# THE EFFECTS OF CONCEPT MAPPING ON PRE-NURSING STUDENTS' ABILITY TO RECALL PHYSIOLOGICAL CONCEPTS

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BY

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August 18, 1993
Date

To the Associate Vice President for Research and Dean of the Graduate School:

I am submitting herewith a dissertation written by

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entitled "The Effects of Concept Mapping on Pre-Nursing Students' Ability to Recall Physiological Concepts."

I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Nursing.

Jeanette Kernicki
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We have read this dissertation and recommend its acceptance:

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Accepted

Leslie M Thompson
Associate Vice President for Research and Dean of the Graduate School

THIS DISSERTATION IS DEDICATED

TO THE MEMORY OF

DEBORAH D. GAINES

A sister who shared
warmth, caring, and enthusiasm
(1959 - 1992)

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ABSTRACT

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The purpose of the study was to compare the effects of two instructional strategies on pre-nursing students' ability to recall physiological concepts. Two computer programs, one using paragraphs and concept maps and another using paragraphs and fill-in-the-blank questions, comprised the instructional strategies. Ausubel's Assimilation Learning Theory was used as the conceptual framework. The sample consisted of 46 pre-nursing students enrolled in an anatomy and physiology course.

A two-group, before-after, quasi-experimental design was used to study the hypotheses. Four intact course sections were randomly assigned to the control (fill-in-the blank questions) or the experimental (concept mapping) group. The experimental group completed the computer assisted program that used paragraphs and interactive concept maps of specific physiological concepts about fluid

volume. The control group completed the computer assisted program that covered the same concepts with paragraphs and fill-in-the-blank questions. The treatment was administered during the laboratory class periods. Both groups received a pretest, an immediate posttest, and a 6-week posttest.

Demographic data about the subjects was obtained by using a questionnaire. A 20-item multiple-choice test was administered as the pretest, immediate posttest, and 6-week posttest. Descriptive statistics including frequencies, percentages and means were used to describe the sample. The alpha level was set at .05 and the hypotheses were analyzed by using a two-way analysis of variance with repeated measures and an analysis of covariance. The analyses showed no significant differences between the treatment groups in the scores for either the immediate posttest or the 6-week posttest.

In this study, as a method for recalling physiological concepts, concept mapping was no more effective than reading paragraphs and filling in the blanks. Extraneous variables such as prior knowledge, learning styles, achievement motivation, and practice could have contributed to the nonsignificant results. The nonsignificant findings of this study contradicted previous research findings and could possibly be explained by the one-time implementation of the strategy, random assignment of intact classes, and the advanced level of the instruments.

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# CHAPTER 1

# INTRODUCTION

Recall of concepts is an essential process for success in education. Basic concepts, learned at the beginning of an education program, become the building blocks for future learning as the student progresses through the curriculum. Vital to successful progression through the curriculum is the student's ability to learn concepts in a way that will increase the probability of recalling those concepts when needed.

Recall of concepts is particularly important in professional programs, such as nursing. Students bring to nursing programs concepts from the biological and physical sciences, including microbiology, anatomy, physiology, and chemistry. Concepts from these disciplines represent the physiological foundation of nursing knowledge. Students must recall fundamental scientific concepts and use them in client situations to build a sound theoretical base for nursing practice. If a sound base is not built, students are at risk for failing nursing courses that have a physiological focus.

To assist the student with the process of recall, instructional strategies that facilitate storage of information in the long-term memory must be used. The purpose of this study was to compare the effectiveness of two instructional strategies on pre-nursing students' recall of physiological concepts. The two strategies were a computer program that used concept mapping and a computer program that used fill-in-the-blank questions.

## Problem of Study

In an upper division nursing program in which the researcher is on faculty, the National League for Nursing's (NLN) anatomy and physiology examination was administered to beginning junior level nursing students to assess recall of anatomy and physiology concepts. The results of the examination revealed students' weaknesses in recalling physiological concepts. Scores on the physiological section ranged from 14 to 47 (highest possible score = 65) with a mean score of 26. The class mean score was lower than the mean score (38.66) achieved by nursing students in other baccalaureate degree programs (National League for Nursing, Inc. [NLN], 1991). Inability to recall knowledge contributed to the low scores and seemed to correlate with the failures in the required pathophysiology course. Final semester course reports from two semesters indicated that one-third to one-half of the students failed the required pathophysiology course. Those who passed the course had grades of 70% to 79%. Data therefore revealed that these students generally were not able to recall basic physiological concepts.

Because of the low achievement scores and the failures in the pathophysiology course, it was imperative to investigate instructional strategies that enhanced recall of concepts and could be implemented in a nursing curriculum. Therefore, the problem of this study was to answer the question: Does a computer program with concept mapping have a more positive effect on students' recall of key concepts than a computer program with fill-in-the-blank questions? Concept maps are visual, hierarchical structures which consist of concepts and show linkages and relationships (Novak & Gowin, 1984). These maps encourage meaningful learning by requiring that key concepts and relationships in the material be identified.

## Rationale for Study

On the basis of both the information about storage of concepts in the long-term memory (Davis, 1988), and of the failures in the pathophysiological course, research into instructional strategies that enhance concept recall was necessary. Currently no nursing research studies have been reported that examine students' ability to recall physiological concepts.

Research in some non-nursing disciplines, although not specifically directed toward instructional strategies for recalling physiological concepts, does include studies addressing several general strategies (Abayomi, 1988; Barron & Schwartz, 1984; Carter, 1983; Stensvold, 1989; Van Patten, Chao, & Reigeluth, 1986; Wallace, 1989). One such strategy, which has been used in elementary, secondary, and college curricula, is concept mapping.

Investigators have conducted experiments in biology education that use concept mapping. Novak, Gowin, and Johansen (1983) studied the use of concept mapping by junior high school science students. The researchers hypothesized that when learning is meaningful, students will organize knowledge hierarchically and will be able to better conceptualize the information. Results of the study indicated that after less than 6 months of concept mapping course content, students in the experimental group demonstrated greater problem-solving ability in the science course than did their counterparts.

Cliburn (1985) compared two teaching methods—traditional lecture versus concept mapping—for organizing and presenting content in a junior college anatomy and physiology course. Data from the concept mapping approach revealed only marginally higher immediate posttest scores but significantly higher 6-week posttest scores. The latter, according to the investigator, implied that students retained and applied information more successfully when concept mapping was used as a teaching strategy.

Concept mapping via an interactive computer program positively affected college students' ability to read, comprehend, and reconceptualize scientific textbook material (Mikulecky, Clark, & Adams, 1989). Participants scored significantly higher on posttest examinations and were able to transfer the mapping strategies to reading assignments.

Many authors (Ault, 1985; Heinze-Fry, Cronello, & Novak, 1984; Moreira, 1979; Stewart, Van Kirk, & Rowell, 1979) have likewise reported successful educational applications of concept mapping in a variety of science and science- related courses. Because concept mapping has had significant and positive results in other fields, it was reasonable to inquire whether concept mapping could have a similar effect in nursing courses to facilitate recall of physiological concepts.

Nursing students must acquire, recall, and apply large amounts of subject material to practical situations. If recall, a core skill, is weak, students will have a weak base for decision-making and problem-solving (Marzano, Brandt, & Hughes, 1988). The process is essential for implementation of appropriate independent nursing care. Therefore, the results of this study could provide data about the effectiveness of a specific instructional strategy, namely, a computer program with concept mapping, to enhance pre-nursing students' recall of physiological concepts.

## Conceptual Framework

A nursing curriculum consists of a large body of health-related knowledge that must be learned by students over a finite period of time. To assist students in organizing nursing information so that it may be learned and recalled in future situations, teaching strategies that organize content should be used throughout the curriculum. One such strategy could be based on the learning theory of Ausubel (1967).

Ausubel's (1967) assimilation theory, a cognitive theory of learning, is concerned with the acquisition of materials in a classroom setting. As an educational psychologist, Ausubel perceived a lack of plausible research in the area of classroom learning. He argued that laboratory research results were inadequate for the basis of a learning theory because the majority of the laboratory research was performed with lower species of animals and with rote learning. Instead, Ausubel suggested that principles governing classroom learning must be discovered only through applied research in the school setting. This argument was the basis for his theory.

The central theme in Ausubel's assimilation learning theory is meaningful learning. Meaningful learning occurs when the learner links new information to existing information in long-term memory. In this type of learning, the content that is to be learned is presented to the learner in an organized and inclusive form. When internalized by the learner, new knowledge undergoes several processes: subsumption, progressive differentiation, integrative reconciliation and superordination (Ausubel, 1967). When new knowledge is subsumed, it is incorporated into more general concepts. The process of subsumption facilitates the movement of relevant information through perceptual barriers and provides linkage between newly perceived information and previously acquired knowledge (Ausubel, Novak, & Hanesian, 1986). Subsumption is interactive and depends on previously learned concepts.

After the concepts are subsumed, they undergo a process called progressive differentiation. In this process, information such as concept attributes increases and becomes a part of larger concepts. As the learner is exposed to more information about the concept, the more the learner is able to associate the concept with other concepts. For example, the concept of protein can become a part of the larger concepts of nutrition and fluid volume. Within the concept of nutrition, protein is viewed as a component of muscle building, and in the concept of fluid volume, protein is seen as an important regulator of fluid volume.

Progressive differentiation of concepts occurs through the processes of integrative reconciliation and superordination. Integrative reconciliation occurs when two or more concepts relate to each other in a new way (Ausubel et al., 1986). For example, the concepts of blood pressure, blood volume, and circulation relate to one another differently in shock than in hypertension.

In contrast, superordinate learning occurs when previously learned concepts are recognized as elements of a larger, more inclusive concept. In this process, subsumed concepts take on new meaning and new relationships to one another (Ausubel et al., 1986). Blood is an example of a superordinate concept. As a general, more inclusive concept, it can be differentiated into several specific concepts. Some of these concepts are red blood cells, platelets, and plasma. Ausubel's (1967) learning theory is illustrated in Figure 1.

According to Ausubel et al. (1986), meaningful learning has these advantages:

1. Knowledge acquired meaningfully is retained longer.

2. There is easier subsequent learning of related materials when learning is meaningful.

3. If knowledge is forgotten after it has been meaningfully acquired, it is easier to relearn the same information and any relevant materials.

Meaningful learning can be affected by cognitive, affective, and social variables of the learner. Of these three, the cognitive variables have the most influence on the learner (Ausubel et al., 1986). Cognitive variables include prior knowledge and instructional materials.

Instructional strategies that assist meaningful learning include: (a) preassessment of prior knowledge, (b) advance organizers, and (c) graphic organizers. A preassessment identifies what the learner knows about the content before the content is presented. Advance organizers are paragraphs containing general information that is to be taught. Graphic organizers present the material to be learned in a hierarchical form.

THE LEARNING PROCESS

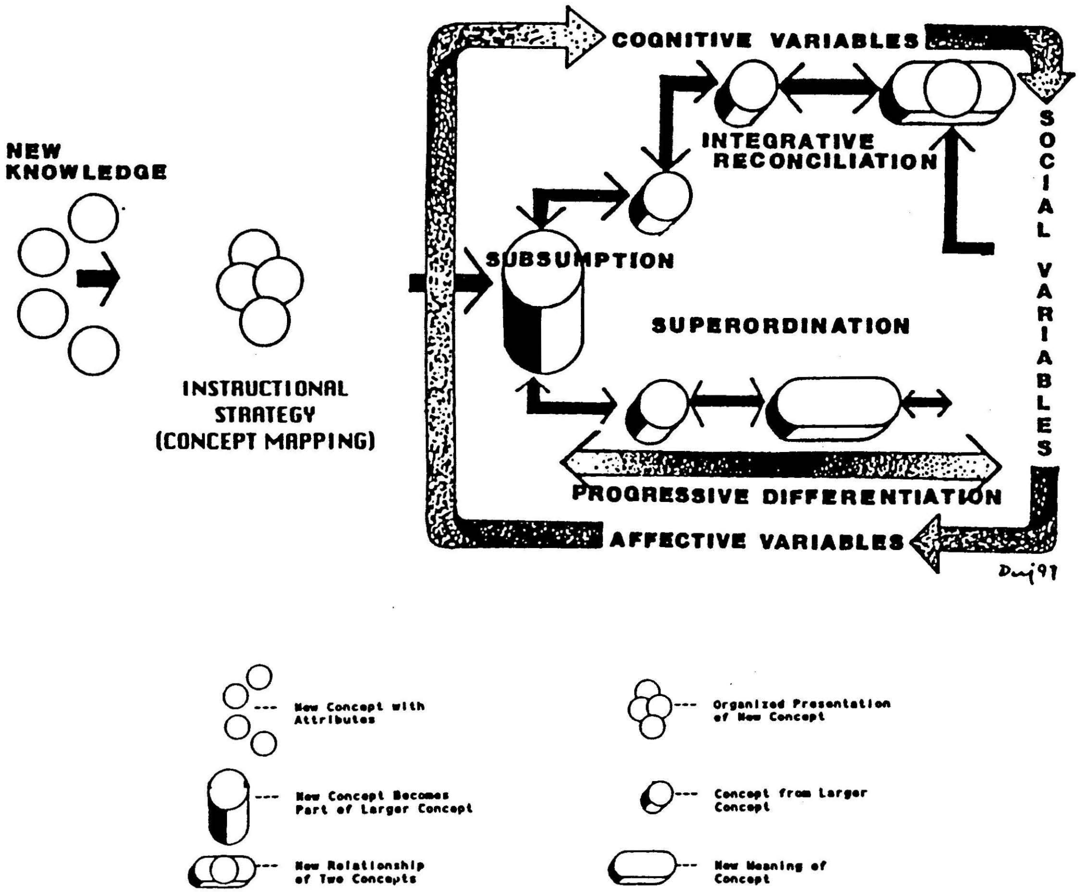


Figure 1. Assimilation of concepts (an adaptation of Ausubel's [1967] learning theory).

