maps and Study for labelling quiz.

Comments: None.

DAY 27

Lesson Plan: Labelling quiz on 3 types of protists.  
15 minutes to work on concept maps. Test soon.  
Begin new chapter – Fungi. Give overhead notes.

Comments: None.

DAY 28

Lesson Plan: Completion of overhead notes on Fungi. Add a Fungi phyla table into notes.  
Handout worksheets on Fungi - includes diagrams and special terms to learn.

Comments: None.

DAY 29

Lesson Plan: Test on Protists. – collect concept maps.  
After test, work on Fungi worksheets and assigned questions.

Comments: Marked concept maps.

DAY 30

Lesson Plan: Work on Fungi questions.

Comments: None.

DAY 31

Lesson Plan: Mark review questions in class.  
Collect Concept Mastery questions to grade.

Comments: Marking not very well done. Answers were assumed to be right and were not properly checked. More marks were given than had actually been earned.

DAY 32

Lesson Plan: Lab Work – microscope drawings of fungi and algae.  
Provide worksheets on Algae to be completed for homework.

Comments: None.

DAY 33

Lesson Plan: Go over and discuss Algae worksheets.  
Discuss how to apply information known to figure out reasonable answers to questions.  
Complete Concept Mastery questions for homework.

DAY 34

Lesson Plan: Concept Mastery questions handed in.  
Work on and complete Algae Concept Maps.  
Group work for Mosses & Ferns Concept Map to be shared with class in 2 days.

Comments: None.

DAY 35

Lesson Plan: Complete Concept Maps.  
Assign Review Questions.

Comments: None.

DAY 36

Lesson Plan: Sharing of concept maps created in groups with entire class.  
These maps will be allowed for use on next test.  
Review questions handed in.

Comment: I had to lead the discussion of the concept maps and encourage the participation of the group members. As well as encourage other group members to add to the knowledge of the class.

DAY 37

Lesson Plan: Test on Simple Plants with Concept Maps being used.

Comments: Those students with the better concept maps seem to have better test results. However, there are still those who either copied other maps, or tried to rely on the maps entirely, rather than put in the efforts needed to focus on the important concepts and terms when making the maps. It is the process not so much the map that seems to make the difference.

DAY 38

Lesson Plan: New unit on Plants (4 Chapters). Assign work/note sheets with diagrams. Students to work on their own or in small groups. Requires both texts.

Comments: This type of work sure keeps the majority of students busy. How good the learning taking place – it remains to be seen.

DAY 39

Lesson Plan: Complete note sheets, diagram labelling, concept mapping to be started.

Comment: None.

DAY 40

Lesson Plan: Correct Worksheets and Label diagrams. Work on Concept Maps.

Comments: Some students are putting great efforts into their maps. Better efforts create better maps. Beginning to see signs of better learning on assignments and tests.



DAY 41

Lesson Plan: Continue working on Concept Maps. Give list of diagrams to learn that will be on the test.

Comments: None.

DAY 42

Lesson Plan: Test on Plants (Multiple Choice & Labelling) – may use Concept Maps.

Comment: Tried to have them do the diagram labelling without maps – it didn't work. Allowed the use of diagrams as well as maps to help them finish the test.

DAY 43

Lesson Plan: New unit on Sponges. Give overhead notes. Assign reading and questions to begin working on.

Comments: None.

DAY 44

Lesson Plan: Give overhead notes on Cnidarians. Assign reading and questions.

Comments: None.

DAY 45

Lesson Plan: Give overhead notes on Unsegmented Worms. Assign questions to be finished as well as diagrams to label and worksheets to complete.

Comments: None.

DAY 46

Lesson Plan: Test day. Hand in Concept Maps.  
Assign Reading of Chapter 27 Mollusks for homework after test.

Comments: Those who most need the mapping process insist on doing it after the test is done or not at all. It's sad. Some students don't want to put any effort into the maps.

DAY 47

Lesson Plan: Go over mollusks. Review Labels for diagrams.  
Review key terms and concepts.  
Work on assigned questions. Learn diagram labels.

Comments: None.

DAY 48

Lesson Plan: Go over Annelids – labelling of diagrams, key terms and concepts.  
Continue to work on assigned questions.  
Learn diagram labels for quiz.

Comments: None.

DAY 49

Lesson Plan: Labelling quiz on Mollusks and Annelids.  
Earthworm dissection. Go over directions and give hints on how to best proceed, what to look for, and what to note in lab write-up.

Comments: None.