Preassessment is the most influential strategy for meaningful learning. This strategy provides direction for planning the learning activity.

Advance organizers provide a cognitive bridge between what the learner already knows and what is to be learned. They should be written in familiar terms but "presented at a higher level of abstraction, generality, and inclusiveness than the new material to be learned" (Ausubel et al., 1986, p. 171). To be effective, an advance organizer should be used before new material is presented to the learner.

Advance organizers may be expository or comparative. An expository organizer consists of inclusive or superordinate ideas that anchor new information in the mind. This organizer is used when the learning material is unfamiliar. An example of expository organizer is a paragraph describing a water hose and water pressure to introduce content on blood pressure. Comparative organizers are used when the material is somewhat familiar. In a comparative organizer, concepts are compared and contrasted (Ausubel et al., 1986).

In graphic organizers, the most general and inclusive ideas are presented first. This basic information is followed by the presentation of detailed and specific concepts. Concept mapping as developed by Novak (1979) is an example of this strategy.

## Assumptions

The following assumptions from assimilation learning theory (Ausubel et al., 1986) govern the design of this research:

1. Humans think with concepts.

2. Humans organize content in a hierarchical form in the mind.

3. Organization of knowledge prior to memory storage will enhance recall and application of concepts.

## Hypotheses

For the purposes of the study, the following hypotheses were tested:

$H_1$. Pre-nursing students who complete the concept map computer program will score higher on an immediate test of the recall of physiological concepts than pre-nursing students who complete the computer program without concept maps.

$H_2$. Pre-nursing students who complete the concept map computer program will score higher on a long-term, 6-week posttest of the recall of physiological concepts than pre-nursing students who complete the computer program without concept maps.

## Definition of Terms

For the purposes of the study, the following terms were defined:

1. Concept mapping. Visual hierarchical structures which consist of linkages and relationships of concepts (Novak, 1984). These structures were incorporated into a computer-assisted program.

2. Immediate recall. The process of retrieving information from short-term memory (Halpern, 1989). The operational definition of immediate recall was the score on a multiple-choice, teacher-made test administered to subjects immediately after they complete a computer program.

3. Long-term recall. The process of retrieving information from long-term memory (Marzano et al., 1988). The operational definition of long-term recall was the score on a multiple-choice, teacher-made test administered to subjects 6 weeks after they completed a computer program.

4. Physiological concepts. Constructs and ideas relating to the processes and functions of the human body (Mosby's Medical and Nursing Dictionary, 1986). The operational definition of physiological concepts was the constructs and ideas related to the processes of fluid volume and electrolytes.

5. Pre-nursing students. Students enrolled in liberal arts and science courses in a generic baccalaureate degree nursing program (Ellis & Hartley, 1984). The operational definition was students enrolled in an anatomy and physiology course offered in a generic baccalaureate degree nursing program.

## Limitations

The study results may be limited in their generalizability to the population because only one nursing program was used and the size of the sample was limited. The use of a convenience sample and intact groups also limited generalizability. The subjects were unfamiliar with the experimental instrument of concept mapping and only a limited amount of time was devoted to this experimental treatment which also limited generalizability. Subjects were allowed only two opportunities during the 1st week of the study to use the computer program.

## Summary

Determining how effective an instructional strategy is for enhancing students' recall of content can contribute to student success in a nursing curriculum. Students are presented many facts and principles that must be recalled at a later date. If the content is presented in an organized and hierarchical form, the student should be able to recall the information (Marzano et al., 1988). Ausubel's (1967) learning theory was used as a framework to study the effectiveness of an instructional strategy, namely, a computer program with concept mapping, on pre-nursing students' ability to recall physiological concepts.

CHAPTER 2

# REVIEW OF LITERATURE

Nursing is a profession that requires informed assessments and accurate communication of information to clients, families, and other professionals. To perform these functions safely and competently, nurses must be able to learn, recall, and apply information from various courses required in a professional nursing curriculum. The student nurse is exposed to some of these courses very early in the nursing curriculum, specifically in pre-nursing science courses. Information from these courses must be encoded into the long-term memory and recalled for use at later times.

The use of Ausubel's (1967) learning theory allows one to view the learning process as a pyramid of knowledge acquisition (see Figure 2). The base of the nursing knowledge pyramid is made up of pre-nursing courses. These are courses in the liberal arts, humanities, and basic sciences.

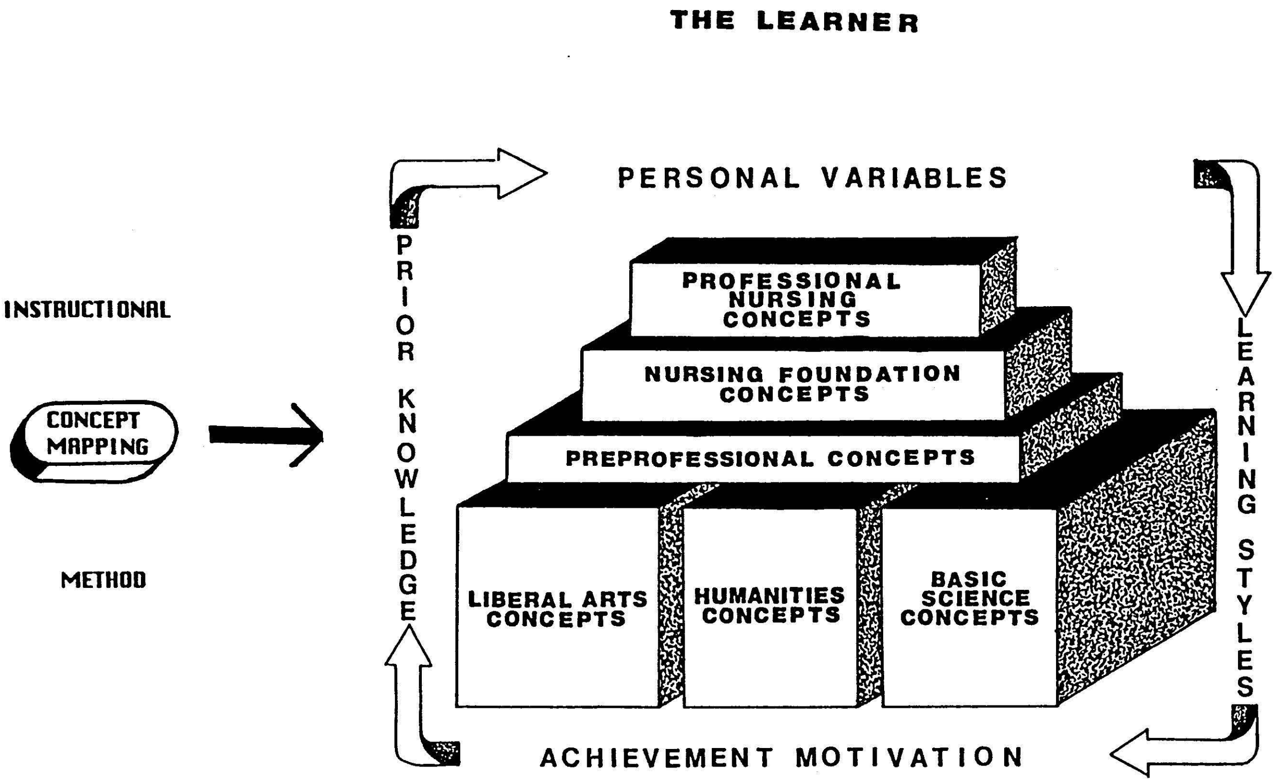


Figure 2. Assimilation of Nursing Concepts (Adaptation of Ausubel's [1967] Learning Theory).

Concepts from these courses form the foundation for sound theoretical nursing knowledge. The second level of the pyramid is comprised of concepts from the nursing foundation courses, including basic nursing concepts, pharmacology, and pathophysiology. These courses are built upon concepts from the pre-nursing courses. The final level of the pyramid is made up of concepts from professional nursing courses, i.e., nursing management, research, community health. Upon completion of these courses, students should be able to make appropriate basic nursing decisions.

Throughout the acquisition of knowledge, nursing students are expected to acquire, retain, and apply many concepts which must be stored and later recalled from long-term memory. Additionally, to make safe nursing decisions, students are expected to assimilate and recall concepts germane to nursing.

The objective of the literature review for this study was to focus primarily on an overview of memory, as well as on published research and anecdotal articles relative to the following: (a) concept mapping, an instructional strategy that has been used to facilitate the learning process, and (b) the cognitive variables that affect learning and recall, namely, prior knowledge and learning styles.

## Recall and Memory

Memory is categorized as either short-term or long-term. Short-term memory is sometimes referred to as the working memory wherein information is received from the senses or retrieved from long-term memory. The information is then manipulated and inferences are made and held for a limited period of time (Hayes, 1989).

Long-term memory, on the other hand, implies an unlimited capacity to retain information. Three processes occur within the long-term memory: encoding, storage, and retrieval (Hayes, 1989). Encoding, or acquisition of information into the long-term memory, affects the other two processes. To encode or "fix" information into long-term memory, one must perform a process called elaboration, that is, forming connections with knowledge previously learned (Hayes, 1989). The stronger the encoding, the better the storage and retrieval (Rose, 1989).

Rose (1989) compares memory to a library wherein books are stored systematically. The systematic storage of books makes retrieval quick and simple. Encoding is the equivalent of the library's systematic storage system. Rumelhart & Ortony (1977) theorized that information is stored in the long-term memory as schemata. A schema is a "data structure representing the generic concepts stored in memory" (Rumelhart, 1980, p. 34). Characteristics of schemata are: (a) they are active processes; (b) they represent knowledge at various levels of abstraction; (c) they have variables; (d) they may be embedded within one another; and (e) they carry out procedures and compare the procedure results to the observations being assessed (Rumelhart & Ortony, 1977; Rumelhart, 1980). Schemata help an individual to perceive information, understand discourse, remember, learn, and problem-solve. It is theorized that the format in which information is presented to the learner will influence the schemata or how that information is elaborated in long-term memory. When information is organized before it is learned, connections or linkages can be made with the information stored in long-term memory and thus can be easily encoded, stored, and recalled (Caine & Caine, 1991; Halpern, 1989; Hayes, 1989).

## Concept Mapping

Concept mapping is an instructional strategy that has been researched as a tool to aid in the encoding and recalling of information. As developed by Novak in 1972, concept maps are flexible diagrams showing relationships between concepts. These diagrams may be linear, one-dimensional, vertical diagrams showing lists of concepts or nonlinear, two-dimensional, horizontal diagrams showing hierarchical relationships among concepts (Moreira, 1979; Stewart, Van Kirk, & Rowell, 1979).

Studies using concept mapping as a tool for learning have been primarily related to science education. In these studies, researchers investigated the effectiveness of concept mapping on (a) the students' cognitive preference, the content and organization of an individual's ideas in a particular subject-matter (Ausubel et al., 1986); (b) the students' achievement; and (c) the students' attitudes toward concept mapping as a learning strategy.

Okebukola and Jegede (1988) researched the effects of concept mapping on cognitive preference. One-hundred forty-five students, enrolled in a pre-degree science curriculum, were nonrandomly assigned to experimental and control groups. The experimental group was taught the biology course by one researcher using the concept mapping technique. Students were required to construct maps of the content. The control group received instructions through the traditional lecture method.

In the study, the learning preference of each student was determined by use of the Biology Cognitive Preference Inventory (BCPI). The BCPI is a 30-item instrument which includes four subscales: (a) recall (learning information in the format presented), (b) principles (learning relationships), (c) questioning (critically analyzing information), and (d) application (learning information through simulations). The reliability coefficients for the four subscales were .69, .68, .79, and .71 for principles, application, questioning, and recall respectively.

Upon completion of the unit, a posttest was administered to the two groups. The scores were analyzed by using the $t$ test and an analysis of variance (ANOVA). The mean score of the experimental group (25.12) was higher than the mean score of the control group (18.23, $p < .01$). Subjects who had a cognitive preference for methods which used principle relationships had the highest mean score on the posttests. The results suggested that concept mapping was a useful teaching strategy for students who had a cognitive preference for relationships.

Pankratius (1987) investigated the effect of concept mapping on levels of achievement. Students in six high school physics classes ($n$ = 87) were the subjects in the study. A Solomon four-group research design was used to test the effects of concept mapping on achievement. The six classes were randomly assigned to control and experimental groups. Two classes served as the control group. One control group completed the pretest, standard instructions, and the posttest whereas the second control group completed only standard instructions and the posttest. Four classes comprised the two experimental groups. Each experimental group was comprised of two classes. In the first experimental group, one class completed the pretest, constructed concept maps of the unit's key concepts, revised the maps as the unit progressed, and completed the posttest whereas the second class only constructed concept maps of the unit's key concepts, revised the maps as the unit progressed, and completed the posttest. In the second experimental group, one class completed the pretest, constructed concept maps at the end of the unit, and completed the posttest whereas the second class constructed concept maps at the end of the unit and completed the posttest. A two-way ANOVA was performed to determine if a pretest-posttest interaction was present. There was not a significant interaction effect ($p < .05$).

The posttest means for the subgroups were then combined and the means of the three groups analyzed. An analysis of covariance (ANCOVA) of the posttest score means revealed significantly higher achievement scores for the experimental group than the control group [$F(1, 86) = 4.47$, $p = .025$]. There was also significant differences between the two experimental groups [$F(1, 83) = 4.17$, $p < .05$]. The experimental group that continuously mapped information scored higher than the group that mapped at the end of the course on the achievement tests. The results implied that, as a learning strategy, concept mapping was most effective when students map content over a period of time.

Willerman and Mac Harg (1991) investigated the effects of a concept map as an advance organizer to improve the science achievement of 82 eighth-grade students enrolled in four physical science classes. A two-group posttest design was used to test the hypothesis that students using a concept map as an advance organizer at the beginning of a physical science unit would have higher scores on a unit test than students who do not use a concept map.

The experimental group ($\underline{n}$ = 40) was presented a teacher-constructed concept map at the beginning of a physical science unit. The introductory lesson for the control group ($\underline{n}$ = 42) was a discussion of the physical science unit objectives. A 50-item teacher-made test (KR21 = 0.64) was used to assess the effectiveness of the concept map. Using a one-tailed $\underline{t}$ test, the mean score of the experimental group (68.86) was significantly higher than the mean score of the control group (63.30, $\underline{p}$ < .05). The authors hypothesized that the teacher-constructed concept map provided more direction for students to learn concepts and facts than did the discussion of the unit objectives.

Wallace and Mintzes (1990) examined the extent to which concept maps revealed changes in cognitive structures. Ninety-one elementary education majors were randomly assigned to experimental ($n$ = 42) and control ($n$ = 49) groups. Over a 3-week period, both groups received training in concept mapping, practiced the mapping technique, reviewed the mapping technique, completed a 40- item pretest ($r$ = .76), received instructions on a specific topic, and completed the pretest as the posttesting. The 3-week period was followed by an instructional period in which the experimental group viewed a computer program on the same topic they had mapped during the training and practice period. The control group viewed a computer program on an unrelated topic.

A split-plot factorial design with repeated measures was used to analyze the data. There was a small but significant difference [$F(1, 89) = 5.47$, $p < .05$] favoring the experimental group. The differences were largely attributed to the pretest differences (experimental group mean = 25.4 and control group mean = 23.6) and the effect of the experimental treatment on the posttest scores. The experimental group was also able to identify critical concepts [$F(1, 89) = 36.33$, $p < .01$] and propositions [$F(1, 89) = 50.24$, $p < .01$].

Hirumi and Bowers (1991) hypothesized that students who received a concept tree as a supplement to text-based materials would experience (a) an increased ability to acquire concepts, (b) a higher perceived level of overall motivation, and (c) a higher perceived level of confidence in successfully completing reading assignments. The researchers also wished to determine whether students who have different reading abilities experience differential gains in achievement when presented with a concept tree as a graphic organizer. The study sample was comprised of 73 undergraduate students enrolled in educational psychology courses. All subjects were administered a 36-item advanced vocabulary test ($\underline{r}$ = .89) as a pretest. Based on the pretest scores, subjects were matched and randomly assigned to experimental and control groups. The experimental group received the material with the concept tree and the control group received the material without the concept tree.

A 2 x 3 factorial design was used to test the hypothesis. The two independent variables were treatment (concept tree vs. no concept tree) and vocabulary ability (low vs. average vs. high). The two dependent variables were the posttest ($\underline{r}$ = .71) and an Instructional Materials Motivation Scale ($\underline{r}$ = .90) with four subscales (attention, confidence, satisfaction and relevance).

A two-factor analysis of variance (Treatment X Ability) was performed for each dependent measure. The mean posttest score for the experimental group was higher than that for the control group [$F(1, 67) = 5.71$, $p < .05$]. There was no significant difference in the ability level for both groups. Students with different reading abilities did not experience significant gains in achievement.

A two-factor ANOVA on the scores for the Instructional Materials Motivation Scale revealed a significant effect [$F(1, 67) = 7.77$, $p < .01$] suggesting that the concept tree may have increased students' perceived level of overall motivation. The treatment also had significant effects on three of the four subscales: attention [$F(1, 67) = 7.16$, $p < .01$], confidence [$F(1, 67) = 11.32$, $p < .01$], and satisfaction [$F(1, 67) = 7.85$, $p < .01$].

Schmid and Telaro (1990) hypothesized that concept mapping would force students whose verbal ability was lower to generate a coherent organizational structure, a process common to more capable students. A 2 x 3 x 2 [Instructional Strategy (Concept Mapping vs. Traditional) X Verbal-Reading Ability (High, Medium, or Low) X Test Position (2-Week Midsession Test and 4-Week Posttest)] mixed-model design was used to test the hypothesis. An affective questionnaire was also administered to the experimental group. The researchers solicited the subjects' attitudes, beliefs, and judgments about the concept mapping strategy. The time frame for the experiment was 4 weeks. The classes met daily for 55 minutes.

The sample consisted of 43 high school students enrolled in a biology course. The subjects were randomly assigned to two regularly scheduled classes, and each class was assigned to either experimental or control conditions. The same instructor taught both classes to control for teacher effect. The control group received traditional, teacher-oriented lectures. The experimental group received the same lectures, but also created maps on specific content. These maps were corrected by the teacher and returned to the students during the next session. Both groups received a pretest, a midsession test during the 2nd week, and a posttest during the 4th week.

A multiple ANOVA was used to test the effects of the independent variable on the dependent variables. No significant interactions or differences were found on the pretest. There were significant differences on the midsession test for all of the reading levels [$F(6, 68) = 5.54$, $p < .001$]. The mean midsession test score for the high reading level experimental group ($M = 15.17$) was significantly higher than the medium and low reading level experimental groups ($M$ = 10.50 and 12.88, respectively). On the posttest, the high-low and high-medium group comparisons were also statistically significant [$F(1, 41) = 22.07$, $p < .001$] and [$F(1, 41) = 9.89$, $p < .005$], respectively. With a two-way ANOVA, the researchers analyzed the effects of the treatment on reading levels. The overall interaction was marginally significant [$F(2, 37) = 3.04$, $p < .059$]. However, there was a significant difference between the low reading level experimental group and the low reading level control group [$F(1, 13) = 7.67$, $p < .05$]. The low reading level experimental group performed better on the posttest than the low reading level control group.

The researchers cited the following results of the affective questionnaire: (a) the high reading level group enjoyed the concept mapping strategy; (b) the low reading level group was only mildly enthusiastic about the strategy, although their posttest scores were significantly elevated; (c) a minimum of 2 weeks was required before the subjects felt comfortable with mapping concepts; and (d) concept mapping had positive effects on the application and analysis test items, not the knowledge and comprehension test items.

Starr and Krajcik (1990) described the effects of concept maps on the cognitive structure of a group of sixth-grade teachers. The teachers, serving as curriculum developers, were assigned to construct a science curriculum. Working in teams of two or three, the teachers developed concept maps from a list of topics they compiled at inservice meetings. After discussions, the maps were revised over a 3-week period. For each successive map, the number of concepts and linkages increased. The quality of each map was also superior to the former. The results showed that by mapping concepts, the teachers were able to gain a more meaningful understanding of the concepts.

Heinze-Fry and Novak (1990) investigated the use of concept mapping as a tool to enhance meaningful learning in college biology students. The researchers also investigated the students' attitudes toward concept mapping. Twenty students volunteered to individually map and receive feedback on maps of three instructional units. The control group, 20 or more volunteers, agreed to complete the three instructional units in the usual self-paced manner (i.e., readings and laboratory demonstrations).

Because the subjects were volunteers, pretest and SAT scores for both groups were compared to identify predifferences in the groups. Based on these scores, the groups were not significantly different. To evaluate the subjects' cognitive structures, a 22-item, multiple-choice posttest and an interview were used. Although there were no statistical differences between the experimental and control groups, the experimental group had higher mean scores on the posttest and interview. The correlation results also indicated stronger correlations between the SAT score and the dependent variables (posttest and interview) for the experimental group than the control group. While the high-SAT control group ($\underline{M}$ = 361) outscored the high-SAT experimental group ($\underline{M}$ = 325) on the initial interview, the high-SAT mappers ($\underline{M}$ = 295) outscored the high-SAT controls ($\underline{M}$ = 252) on the 5-month post interview and the affective questionnaire. The high-SAT mappers also achieved better results on the posttest and interview than the low-SAT mappers and all of the control groups. An analysis of the post interviews also showed that the experimental groups made significantly fewer errors than the control group when answering the three application questions. In the final open-ended evaluation, students claimed that concept mapping "affected their learning style by increasing integration (52%), better organization (18%), not just memorizing (18%), better understanding (12%), and better retention (12%)" (Heinze-Fry & Novak, 1990, p.471).

Jegede, Alaiyemola, and Okebukola (1990) investigated the following hypotheses in a study related to student achievement in biology: (a) that concept mapping reduces students' anxiety and thereby enhances achievement in biology, and (b) that gender has a significant effect on students' anxiety towards the learning of biology when using concept mapping strategy. Using a pretest-posttest design, 51 high school biology students were randomly assigned to the control ($n$ = 29) and experimental ($n$ = 22) groups. The experimental group received 3 weeks of training in concept mapping. Both groups were then pretested in anxiety using the Affective Adjective Checklist (KR20 = .83) and achievement using the Biology Achievement Test ($r$ = .91). The pretests were followed by 6 weeks of the treatment. During the treatment phase, the experimental group was exposed to a teaching method that required each student to construct concept maps for the materials covered. The control group was taught using the lecture/expository method.

A 2 X 2 factorial design with two independent variables (Gender and Groups) and two dependent variables (Achievement and Anxiety) was used to guide the analyses of the data. T-tests on the pretest for achievement [$t(49) = 0.69$, $p > .05$] and for anxiety [$t(49) = .98$, $p > .05$] were not significant. Therefore subjects in both groups had equal entry behaviors on these measures. A 2 X 2 analysis of variance was performed on the posttest scores to identify effects for group [$F(1, 46) = 10.16$, $p < .05$] and for gender [$F(1, 46) = 6.03$, $p < .05$], which were significant. The results suggested that concept mapping enhanced learning in biology more effectively than the traditional learning/ expository method. Concept mapping also reduced the male students' anxiety towards learning biology.

Research has also been conducted to determine the effectiveness of concept mapping on students' affective dimension. In Arnaudin, Mintzes, Dunn, and Shafer's study (1984), 89 students completed an attitudinal inventory about concept mapping. Students agreed that concept mapping was a good strategy to use when learning biology (49%); however, constructing maps took too much time and effort (76%). Seventy percent of the students preferred not to have maps used in tests and 54% would not use them in other courses. These students' attitudes reflect the feelings that individuals have when they are faced with new strategies. For example, students often have familiar study habits, which they have used during their education before college. For many students these habits have led to academic success. Students are also familiar with short-answer and essay examinations and therefore would prefer not to change the evaluation process.

In analyzing results of concept mapping research performed at Cornell University, Novak (1990) reported that the majority of college freshmen and sophomore students preferred rote-mode learning practices. They expressed concern that meaningful learning strategies, such as concept mapping, were not consistent with previous methods of study, nor were they required to pass courses. Memorizing notes was a more expedient way to earn high grades. However, students at the junior class level or enrolled in more advanced courses, verbalized the need to learn more meaningful learning strategies. The change in attitudes was mainly due to a change in course grades. Many students found that when they continue, to use memorization or the rote-mode of learning, their grade point averages dropped to Bs, Cs, or failure when they enrolled in professional or more advanced courses (Novak, 1990).

Few nursing investigators have looked at the implementation of concept mapping as a teaching/learning strategy in pre-nursing and nursing courses. Colling (1984) used concept maps as the teaching-learning strategy in pre-nursing courses for educationally disadvantaged nursing students. Twenty students participated in the study. Concept mapping was introduced and taught in two sophomore level transition courses. Students completed a written essay and were interviewed about their views on learning. The interviews were audio-taped and a concept map of each student's response was constructed. As a result of this three-step assessment process, the researcher determined that the majority of the students used predominately rote modes of learning.

After the assessment phase, the students were taught how to map concepts. Students mapped class readings or field activities each week for 2 semesters. The investigator noted two observations during these semesters:

1. That students who made two lists prior to mapping content, one listing all the concepts, another listing the concepts in hierarchical order, were more successful in producing quality maps than the students who did not make the two lists of concepts, and

2. That redoing maps lead to subsequent maps of higher quality.

Student responses to the mapping activities were obtained by using a post-activity questionnaire. Results of the questionnaire revealed that a majority of the students ($\underline{n}$ = 18) now preferred to use conceptual strategies, such as identifying and organizing concepts, when learning material. The students evaluated concept mapping as helpful with learning tasks such as identifying and differentiating major (superordinate) from minor (subordinate) concepts. The investigator reported that maps drawn at the end of the courses illustrated concept acquisition and conceptual linkages. The study results supported other research findings that concept mapping was an effective instructional strategy for moving students toward meaningful learning.