DAY 50

Lesson Plan: Finish Lab and complete write-ups.

Comment: Organization of maps improving. Several students commented on how the process kept them focussed on the task, helped to put order and sequence to the knowledge. This seems to be a useful process.  
One student felt that the process was too time consuming with not enough “pay-off” in marks. Most students are still not using concept mapping as an ongoing process to “build on their knowledge.”

DAY 51

Lesson Plan: Mollusk & Annelid Test.  
Begin next unit – Arthropods. Read and use chapter outline to make their own notes. Label handout diagrams.

Comments: Student comment: Can’t rush concept map, otherwise, it’s no use. Concept Maps done over several days allow information to sink in better. Better recall for tests.

DAY 52

Lesson Plan: Arthropod review and correction of diagram labelling.  
Work on Arthropod questions.

Comments: None.

DAY 53

Lesson Plan: Dissection of Crayfish.  
Begin comparison of structures used to accomplish life functions – previous phyla to current ones.  
Arthropod Questions due.

Comments: Many not ready for dissection. Getting sloppy and lazy.  
How does one get students to use time more wisely, especially in such an academic course?

DAY 54

Lesson Plan: Grasshopper Dissection.

Comments: None.

DAY 55

Lesson Plan: Review of Arthropod Unit. Discussion of terms and concepts in preparation for the upcoming test.  
Assign completion of concept maps for homework.

Comments: None.

DAY 56

Lesson Plan: Test on Arthropods. Concept Maps submitted.  
Begin new unit – Fish and Amphibians. Focus on the 7 life functions, life style, and unique characteristics of the phyla.

Comments: Most students only learned 1 of the 2 required organisms to label for the test. There seems to be some problems with cross labelling of terms from one diagram to the next. Obvious problems in learning the proper terms and where to place them on a diagram.

DAY 57

Lesson Plan: Go over the classification of fish and the characteristics of each class.

Comments: None.

DAY 58

Lesson Plan: Go over Amphibians. Label diagrams.

Comments: None.

DAY 59

Lesson Plan: Frog dissection and lab write-up.

Comments: None.

DAY 60

Lesson Plan: Finish lab write-up.  
Assign Fish and Amphibian questions.  
Begin Concept Maps.

Comments: None.

DAY 61

Lesson Plan: Assign: 1) a comparison Chart for Reptiles and Birds 2) Diagrams to label  
3) Questions to work on.

Comments: None.

DAY 62

Lesson Plan: Go over Reptiles and Birds. Assign questions. To work on Concept Maps  
for this chapter.  
Begin new chapter on Mammals.

Comments: None.

DAY 63

Lesson Plan: Go over Mammals. Assign: 1) completion of comparison Chart with  
addition of mammals 2) diagrams to label 3) Questions.

Comments: None.

DAY 64

Lesson Plan: Rat dissection and Lab write-up. To complete unit questions.

Comments: None.

DAY 65

Lesson Plan: Questions to be handed in. Lab write-up completed and handed in.  
Make Concept Map in preparation for use on test.

Comments: None.

DAY 66

Lesson Plan: Vertebrate Test.  
Students may use their Concept Maps for the test.

Comments: 18 of 21 students used their concept maps to complete the short answer portion of the test.  
Point of interest, the 3 students who did not use maps are also currently failing the course.  
Those students with the better, more complete maps coped better with answering the questions. There was some consultation of the maps throughout the test.  
The students with the best maps had the best results on the test.  
Those with maps showing less connectivity had lower marks.  
Those with no maps had abysmal results.

DAY 67

Lesson Plan: Labelling Test on Vertebrates.  
Final reviews to begin in preparation for the final exam.

Comments: None.

DAY 68

Lesson Plan: Mapping Review. To use old maps and add to or change and redo as needed as part of the review process for finals.

Comments: Mapping is a good way to organize, to focus on the task, to see connections, to summarize, to picture relationships.

THE END

### FINAL OBSERVATIONS AND COMMENTS

- Maps are beneficial for review and studying. They work.
- Maps for Notes from reading and lectures are an interesting possibility that needs to be tried.
- Mapping requires step-by-step training.
- Mapping requires time. Time to work through the information, to select terms and concepts, to organize, to practice.
- Mapping requires lots and lots of practice.
- Mapping requires lots of encouragement from the teacher.
- Mapping improves on-task behaviors – paying attention to what needs to be done, focussing on the key terms and concepts that need to be known, more productive team work, better communication between members of the group,
- A good Concept Map is no guarantee of understanding or remembering.