Smith (1992) conducted a quasi-experimental study to evaluate the effectiveness of concept mapping and Vee mapping on nursing students in a basic nursing skills course. Vee diagrams (Novak & Gowin, 1984) are used to analyze events or objects by using focus question(s), conceptual information about the event (i.e., concepts, principles, theories) and methodological information about the event (i.e., facts, value claims, knowledge claims). In this study, Vee mapping was used to explain the theoretical and practice perspectives for the nursing skills covered in the course. Major concepts, basic physiological principles, and theories were described. The practice aspect of the Vee map covered what the nurse would do when performing the skills. Concept mapping, on the other hand, was used to identify key skill concepts and show relationships between those concepts.

Forty-two junior-level students comprised the convenience sample. The students were nonrandomly divided into six laboratory groups of no more than eight students per group. Three instructors were assigned to the six competency laboratory groups.

Each instructor taught a traditional (control) group and a treatment (experimental) group. Strategies for the control group included completing assigned weekly textbook readings, viewing films, and completing definitions of glossary terms before each laboratory period. During the 3-hour weekly college laboratory practice time, the control group asked questions and discussed the week's basic nursing skills.

The experimental group followed the same strategies as the control group with three exceptions. In the first laboratory session, they were oriented to Vee mapping and concept mapping. During each week's laboratory time, two Vee diagrams of the week's skills were discussed. These diagrams were designed by the researcher.

The experimental group also prepared a weekly concept map of selected glossary terms. Concept maps showed the relationships of the key glossary terms. The maps were reviewed by the researcher and returned to the students the following week. Misconceptions of the terms were corrected.

Three tools were used to evaluate the subjects' acquisition of the laboratory skills: 10 short-answer questions about scientific principles for 10 nursing skills, return demonstration evaluations, and taped interviews of the students' perception of the strategies used. Using an ANOVA, there was no significant difference in the acquisition of knowledge in the short-answer questions between groups. However, the single mean score (3.30) for the experimental group was significantly higher than the single mean score (2.76) for the control group ($p = .005$). The experimental group's mean of 1.9 for all return demonstrations was not significantly higher than the control group's mean of 1.6 ($p < .09$). The analyses of the taped clinical interviews were not significant; however, the researcher reported that a significant number of students in the experimental group experienced a change in learning and study styles. The experimental group valued being forced to connect theory to skills.

Wood (1992) developed a computer program using concept maps to facilitate nursing students' knowledge of a specific subject. A convenience sample of 28 students volunteered to participate in the study. The author postulated that a well-constructed concept map could facilitate student learning of content.

Students were alternately assigned to two groups: one used a concept map computer program, the other used a linear-format computer program. Interviews containing open-ended questions were conducted and tape-recorded during and after the program. Student comments about the medium, program content, and format were elicited.

The students also completed a 31-item posttest after the program. A one-tailed _t_ test was used to measure the differences between the mean posttest scores. Although means were not identified, the author reported that students who used the concept map computer program showed significantly higher scores on 18 of the 31 items than the students who completed the linear-format computer program ($p < .05$). There were no significant differences between the remaining 13 items.

Research on concept mapping has been focused on evaluating the effects of mapping on students' cognitive structures, academic achievement, and motivation. Because the results of these research studies have been positive, concept mapping has been viewed as an effective instructional strategy for meaningful learning. By constructing maps, the learner is able to identify concepts and form relationships.

# Cognitive Variables Affecting Learning and Recall

Meaningful learning and recall can be influenced by the cognitive, affective, and social variables of the learner (Ausubel et al., 1986). The cognitive variables are the most influential of these variables. This section contains a discussion of research related to the effects on learning and recall of two cognitive variables: prior knowledge and learning styles.

## Prior Knowledge

Prior knowledge, knowledge previously learned about the subject (Halpern, 1989), is assessed as the most important variable that affects learning. According to Ausubel et al. (1986) "the most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly " (p. 103). Prior knowledge facilitates comprehension, encoding, and recall of new information.

Hall and Edmondson (1992) hypothesized that domain knowledge, prior knowledge about the subject, aided immediate recall, but that aptitude tests, for example the SAT-Verbal test, measured abilities important for delayed recall. Using an historical passage about basketball, the researchers assessed immediate recall and 1-week recall.

Seventy-eight college students enrolled in a psychology course were randomly assigned to three groups.

A three-group pretest-posttest design was used to test the hypothesis that "domain knowledge aids immediate recall but aptitude tests measure abilities important for delayed recall" (Hall & Edmondson, 1992, p. 220). One group (immediate posttest and delayed posttest) took the pretest, read the article, took a 27-item immediate posttest and a 1-week delayed posttest. The second group (delayed posttest only) took the pretest, read the article, and took a 54-item posttest 1 week later. The third group (pretest-posttest only) took the pretest and the 54-item posttest without reading the article. The sample sizes for the first, second, and third groups were 31, 25, and 22 respectively.

The control group (pretest-posttest only) had a mean of 11.5 out of 54 (22%) on the posttest. The authors stated that this was chance for the five-distractor items. For this group, performance on the pretest was not significantly related to performance on the posttest ($r = .30$, $p > .05$). For the experimental group (immediate posttest and delayed posttest) both the SAT-Verbal and pretest were positively correlated with the immediate posttest, but only the pretest correlation was significant ($r = .37$, $p < .05$).

For both the experimental groups, the pretest and SAT-Verbal scores were significantly related to the delayed posttest scores. The multiple regression statistical test was used to determine how much variance on the delayed posttests could be explained by the pretest and SAT-Verbal. For the immediate-delayed posttest group ($R2 = .32$), the percentage of delayed posttest variance explained by the SAT-Verbal was significant [$F(1, 29) = 6.96$, $p < .025$] as was that percentage explained by the pretest [$F(1, 28) = 3.13$, $p < .10$]. For the delayed posttest group ($R2 = .45$), the percentage of delayed posttest variance explained by the SAT-Verbal was significant [$F(1, 23 = 11.26$, $p < .01$] as was that percentage explained by the pretest [$F(1, 22) = 6.54$, $p < .05$]. The authors concluded that although aptitude accounted for some delayed memory, prior knowledge aided both the immediate and delayed memory for new-domain-related knowledge in historical texts.

Eckhardt, Wood, and Jacobvitz (1991) assessed the influence of verbal ability and prior knowledge on adults' comprehension of a 70-minute dramatic television program both immediately and after a 1-week delay. The researchers used a factorial design with subjects at three levels of verbal ability and 3 levels of prior knowledge. The data from two studies were combined. All subjects were pretested to determine prior knowledge of the program content. In the first study, 72 undergraduates who were enrolled in a psychology course, participated. After being tested for prior knowledge, the subjects viewed the program and received an immediate posttest for comprehension. They were also administered the Peabody Picture Vocabulary Test (reliability not reported) to assess verbal ability. The second group, divided into two subgroups, consisted of 172 undergraduates. One subgroup ($n$ = 85) viewed the program and was immediately tested for comprehension and verbal ability. The second subgroup ($n$ = 87) viewed the program and was tested 1 week later.

The authors reported the results of a multivariate ANOVA with three between-subject variables, retrieval time (immediate and 1-week delay), verbal ability level (high, medium, and low), and prior knowledge level (high, medium, and low), and one within-subject variable, type of content (event and inference). The results of the analyses indicated that both verbal ability and prior knowledge played an important role in memory and comprehension of complex televised narratives. For the immediate comprehension test, verbal ability was the best predictor. However, prior knowledge was the best predictor for comprehension in the 1-week delayed condition.

There was a significant main effect of the retrieval interval [$F(1, 226) = 27.7$, $p < .001$] with a decrease in comprehension scores over the 1-week delay interval. The main effects of verbal ability and prior knowledge were also significant [$F(2, 226) = 7.92$, $p < .001$] and [$F(2, 226) = 6.07$, $p < .001$], respectively. The results indicated that subjects who had low verbal ability and/or low prior knowledge scored lower on the comprehension test than the average-and high-prior-knowledge groups and the average-and high-verbal groups.

To ascertain how prior knowledge influenced the acquisition of new domain-related information, Chiesi, Spilich, and Voss (1979) conducted five experiments. Because experiment 3 investigated recall of information, the results of only experiment 3 will be discussed. In experiment 3, the authors hypothesized that (a) high-knowledge individuals would recall more events than lower-knowledge individuals after reading two passages about baseball; (b) scrambled event sequences would produce poorer recall for both high-knowledge and low-knowledge groups, but scrambling would have a greater effect upon high-knowledge recall; and (c) there would be no difference in recall for high-knowledge and low-knowledge subjects after viewing a description of nonbaseball visual scenes. Subjects were placed in high-knowledge and low-knowledge groups according to their scores on a pretest of baseball knowledge. Reliability for the pretest was not reported.

For each of three passages, the subjects ($n$ = 42) listened to a tape of the passage and immediately recalled content for that respective passage. The high-knowledge group demonstrated significantly greater recall for the "normally ordered baseball information" [$F(1, 80) = 53.17$, $p < .001$] and for the scrambled baseball information [$F(1, 80) = 14.84$, $p < .01$] than the low-knowledge group. For the visual scenes, the low-knowledge group performed better than the high-knowledge group [$F(1, 80) = 5.93$, $p < .05$]. The authors speculated that the significant difference was due to the prior knowledge of the high-knowledge group. High-knowledge individuals encoded and retrieved domain related information more readily than low-knowledge individuals.

Spilich, Vesonder, Chiesi, and Voss (1979) researched the hypothesis that the recall of high-knowledge individuals would be superior to the recall of low-knowledge individuals in both amount and the nature. The sample consisted of 46 subjects with 23 designated as high in baseball knowledge and 23 designated as low in baseball knowledge. The subjects were pretested using a 45-item baseball test and the Davis Reading Test. The reliabilities for these tests were not reported.

Subjects listened to a taped account of a fictitious half-inning of a baseball game. Following the presentation, subjects were asked to write a one- to two-sentence summary of the half-inning, to write down as much of the account as they could recall, and to write answers to 40 open-ended questions. The questions were related to specific information about the half-inning. The high-knowledge individuals ($M$ = 48.4, $SD$ = 18.8) recalled more information about the half-inning, both specific and general, than the low knowledge individuals [$M$ = 30.6, $SD$ = 12.2, $F(1, 44)$ = 14.53, $p < .001$].

The significant results in these studies support the claim that prior knowledge affects recall of information. Subjects with high prior knowledge of the content were able to recall and relate more subject information than subjects with low prior knowledge. Therefore, preassessment of prior knowledge is necessary when planning instructional strategies.

## Learning Styles

Learning styles are defined as strategies an individual prefers to use when taking in and processing information (Ostmoe, Van Hoozer, Scheffel, & Crowell, 1984). These strategies include behaviors in the cognitive, affective and physiological dimensions. Research related to the cognitive dimension of learning styles for 1st- and 2nd-year undergraduate college students will be the focus of this review.

Using grade point averages (GPA) as an index of academic achievement, Miller, Alway, and McKinley (1987) identified learning styles associated with high academic performance in college. The learning styles and strategies of 109 undergraduate students were assessed using Schmeck's Inventory of Learning Process (KR20 = .58 to .82). The inventory consists of four scales: (a) Deep Processing (comparing, contrasting, and encoding ideas); (b) Elaborate Processing (associating new information with prior knowledge); (c) Fact Retention (learning and remembering names, dates, formulas and unrelated facts); and (d) Methodical Study (reading assigned material and reviewing regularly each week). The sample was divided into three groups: (a) students on academic probation with GPAs below 2.00 ($n$ = 27), (b) students with GPAs in the range of 2.00-2.99 ($n$ = 39), and (c) students with GPAs in the range of 3.00 to 4.00 ($n$ = 43). Eighty percent of Groups B and C were 2nd-semester freshmen. Group A subjects were randomly selected from a list of approximately 1,800 students.

As predicted, students with high GPAs (3.00 to 4.00) scored significantly higher than students with average GPAs (2.00 to 2.99) and students on academic probation (GPAs lower than 2.00) on the Deep Processing Scale [$F(2, 106) = 2.38$, $p < .01$]. Students who achieved high GPAs were able to meaningfully associate main ideas with supporting details. In contrast, students with GPAs had low scores on the Deep Processing and Elaborate Processing scales. There were no significant differences between the average and low GPA groups on any of the four scales.

Nortridge, Mayeux, Anderson, and Bell (1992) investigated the use of a predictor for academic success of 1st-semester diploma nursing students. Results of the modified Hill Cognitive Style Model instrument for 325 subjects were correlated with their final-semester theory grades. Success was defined as having a final course grade of 77% or above.

The modified Hill Cognitive Style Model instrument (reliability not reported) measures preferences in 28 areas and is divided into four major categories: (a) finding meaning through words you hear, see, or read (four theoretical symbols); (b) perceiving meaning through the sense of smell, taste, or touch, or by use of body language (16 qualitative symbols); (c) meaning influenced by associates, family, or church (three cultural determinants); and (d) reasoning by comparing and contrasting or preferring a clear set of rules (five modalities of inference).

The researchers reported that 7 of the 28 areas correlated with success. Three of seven were positively correlated: (a) theoretical visual linguistics, a preference for finding meaning from written words, (b) individual, a preference for independent problem-solving, and (c) logic, a preference for a logical deductive approach in decision-making.

Four of seven elements negatively correlated with success: (a) theoretical auditory linguistics, a preference for finding meaning from the spoken word, (b) qualitative visual, a preference for finding meaning from sight, (c) associates, preference for problem-solving with peers, and (d) magnitude, preference for categorical reasoning. The seven significant predictors accounted for 13.7% of the variance in predicting final theory grades.

In this study, the successful students preferred to learn and to solve problems independently. The students were also able to use critical thinking skills effectively. Therefore, instructional methods that facilitate independent learning and critical thinking should be used in classrooms.

To assess the instructional preferences of 1st-year college students, Matthews (1991) used Cantfield's Learning Styles Inventory. Seven-hundred and ninety-six 1st-year students completed the 30-item, self-reported questionnaire. The questionnaire (split-half item reliability .96 to .99) allowed students to describe what features of their educational experience they most prefer. The students responses were categorized into one of nine learning style preferences: social, independent, applied, conceptual, social/applied, social/conceptual, independent/applied, independent/conceptual, and neutral preference. The majority of the students had a preference for social styles: social/conceptual (14.4%) and social (14.1%). These students preferred opportunities to interact with instructors and peers. The neutral preference (13.7 %) and conceptual (13.1%) preference were second. Independent/ applied (6.3%), applied (7.8%) and independent (8.8%) were the least preferred learning styles.

Students with the highest grade point averages preferred the social/applied style (mean GPA = 2.62), conceptual style (mean GPA = 2.61), and social style (mean GPA = 2.57). These students preferred interacting with peers and instructors in activities that simulated life experiences, working with organized materials, and interacting with peers and instructors, respectively. Students with no strong preference, neutral preference (mean GPA = 2.22), had the worst grade point average.

Laschinger and Boss (1984) examined the learning styles of 166 incoming nursing students and 102 advanced nursing students using Kolb's Learning Style Inventory. Based on the scores of the 12-item self-reported questionnaire (reliability not reported), subjects were classified into one of four learning styles: convergers (practical application of ideas), divergers (generation of ideas, imaginative), assimilators (inductive reasoning), and accommodators (trial and error problem solving). The subjects also completed a career choice questionnaire developed by the researcher. The researchers hypothesized that the accommodator learning style would be the most common learning style of 1st-year nursing students.

Although nursing students were represented in all of the four learning styles, the diverger style ($\underline{n}$ = 52) was the most frequently occurring learning style for the 1st-year group followed by the accommodator style ($\underline{n}$ = 37). For the more advanced students, 73% were either accommodators ($\underline{n}$ = 37) or divergers ($\underline{n}$ = 38).

The results of the study implied that both the 1st-year and more advanced nursing students were concrete learners. These students preferred instructional strategies such as group discussion, role playing and audio-visual aids.

Wells and Higgs (1990) used the Gregorc Style Delineator and Wells Preference Survey to investigate the predominant learning styles and learning preferences of baccalaureate nursing students. The sample size was 129 students of which 49 (38%) were junior nursing students and 80 (62%) were senior nursing students. With the Gregorc Style Delineator (reliability not reported), subjects were placed in one of four learning styles: concrete sequential (methodical and structured), concrete random (intuitive and impulsive), abstract sequential (logical and rational), and abstract random (emotional and imaginative). The predominant learning styles demonstrated by the 1st-semester nursing students were concrete sequential (42.6%) and abstract random (38.3%). The 4th-semester nursing students demonstrated the same learning styles only in different percentages: abstract random (39.7%) and concrete sequential (34.2%). There was no statistically significant difference in the learning styles of 1st-semester and 4th-semester nursing students. Abstract random and concrete sequential were the two most predominant learning styles for both groups.

The Wells Learning Preference Survey, a 12-item Likert-type scale, was used to determine learning preference for the group. No measure of reliability existed for this learning preference survey. Although group discussion received the highest percentage (84%, $n$ = 41) of positive responses from 1st-semester nursing students, lecture (Tau = .16, $p$ = .04), slide/filmstrip with audiotapes (Tau = .21, $p$ = .01), and group discussion (Tau = 20, $p$ = .02) were significantly higher. Fourth-semester nursing students ($n$ = 66, 82.6%) preferred television/movies and drills and practice, but statistically preferred games. Of the five learning preferences that received 70% or higher positive responses by the total sample group, three of the five, television/movies, group discussion, and short lecture with question/answer periods, are consistent with abstract random learners. Drill and practice and computer-assisted instructions were consistent with concrete sequential learners.

Researchers have used many scales and inventories to assess learning styles of 1st- and 2nd-year undergraduate students. The research results indicate that, when learning, students who have high GPAs preferred to identify main ideas, compare and contrast concepts, and establish concept relationships. These students also preferred structured, organized instructional strategies with peer and faculty interactions.

## Summary

Concept mapping is an instructional strategy that has been researched as a tool to aid in the encoding and recalling of curricula content. Researchers reported positive effects of concept mapping on (a) the students' cognitive preference, (b) the students' achievement, and (c) the students' attitudes toward concept mapping as a learning strategy.

After using concept mapping over a period of time, students were able to identify critical concepts and propositions of instructional material (Okebukola & Jegede, 1988; Pankratius, 1987; Wallace & Mintzes, 1990). Identification of these concepts and propositions facilitated better recall of information and thus higher achievement scores. Students also perceived concept mapping as a motivator and a helpful learning strategy (Heinze-Fry & Novak, 1990; Colling, 1984). Thus, the literature review supported the purpose of this study to empirically determine the effectiveness of concept mapping on pre-nursing students' ability to recall physiological concepts.

# CHAPTER 3

## PROCEDURE FOR COLLECTION AND TREATMENT OF DATA

A two-group, before-and-after, quasi-experimental design was used to compare the effectiveness of a computer program with concept mapping and a computer program with fill-in-the-blank questions on pre-nursing students' ability to recall physiological concepts. The sample was comprised of 51 pre-nursing students enrolled in four sections of an anatomy and physiology course. The intact classes were randomly assigned to experimental and control groups. Both groups completed a pretest, a computer program, an immediate posttest, and a 6-week posttest to answer the research question: Does a computer program with concept mapping have a more positive effect on students' recall of key concepts than a computer program with fill-in-the-blank questions?

The proposed study met the criteria of a two-group before-and-after, quasi-experimental design as described by Abdellah and Levine (1965) and Wilson (1985). The design allowed for comparisons between the experimental and control groups on the variable of interest, instructional strategies. Analyses of changes within each group could also be addressed.

The variables in this study were recall and instructional strategies (a computer program with concept mapping and a computer program with fill-in-the-blank questions). The independent variable (instructional strategies) was manipulated. The dependent variable was recall. The extraneous variable of previous knowledge of the fluid volume concepts (Ausubel, 1967) was measured by scores on the pretest examination administered prior to the treatment (see Appendix D).

## Setting

The study was conducted in a generic baccalaureate degree nursing program located in a metropolitan area of southwestern United States. The university setting was a 4-year campus located in southwest Texas. The total student enrollment at this comprehensive university was 5,000. Approximately 10% of the enrollment were nursing majors.

Subjects completed the computer-assisted program in the biology laboratory classroom at the university. The laboratory classroom was located at the end of the hall on the second floor of the Biology Department. The physical setup of the laboratory classroom included 12 tables, 24 stools; two windows positioned at the back of the room, and one podium. The computer with the liquid crystal device was located in the middle of the room. The information was projected on the screen in the front of the laboratory classroom.

## Population and Sample

The target population consisted of pre-nursing students seeking first baccalaureate degrees enrolled in 4-year generic baccalaureate degree nursing programs. These students were freshmen and sophomores enrolled in liberal arts and science courses, specifically, pre-nursing students enrolled in anatomy and physiology courses.

Only pre-nursing students enrolled for their first baccalaureate degree were included in the sample. According to several authors (Seidl & Sauter, 1990; Smith 1989), pre-nursing students with college degrees have adult learning style characteristics and have been successful in fast track master's degree nursing programs. These students are highly motivated, independent learners and bring a wealth of life experiences to the academic setting. Therefore, pre-nursing students pursuing a second degree were omitted from the sample.

Volunteers from four anatomy and physiology sections who agreed to participate in the study comprised the sample. Initially a total of 51 students volunteered. Five students did not complete the 6-week posttest; therefore 46 students comprised the sample.

Using the following procedure, the four intact anatomy and physiology classes were randomly assigned to the experimental and control groups. Four numbers were placed into a container and shuffled. At the beginning of each class, a number was drawn. If the number was even, the class was placed in the experimental group; and if the number was odd, the class was placed in the control group. Based on this procedure, the 1st- and 2nd-period classes were placed in the control group and the 3rd- and 4th-period classes were placed in the experimental group. The selection of intact classes as samples has been used by researchers (Lehman, Carter & Kahle, 1985; Pankratius, 1987; Stensvold & Wilson, 1990) to investigate the effectiveness of concept mapping on learning.

## Protection of Human Subjects

Prior to beginning research, the research proposal was submitted to the Human Research Review Committee at Texas Woman's University and the participating baccalaureate nursing programs for approval. Each subject received a verbal explanation and a written letter (see Appendix A) explaining the purpose of the study. The subjects were also asked to sign an informed consent (see Appendix B). Each subject was then assured confidentiality, informed of his/her rights to refuse to continue in the study or to withdraw at any time without penalty, and assigned a code number. Subjects were also provided the telephone number of the researcher and encouraged to contact her for clarification of any aspect of the study.

## Instruments

Four instruments were used to test the hypotheses. The first instrument, the Demographic Data Questionnaire (see Appendix C), was used to request information about age, sex, ethnic origin, and health care experience. The levels of measurements for these variables were ratio (age) and nominal (sex, ethnic origin, and health care experience). Information about age, sex and ethnic origin was collected and analyzed to describe the characteristics of the subjects. The subjects' health care experience may have influenced their recall of the concepts (Ausubel et al., 1986). Therefore, data regarding health care experience was also collected and described.

The second instrument was a 20-item, multiple-choice, teacher-made test (see Appendix D), which was used as a pretest and posttest. Questions on the instrument were used to ascertain recall (interval level measurement) of fluid volume concepts. The test, developed by the investigator, was constructed using the computer program objectives as a guide. The items were reviewed for content validity by a panel of experts which included four faculty members. All four had master's degrees in nursing. Three were specialists in medical-surgical nursing and one had a specialization in rehabilitation nursing. All faculty members had experience in test construction. After reviewing the computer program, the expert faculty examined the test items for objectives and content representation. Some items were revised on the basis of faculty recommendations.

To establish test reliability, the instrument was pretested by submitting it to 20 junior and senior nursing students. Each test item was counted as 1 point. Thus the subject's score was the number of correct answers. The chance of guessing was 25%. The total scores for the group ranged from 4 to 13. The test mean and standard deviation were 7.6 and 2.41, respectively. The small standard deviation indicated that the scores clustered around the mean. Test reliability and item analysis of the test items were determined by using the ParSCORE computer program by Economics Research, Inc. (1988). The reliability coefficient (Kuder-Richardson Formula 20) for the test was .33. For a 20-item test, the reliability was low. Variables that may have contributed to the low reliability included the length of the test, the motivation of the subjects, and the homogeneity of the group.

An item analysis was performed to identify which items were acceptable and which items should be revised. The discrimination index (point biserial) and the difficulty level of each item was reported using the ParSCORE program. The item analysis is summarized in Table 1.

Each item's discrimination index (D) and difficulty level (P) was analyzed using the discrimination index by Ebel and Frisbie (1986) and the difficulty index by Waltz, Strickland, and Lenz (1984). The criteria for the discrimination index and difficulty level are listed in Table 2.

The revision of test items was based on the item revision guidelines by Ebel and Frisbie (1986). Eleven items did not require revision because their difficulty level and discrimination index were within the recommended guidelines. Nine items were revised because the discrimination index was .29 and below, the difficulty level was between 0 and .29, or both.

Table 1

Item Analysis for Questions on Pre- and Posttests

| Item | Difficulty Level | Discrimination Index |
|---|---|---|
| 1 | .70 | 0.17 |
| 2 | .35 | -0.32 |
| 3 | .45 | 0.50 |
| 4 | .35 | 0.17 |
| 5 | .40 | 0.44 |
| 6 | .20 | -0.02 |
| 7 | .20 | 0.03 |
| 8 | .75 | 0.39 |
| 9 | .15 | -0.17 |
| 10 | .50 | 0.59 |
| 11 | .35 | 0.48 |
| 12 | .30 | 0.06 |
| 13 | .25 | 0.25 |
| 14 | .25 | 0.74 |
| 15 | .20 | 0.08 |
| 16 | .15 | 0.37 |
| 17 | .75 | 0.59 |
| 18 | .60 | -0.23 |
| 19 | .35 | 0.57 |
| 20 | .35 | 0.44 |

Table 2

Discrimination Index and Difficulty Level of Questions on Pre- and Posttests

| | |
|---|---|
| Discrimination Index (Ebel & Frisbie, 1986) | |
| .40 and up | very good item |
| .30 to .39 | reasonably good item |
| .20 to .29 | marginal item (improve) |
| below .19 | poor items (reject or revise) |
| Difficulty Level (Waltz et al., 1984) | |
| .71 to 1.00 | too easy |
| .30 to .70 | desirable |
| .00 to .29 | too hard |

The revised 20-item test was administered to 10 junior nursing students during the fall 1991 semester. The test reliability and item analysis of the test items were again determined by using the ParScore computer program. The reliability coefficient (Kuder-Richardson Formula 20) for the revised pretest was .45, while the reliability coefficient for the same test administered as the posttest was .71. According to Ebel and Frisbie (1986), the posttest reliability of .71 is an acceptable reliability for a test with 20 items.

The third instrument, Fluid Volume Concepts (see Appendix F) was a computer assisted program that introduced the concepts through paragraphs and concept maps (nominal level). The computer program was written by two individuals: the investigator, who was also an expert in medical-surgical content, and a computer programmer with 6 years of programming experience. The development phase for the program is described in Appendix E. The program presented information about a concept in paragraph form, then presented an incomplete concept map, which the subjects were asked to complete. To introduce the subjects to the skill of concept mapping, the computer mapped the introduction content.

The content of the computer program was validated by an expert panel of three faculty members, each of whom had a master's degree in nursing and 20 or more years of experience in medical-surgical nursing. Each faculty member completed the computer program and a program evaluation. The program was revised on the basis of their recommendations.

As a result of these recommendations, an example of concept mapping was constructed and placed at the beginning of the program. The example allowed the student to map out simple, familiar, nonphysiological content. Therefore at the beginning of the program, the computer completed a concept map, then the student completed a different, simple map.

The fourth instrument was a computer program, Fluid Volume Basics, also authored by the investigator. Using the same paragraphs in the Fluid Volume Concepts program (Instrument 3) and fill-in-the-blank questions, this program introduced the fluid volume concepts without concept mapping. The three faculty members who reviewed the third instrument also validated the content of the fourth instrument.

Both computer programs had a set of beginning directions that were followed in the same manner by all subjects in the pilot study. The programs ran in the same manner when the directions were executed.

## Data Collection

In the proposal, the data was to be collected by having students complete the computer programs individually. Because of the difficulty in scheduling the use of individual computers at the University's Learning Resource Center, the research was conducted by displaying the computer program on an overhead screen to the four intact anatomy and physiology classes. The research was conducted for each class in the laboratory classroom during the laboratory class period. The time frame for the class was 1 hour and 50 minutes.

The 1st- and 2nd-period classes were assigned to the control group whereas the 3rd- and 4th-period classes were assigned to the experimental group. The experimental group received the computer-assisted program, Fluid Volume Concepts, with paragraphs and the concept maps. The control group received the computer program, Fluid Volume Basics, with the paragraphs on fluid volume concepts and fill-in-the-blank questions.

At the beginning of each experimental or control session, the researcher explained the study and obtained written individual consent. Subjects were given 20 minutes to individually complete a 20-item, multiple-choice, pretest. Each subject then received a written copy of the contents of the computer program. The researcher displayed the program on a screen using an IBM compatible computer and a liquid crystal display device. This device is an overlay machine that projects the contents of computer programs onto a screen.

The subjects were asked to read the instructions silently while the researcher read the instructions aloud. At this point in each instructional session, the group was asked if there were questions about the procedure. The experimental group completed the sample concept map at this time.

The subjects were asked to read each text screen silently while the researcher read it aloud. They were then asked to individually complete the map(s) or fill-in-the-blank question(s) that corresponded to the text screens. A volunteer then verbally completed the on-screen concept map or fill-in-the-blank question. If the answers were incorrect, a second volunteer verbally attempted to answer. The correct answers were then placed on the screen. There was no further discussion of the content.

The experimental group completed the concept mapping program in 1 hour while the control group completed the computer program in 45 minutes. Both experimental and control groups were then given 20 minutes to complete the immediate posttest. The 6-week posttest was administered at the beginning of the laboratory classes. Subjects were again given 20 minutes to complete the posttest.

At the end of the 1st-day procedure, students were informed that the computer programs would be placed in the Learning Resource Center for additional viewing during the 1st week. The students were also instructed to present their assigned code numbers to the Learning Resource Center's personnel to review the appropriate computer program. The director of the center was also given the student code numbers and instructions on which code numbers were placed in the experimental group and the control group. The director of the center reported that students did not seek the additional opportunity to review the programs.

## Pilot Study

Two pilot studies were conducted to test the instruments and the procedure for data collection. The first pilot study was conducted in the summer of 1991 and investigated the following hypotheses: (a) Subjects who completed the concept-map computer program will have higher scores on the recall-of-physiological-concepts test than subjects who complete the computer program without concept maps; (b) Subjects who have a learning style preference for visual methods will have higher scores on the recall-of-physiological-concepts test than subjects who prefer auditory, social, and solitary learning methods; and (c) Subjects who have previous health care experience will have higher scores on the recall-of-physiological-concepts test than subjects who do not have health care experience.

A second pilot study was conducted during the fall 1991 semester to reinvestigate the hypothesis that novice nursing students completing the concept map computer program will have higher scores on the immediate recall of physiological concepts test than novice nursing students completing the computer program without concept maps and to obtain reliability on the revised pretest/posttest instrument.

The sample sizes for the pilot studies were 20 junior and senior nursing students in the first pilot study and 10 junior nursing students in the second pilot study. Subjects in both pilot studies were randomly assigned to experimental and control groups. Both groups were administered a 20-item multiple choice pretest, followed by a computer program. The experimental group received the Fluid Volume Concepts computer program with concept maps, and the control group received the Fluid Volume Basic computer program with fill-in-the-blank questions. Upon completion of the program, both groups were completed an immediate posttest.

A one-way ANOVA and an ANCOVA were performed to determine the effects of the independent variable, concept mapping, on the dependent variable of recall scores. The $F$ ratios of both statistical tests ($p < .05$) indicated no significant difference in the posttest scores of the groups. The results suggest that concept mapping had no effect on immediate recall of physiological concepts. Possible factors contributing to the nonsignificant results included the small sample size, student's unfamiliarity with concept mapping, and limited exposure to concept mapping.

Based on the pilot studies results, the hypotheses concerning learning style preference and experience were deleted. Hypothesis 2, pertaining to learning styles, was deleted because the majority of the subjects (65%) had visual learning style preferences. It would have been impossible to equalize the groups with all learning styles. Hypothesis 3, concerned with experience, was also deleted. The extraneous variable of experience will be controlled by equalizing the groups with subjects who have health care experience. An effect size was also calculated to determine an appropriate sample size (Cohen, 1988). With an effect size of .50 and an alpha of .05, 22 students in each group were required to obtain a power of 90%. To increase the sample size, the subject population was changed to pre-nursing students in a generic baccalaureate degree nursing program instead of novice nursing students. Pre-nursing students are enrolled in liberal arts and science courses which form the foundation for building nursing courses.

During the pilot studies, students required longer periods of time, up to 1½ hours, to complete the computer program. Therefore, the time to complete the entire activity, program and tests, was increased to 2 hours.

## Treatment of Data

Descriptive statistics of modes and percentages were used to describe the sample in terms of sex, ethnic origin and experience. The demographic data of age was reported in terms of means and range. To assess Hypotheses 1 and 2, the effect of concept mapping on the immediate posttest and 6-week recall scores, a two-way ANOVA with repeated measures and an ANCOVA were used to analyze the data. With an ANCOVA, the pretest scores were controlled for previous knowledge before analyzing the differences between the experimental and control groups on the posttest scores. The alpha level of significance for rejection of the hypotheses was set at .05.

## Summary

A two-group, before-after, quasi-experimental study was conducted to determine if concept mapping influenced the ability of pre-nursing students to recall concepts. Forty-six pre-nursing students, enrolled in four anatomy and physiology classes, comprised the sample. The four intact classes were randomly assigned to control and experimental groups.

The research was conducted during the assigned laboratory class times. Following verbal and written explanation of the study, each student signed an informed consent. The students also completed a demographic data questionnaire and a 20-item, multiple-choice, pretest. The experimental group then completed a computer program with concept maps and the control group completed a computer program with fill-in-the-blank questions. For each group, the computer programs were placed on an overhead screen in a biology laboratory classroom at the university. Following completion of the computer programs, both groups completed an immediate posttest and a 6-week posttest.

# CHAPTER 4

## ANALYSIS OF DATA

The purpose of this chapter is twofold: (a) to describe the sample population and (b) to summarize data analyses for the two hypotheses. Using inferential statistics, the effects of two instructional strategies (a computer program with concept mapping and a computer program with fill-in-the-blank questions) on pre-nursing students' ability to recall physiological concepts were evaluated.

### Description of Sample

Volunteers were solicited from two universities. Forty-six pre-nursing students from one university and two pre-nursing students from the second university volunteered to participate in the study. However, the two volunteers from the second university had achieved 1st-time bachelor's degrees in another area and could not be included in the sample. The mean age for the participants was 19.5 years with a range of 18 to 39 years. Of the 46 participants, 39 were female, and 7 were males. Forty-four subjects were African-American, one was Caucasian, and one was Hispanic.

Forty of the participants had no previous experience in health care; six participants had experience. The subjects were enrolled in an anatomy and physiology course during the spring semester. The anatomy and physiology course is sequenced in the 1st year or freshman year of the pre-nursing program. Distribution of the sample according to the demographic data is detailed in Tables 3 and 4.

## Findings

The purpose of this study was to determine the effects of concept mapping on pre-nursing students' ability to recall physiological concepts immediately after presentation of concepts and 6 weeks after presentation of the concepts. With the alpha level set at .05, a two-way ANOVA with repeated measures and an ANCOVA were used to test the two hypotheses: (a) pre-nursing students who completed the concept-map computer program will have higher scores on the immediate recall-of-physiological-concepts test than pre-nursing students completing the computer program without concept maps; and (b) pre-nursing students who complete the concept-map computer program will have higher scores on the long-term, 6-weeks after, recall-of-physiological-concepts test than pre-nursing students who complete the computer program without concept maps. By using an ANOVA and an ANCOVA, a comparison of group means was performed, the

Table 3

Distribution of the Sample According to Age

| Variable | Control (n = 23) | Experimental (n = 23) |
|---|---|---|
| Age | | |
| Mean | 19.43 | 19.73 |
| Range | (18 - 32) | (18 - 39) |

Table 4

Distribution of the Sample According to Ethnic Origin, Experience, and Gender

| Variable | Control number | Control % | Experimental number | Experimental % |
|---|---|---|---|---|
| Ethnic Origin | | | | |
| African-American | 22 | 96 | 22 | 96 |
| Caucasian | 0 | 0 | 1 | 4 |
| Hispanic | 1 | 4 | 0 | 0 |
| Experience | | | | |
| Nursing Assistant | 2 | 9 | 1 | 4 |
| Paramedic | 0 | 0 | 1 | 4 |
| High School Health Profession | 1 | 4 | 0 | 0 |
| No Experience | 20 | 87 | 20 | 87 |
| Gender | | | | |
| Male | 4 | 17 | 3 | 13 |
| Female | 19 | 83 | 20 | 87 |

extraneous variable of prior knowledge were controlled, and the amount of variance to the results caused by prior knowledge was removed. The statistical package of GB-STAT (Friedman, 1991) was used for the analysis. Table 5 reflects the comparison of the control and experimental group means for the pretest, immediate posttest, and 6-week posttest scores.

Table 5

Mean Score Comparisons for the Control and Experimental Groups

| | Control | Experimental |
|---|---|---|
| Pretest Means | 7.43 | 5.56 |
| Range of Scores | (5 - 11) | (4 - 11) |
| Immediate Posttest Means | 7.39 | 6.73 |
| Range of Scores | (4 - 11) | (2 - 11) |
| 6-Week Posttest Means | 6.34 | 5.95 |
| Range of Scores | (3 - 10) | (3 - 10) |

Evaluation of the means disclosed differences on all three of the tests between the control and experimental groups. Therefore, a two-way ANOVA with repeated measures was performed to analyze the mean test scores of the two groups (see Table 6). One factor was the level of treatment: computer program with concept mapping and computer program with fill-in-the-blank questions. The second factor was the test administration over time: pretest, immediate posttest, and 6-week posttest. Statistically, there was a significant difference between the treatment groups [$F(1, 45) = 4.08$, $p < .05$]. The post

Table 6

Two-way ANOVA with Repeated Measures Pretest—Immediate Posttest—6 Week Posttest Effects

| Source | SS | df | MS | F | p |
|---|---|---|---|---|---|
| Treatment | 32.53 | 1 | 32.53 | 7.78 | .00* |
| Within Group | 183.91 | 44 | 4.18 | — | — |
| Tests | 19.54 | 2 | 9.77 | 2.12 | — |
| Interaction | 14.32 | 2 | 7.16 | 1.55 | — |
| Within Group | 405.48 | 88 | 4.16 | — | — |
| Total | 655.78 | 137 | — | — | — |

* $F(1, 45) = 4.08$; $p < .05$.

hoc analysis using Tukey's HSD procedure revealed that the significant difference existed between the pretest means [$F(1, 45) = 1.23$, $p < .05$].

To determine if there were statistical differences between groups while controlling for prior knowledge effects, an ANCOVA of the posttest means was performed. The pretest which measured prior knowledge was used as the covariate. There were no significant differences in the immediate posttest scores or the 6-week posttest scores. Tables 7 and 8 summarize the results.

Table 7

Analysis of Covariance Summary for Immediate Posttest Scores

| Source of Variance | SS | df | MS | F | p |
|---|---|---|---|---|---|
| Treatment | 3.26 | 1 | 3.26 | .59 | .54 |
| Error | 237.73 | 43 | 5.52 | — | — |
| Covariate | 1.79 | 1 | — | — | — |
| Total | 242.80 | 45 | — | — | — |

Table 8

Six-Week Posttest Scores Analysis of Covariance Summary for 6-Week Posttest Scores

| Source of Variance | SS | df | MS | F | p |
|---|---|---|---|---|---|
| Treatment | 1.50 | 1 | 1.50 | .36 | .56 |
| Error | 180.17 | 43 | 4.19 | — | — |
| Covariate | .27 | 1 | — | — | — |
| Total | 181.93 | 45 | — | — | — |

## Summary of Findings

The purpose of this study was to compare the effects of two instructional strategies on pre-nursing students' ability to recall physiological concepts immediately after presentation of the concepts and 6 weeks after presentation. The two strategies were a computer program with concept mapping and a computer program with fill-in-the-blank questions. The sample consisted of 46 pre-nursing students enrolled in an anatomy and physiology course. The mean age for the group was 19.58 years. The majority of the subjects were African-American females who had no previous experience in health care.

Using an alpha level of .05, a two-way ANOVA with repeated measures and an ANCOVA, the two hypotheses were tested. There were no significant differences between the control and experimental group scores for either hypothesis. The control group, however, had higher mean test scores than the experimental group on all three tests (pretest, immediate posttest, and 6-week posttest).

## CHAPTER 5

## SUMMARY OF THE STUDY

The problem of the study was to answer the question, Does a computer program with concept mapping have a more positive effect on students' recall of key concepts than a computer program with fill-in-the-blank questions? Ausubel's Assimilation Theory was the conceptual framework for the study. Two hypotheses were formulated to guide the study. The hypotheses were:

$H_1$. Pre-nursing students who complete the concept map computer program will score higher on an immediate test of the recall of physiological concepts than pre-nursing students who complete the computer program without concept maps.

$H_2$. Pre-nursing students who complete the concept map computer program will score higher on a long-term, 6-week posttest of the recall of physiological concepts than pre-nursing students who complete the computer program without concept maps.

In the literature review, storage of information in the long-term memory, as well as the effects of an instructional strategy (concept mapping) on the recall and learning, were discussed. Cognitive variables that influence learning and recall were also discussed. These variables were prior knowledge and learning styles.

In this chapter, the study will be summarized and the findings will be discussed. Conclusions, implications and recommendations for further study are also included.

## Summary

The focus of this study was to compare the effects of two instructional strategies on pre-nursing students' ability to recall physiological concepts. These strategies consisted of a computer program with concept mapping and a computer program with fill-in-the-blank questions. The sample included freshman and sophomore students enrolled in a pre-nursing, anatomy and physiology course, at a university located in the southwestern United States. The research design was a two-group, before-after, quasi-experimental design. A convenience sample of 46 pre-nursing students who volunteered to participate in the study was utilized.

Four intact anatomy and physiology classes were randomly assigned to the experimental and control groups. Following verbal and written explanations of the study, all students signed a consent form. Subjects completed a demographic data questionnaire and a 20-item, multiple-choice pretest. The mean scores for the pretest were 7.43 for the control group, 5.56 for the experimental group, and 6.50 for the total group. The individual scores ranged from 2 to 11. The experimental group completed a computer program on fluid volume with the concepts presented in paragraphs followed by incomplete concept maps. The subjects had to complete each concept map before proceeding to the next screen. The control group also completed a computer program on fluid volume. The concepts were presented using the same paragraphs in the experimental group's program but followed by fill-in-the-blank questions. Each group completed an immediate posttest and a 6-week posttest.

Using a two-way ANOVA with repeated measures and an ANCOVA, the immediate and 6-week posttest scores of the control group were not significantly different from the immediate and 6-week posttest scores of the experimental group. A comparison of the mean scores on the pretest and both posttests indicated that the control group had higher mean scores for all three tests (7.43, 7.39, and 6.34, respectively) than the experimental group (6.34, 6.73, and 5.95, respectively). The higher mean scores of the control group may have resulted from the effects of random assignment of intact classes to experimental and control groups rather than random assignment of individuals to the groups. Extraneous cognitive variables such as prior knowledge, learning styles, and limited practice could have accounted for the lower scores in the experimental group.

## Discussion of Findings

The first hypothesis was that pre-nursing students who completed the concept-map computer program would have higher scores on the immediate recall-of-physiological-concepts test than pre-nursing students who completed the computer program without concept maps. Analysis of the results indicated that concept mapping had no significant effect on the pre-nursing students' ability to recall physiological concepts immediately after the presentation of the concepts.

The second hypothesis was that pre-nursing students who completed the concept-map computer program would have higher scores on the long-term, 6-weeks after recall-of-physiological-concepts test than pre-nursing students who completed the computer program without concept maps. Analysis of the results again indicated that concept mapping had no significant effect on pre-nursing students' ability to recall physiological concepts 6 weeks after the presentation of the concepts. Therefore, the hypotheses were not supported.

The nonsignificant results are similar to the results reported by Allen (1989), Bousquet (1982), Lehman, Carter, and Kahle (1985), and Stensvold (1989). In these studies, the use of concept mapping was compared to an alternative learning strategy over a period of time. The maps were constructed by the students in the experimental groups. Allen and Lehman et al. stated that students had difficulty constructing the maps (Ausubel's Cognitive Variable—Figure 1) and cited this factor as contributing to the nonsignificant results. The use of a similar hierarchical structure as the treatment for the control group was a second factor cited by Lehman et al.

Prior knowledge, cognitive styles, and limited practice were extraneous cognitive variables (Ausubel—Figure 1) that may have contributed to the nonsignificant findings. Prior knowledge affects the encoding and recalling of information (Ausubel, 1967). If an individual has low knowledge of a subject area, learning new material will be more difficult (Ausubel, 1967; Chiesi, et al., 1979). In this study, the mean pretest scores for both groups were low (experimental group, 5.56; control group, 7.43). The mean score for the experimental group was at the level of chance for four distractor items, while the mean score for the control group was only 2 points higher.

Additionally, the strategy of concept mapping may not have been complementary to the learning styles (Ausubel's Cognitive Variable—Figure 1) of the experimental subjects. All subjects were classified as freshmen and sophomores. These students usually prefer to learn by using rote memory (Novak, 1990). They also prefer structured classes and directions from the instructor (Matthews, 1991; Wells & Higgs, 1990). Although the computer programs were structured, they were not included in the class syllabus and were not guided by the instructor.

For the subjects in the experimental group, concept mapping (Ausubel's Cognitive Variable—Figure 1) was a new approach to learning material. Because they were exposed only once to the concept-mapping approach, subjects had minimal time to practice. Practice is essential when learning new material (Hayes, 1989; Symonds & Chase, 1992). The control group, on the other hand, was familiar with fill-in-the-blank questions. This short-answer method, along with others, was used to evaluate knowledge in the course. Familiarity with this method could explain the higher immediate and posttest scores for the control group.

Although this study did not include an examination of the learner's affective and social dimension (Ausubel—Figure 1), the variables in these dimensions could have contributed to the nonsignificant results. For example, it is reasonable to assume that the subjects' motivation was low for learning a new strategy. Individuals pay attention to those things that are important to them (Bandura, 1977; McCombs & Marzano, 1990). Since subjects in this study were volunteers and did not receive course credit, lack of motivation or a tangible incentive may have been contributing factors.

In addition to the above extraneous variables, the method of selection, random assignment of intact groups, could have also affected the nonsignificant results in two ways. The random assignment of intact groups limited the equalizing effect of the extraneous variables (Abdellah & Levine, 1965; Wilson, 1985).

Secondly, individual participation was limited with the use of intact groups. Active participation for completing the concept maps was limited for all individuals. Because individuals could not pace the computer program, slow readers might have experienced insufficient time to complete the maps.

Although the concepts in the interactive, tutorial computer program were discussed in basic anatomy and physiology textbooks, these concepts could have contributed to the nonsignificant results. The terminology could have been too advanced for pre-nursing students. Students' exposure to these concepts might have also been limited. The results of the prior knowledge pretest support the limited exposure.

## Conclusions and Implications

Due to the use of a small sample size, intact groups and utilization of one school, the conclusions derived from this research are limited to this sample. The conclusions include the following:

1. Concept mapping was not an effective method for recalling physiological concepts immediately and 6 weeks after presentation of concepts.

2. The sample demonstrated a low knowledge level about fluid volume concepts.

The following implications are drawn from the findings of the study. The results of this study demonstrated that under one-time conditions, recall of concepts was not significantly affected by the use of concept mapping via the computer. The literature does, however, report concept mapping as an effective teaching strategy when used as an advance organizer and a study tool. In the majority of these studies (Arnaudin, Mintzes, Dunn, & Shafer, 1984; Colling, 1984; Mikulecky, Clark, & Adams, 1989; Smith, 1992; Willerman & Mac Harg, 1991; Wood, 1992), the students constructed the maps.

The affective dimension or attitude of the learner is another influencing variable for learning concepts meaningfully. In several studies (Arnaudin, Mintzes, Dunn & Shafer, 1984; Colling, 1984; Jegede et al., 1990; Mikulecky et al., 1989; Smith, 1992), students' attitudes towards concept mapping were evaluated. Students who mastered the technique of mapping were able to identify the main concepts and relate those concepts. They also understood the material and had fewer misconceptions.

Researchers also discussed the time required for learning how to map concepts. It is estimated that 2 to 6 weeks is required for the learner to become comfortable with the mapping process (Pankratius, 1987; Schmid & Telaro, 1990). Researchers reported significant results when students mapped content for a minimum of 3 weeks or for an entire course (Schmid & Telaro, 1990; Starr & Krajcik, 1990; Wallace & Mintzes, 1990).

These additional components, namely, student-constructed maps, practice, and student attitudes, should be investigated when performing further research on concept mapping as an instructional strategy.

## Recommendations for Further Study

Based on the findings of this study and on the review of the literature, the following recommendations are suggested:

1. Undertake a similar study that allows subjects to individually complete the computer programs.
2. Conduct a similar study that includes pre-nursing students from several different programs.
3. Undertake a study that has concept mapping as an integral component of the course activities or course evaluation.
4. Examine the effectiveness of student-constructed concept maps on recall of physiological concepts.
5. Examine the effects of concept mapping on the affective variable of pre-nursing students' motivation while enrolled in an anatomy and physiology course.

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# APPENDIX A

## Letter of Introduction

Dear Nursing Student:

As a doctoral student in nursing at Texas Woman's University, I am conducting a research study about teaching strategies for learning physiological concepts. The purpose of the study is to investigate teaching strategies that may assist novice nursing students in learning physiological concepts.

Will you please participate by consenting to complete a demographic data questionnaire, a pretest, a computer assisted program, and two posttests? The procedure will require your participation on 2 days. During the 1st day, you will complete the demographic data questionnaire, the pretest, the computer assisted program, a posttest and a computer program evaluation questionnaire. The 1st day procedures will take approximately 1½ hours of your time. On the 2nd day, 4 weeks later, you will complete the second posttest which will require 30 minutes of your time.

It is hoped that the information obtained can enhance students' ability to recall concepts. A direct benefit to you may be a gain in physiological knowledge.

Any records that identify you will be confidential and will be destroyed after the study is completed. You are free to withdraw your consent and to discontinue participation in the study at any time without penalty.

Sincerely,

Chloe Gaines, MSN, RN

APPENDIX B

Informed Consent

## COMPUTER PROGRAM EVALUATION

DIRECTIONS: Please assist me to evaluate the computer program by completing the following questions.

1. Check the computer program you completed.

   _______________ Concept Mapping

   _______________ Fill-in-the-Blank

2. What did you like about the computer program?

3. What did you dislike about the computer program?

4. What would you change in the computer program?

5. If concept map computer programs were available for anatomy and physiology, would you have used them to study this subject? If yes, why? If no, why not?

Thank you,
Chloe Gaines, MSN, RN
6436 Fannin Street
Houston, Texas 77030

TEXAS WOMAN'S UNIVERSITY
COLLEGE OF NURSING
HOUSTON, TEXAS

THE EFFECTS OF CONCEPT MAPPING ON PRE-NURSING STUDENTS' RECALL OF PHYSIOLOGICAL CONCEPTS

INFORMED CONSENT

My name is Chloe Gaines. As a doctoral student in nursing at Texas Woman's University, I am conducting a study of teaching strategies for learning physiological concepts. Students who agree to participate in the study will complete a demographic data questionnaire, a pretest, a computer assisted program, a computer program evaluation questionnaire and two posttests. The procedure will take approximately 1½ hours on 1 day and 30 minutes on a 2nd day. Potential benefits from the study include a gain in knowledge. A possible risk is that you may feel embarrassed due to low scores on the pretest and posttest. Names will not be used at any time in the description of the study.

---

I hearby authorize Chloe Gaines to administer to me a demographic data questionnaire, a pretest, a computer assisted program, a computer program evaluation questionnaire, and two posttests.

The procedures listed in paragraph 1 have been explained to me by Chloe Gaines.

I understand that the procedures described in paragraph 1 involve the potential benefit of gain in knowledge of physiological concepts.

I understand that the procedures described in paragraph 1 involve the potential risk of embarrassment due to low scores on the pretest and posttests.

I understand that all records which can identify me will be confidential and will be kept in a locked drawer. These records will be destroyed after data is completed.
I understand that participation in the study will not affect my course grades.

I understand that no compensation is provided to me by Texas Woman's University or the university I am currently attending for participation in this study.

An offer to answer all of my questions regarding the study has been made. If alternative procedures are more advantageous to me, they have been explained. A description of the possible attendant discomfort and risks reasonably expected have been discussed with me.

I understand that I may terminate my participation in the study at any time without intimidation or prejudice to me. If I have questions about the study, I may contact Chloe Gaines at (713) 797-7000.

______________________________ ____________________

Signature of Subject Date

______________________________ ____________________

Signature of Witness Date

APPENDIX C

Demographic Data Questionnaire

## Demographic Data Questionnaire

Directions: Please complete the following information. This information is confidential and will be used to describe the sample.

1. Gender
   a. Male _____
   b. Female _____

2. Age ________________ years

3. Race/Ethnicity (Check one)

   a. African-American _____
   b. Asian _____
   c. Caucasian _____
   d. Hispanic _____

4. State the number of years of experience you have in health care as:

   a. Licensed Vocational Nurse _____ years
   b. Nursing Assistant _____ years
   c. Student Nurse/Nurse Technician _____ years
   d. High School for Health Professionals _____ years
   e. Paramedic _____ years
   f. I have no experience in health care. _____

5. Do you have a college degree? Yes _____ No _____

   If yes, state the type of degree ___________________

6. Your preferred learning style is ___________________

7. Your college major _________________________________

# APPENDIX D

## Computer Program Objectives and Test

# FLUID VOLUME CONCEPTS
## OBJECTIVES

Upon completion of the computer programs, the learner will be able to:

1. Describe the composition of the three fluid compartments.

2. Describe the mechanisms by which body fluids move between the intracellular, intravascular, and interstitial compartments.

3. Describe how aldosterone, antidiuretic hormone, and thirst mechanisms regulate fluid volume.

4. Identify assessment data that validates fluid volume alterations.

# FLUID VOLUME CONCEPTS
# TEST

DIRECTIONS: There are 20 questions on this exercise. Each question has only one correct answer. Please read each question carefully. Then mark the BEST answer on your scantron sheet. Fill in the square completely. Erase any stray marks.

1. The regulator of intravascular osmolality is:

   a. Sodium
   b. Chloride
   c. Calcium
   d. Potassium

2. Electrolytes move into the cells by which process?

   a. Diffusion and osmosis
   b. Filtration and diffusion
   c. Active transport and diffusion
   d. Active transport and filtration

3. Water movement between intracellular and intravascular fluids is ruled by:

   a. Active transport
   b. Diffusion
   c. Filtration
   d. Osmosis

4. Which of the following compartments has the largest amount of substances?

   a. Extracellular
   b. Intravascular
   c. Intracellular
   d. Interstitial

5. The outward force pushing fluid from the intravascular compartment to the interstitial compartment is:

   a. Hydrostatic pressure
   b. Colloid osmotic pressure
   c. Interstitial hydrostatic pressure
   d. Interstitial colloid osmotic pressure

6. Considering the osmotic ability of sodium, increased sodium (hypernatremia) in the intravascular compartment will cause a shift of fluids from the:

   a. Cell to interstitial
   b. Interstitial to cell
   c. Interstitial to intravascular
   d. Intravascular to interstitial

7. What is mainly responsible for regulation of antidiuretic hormone (ADH)?

   a. Plasma osmolality
   b. Interstitial osmolality
   c. Glucose concentration
   d. Potassium concentration

8. Which condition occurs when water is excreted from the body while sodium and other electrolytes are retained?

   a. Dehydration
   b. Osmotic diuresis
   c. Overhydration
   d. Water intoxication

9. Thirst may occur as a result of decreased:

   a. Glucose levels
   b. Extracellular fluid
   c. Intracellular fluid
   d. Sodium levels

10. As the amount of antidiuretic hormone (ADH) in the blood increases:

    a. Urine is made more acid.
    b. More urine is formed.
    c. Reabsorption of water increases.
    d. Diuresis is accelerated.

11. A sign of intravascular fluid depletion with heart involvement is:

    a. Slow pulse rate
    b. High blood pressure
    c. Slow blood flow
    d. Low blood pressure

12. A decrease in serum albumin level will most likely affect:

    a. Intracellular fluid volume
    b. Serum potassium levels
    c. Serum sodium levels
    d. Interstitial fluid volume

13. Which of the following will be the MOST accurate way to determine a person's fluid loss?

    a. Urine output
    b. Perspiration
    c. Weight
    d. Skin turgor

14. Signs of fluid overload include:

    a. Lung congestion
    b. Cool skin
    c. Low blood pressure
    d. Weak heart rate

15. If a person's blood pressure, hydrostatic pressure, is high and the plasma colloid pressure is low, what would be expected to happen? Fluid would:

    a. Leave the intravascular compartment
    b. Enter the intravascular compartment
    c. Enter the intracellular compartment
    d. Not shift to either compartment

16. If a person has puffy extremities (edema), treatment to reduce the edema will be based on decreasing:

    a. Cellular hydrostatic pressure
    b. Plasma hydrostatic pressure
    c. Interstitial hydrostatic pressure
    d. Intracellular hydrostatic pressure

17. Which data indicated dehydration?

    a. High blood pressure and subnormal temperature
    b. Low blood pressure and poor skin texture
    c. Increased urine output and fast heart rate
    d. Absent pulses in arms and cold legs

18. What changes might occur as a result of excessive loss of body fluids?

    a. Decreased aldosterone secretion and water retention
    b. Puffiness and loss of electrolytes
    c. Increased antidiuretic hormone secretion and water retention
    d. Decreased concentration of fluids and loss of electrolytes

19. To remove excess fluid from the body, a solution should have a/an ___________ as compared to the blood plasma concentration.

    a. Equal osmotic pressure (isotonic)
    b. Lower osmotic pressure (hypotonic)

c. Higher osmotic pressure (hypertonic)
d. Same osmotic pressure (normotonic)

20. Which of the following best helps to provide information regarding a person's hydration status?

    a. Thirst and heart rate
    b. Skin texture and weight
    c. Blood pressure and iron
    d. Electrolytes and urine

# APPENDIX E

## The Development Phase of the Computer Programs

## The Development Phase of the Computer Programs

The computer programs were developed over a period of 6 months by the researcher and a computer programmer. The programs were written using the Pascal Programming Language.

The topic, fluid volume, was selected for the programs because nursing students enrolled in the pathophysiology courses were having difficulty understanding the concept. After the topic was chosen, a review of anatomy and physiology textbooks was performed to reflect current knowledge of the topic area. Program objectives, an outline and the content were then written by the researcher. The SMOG reading grade for the computer program was 13.

In consultation with the programmer, a linear, tutorial, and interactive format was chosen. This format would reinforce content taught in the classroom and provide involvement for the learner when viewing the program. By also placing incomplete maps in the computer program, students would be forced to think about the previously read content.

A flow chart and screen maps were then written. These items depicted the progression of the program as seen on the screen by the learner. During this phase, consideration of each screen (i.e., margins, line spacing, background color) was also done to prevent eye strain. Both upper- and lowercase characters were used in the text screens to facilitate the reading speed. All screens were kept free of clutter and showed only essential information.

The programmer coded information on the screen maps into the programming language. As each map was coded, the programmer also compiled the program to check for errors. The major problem throughout the development phase was time constraints. The programs were written after working hours; therefore uninterrupted time slots were difficult to obtain.

After the development phase, the programs were administered to three faculty members with medical-surgical experience. They were asked to evaluate the programs for clarity, logical sequence, content relevance, ease of start-up, errors, etc. Revisions were made on the basis of these evaluations.

# APPENDIX F

## Computer Programs Excerpts

Fluid Volume Composition

Fluid volume consists of body water (solvent) and dissolved substances (solutes). About two-thirds of fluid volume is within the intracellular compartment and one-third is within the extracellular compartment. The intracellular compartment consists consists of fluid within the cells.

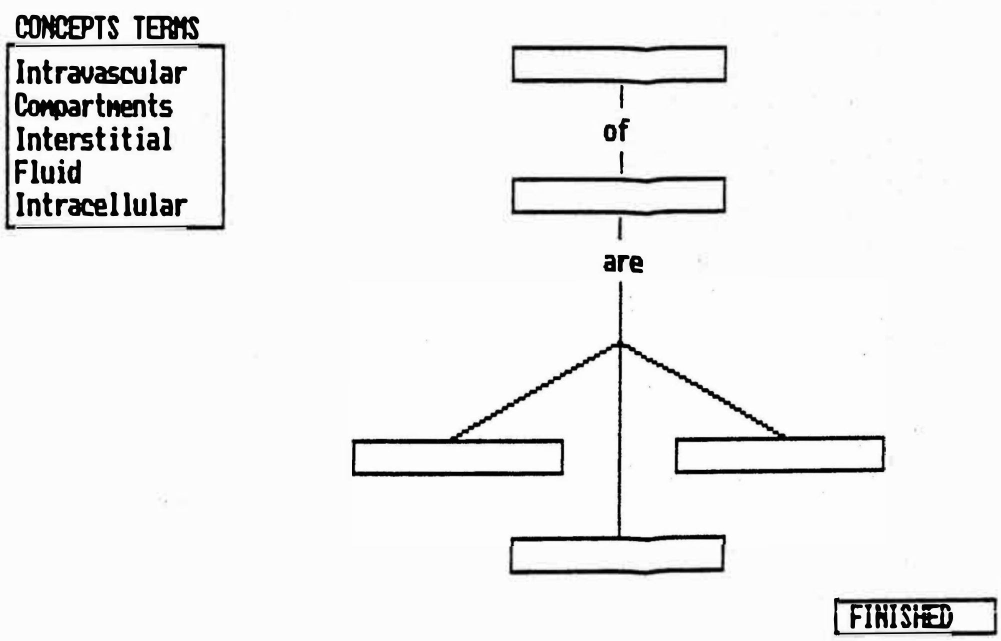
Press any key to continue.

Paragraphs from Computer Programs (Fluid Volume Concepts and Fluid Volume Basics)

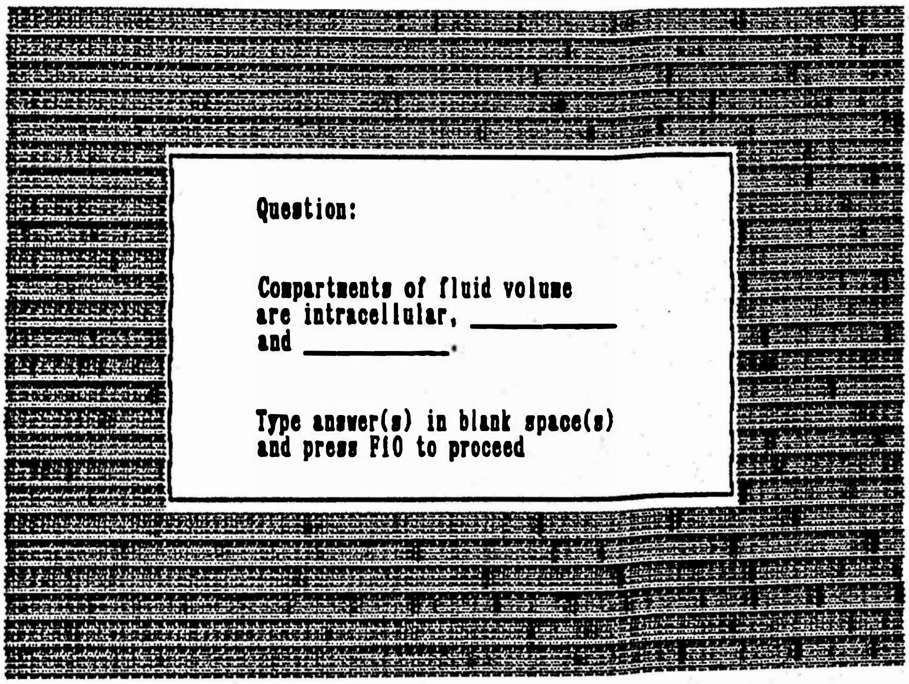
The extracellular compartment is divided into
two parts: interstitial and intravascular. The
interstitial compartment consists of fluid between
the cells and outside of the intravascular compartment.
The intravascular compartment is composed of plasma
and blood elements such as red cells and white cells.

Press any key to continue

Paragraphs from Computer Programs (Fluid Volume Concepts and Fluid Volume Basics)




Concept Map from Fluid Volume
Concepts Computer Program




Fill-in-the-Blank Question From
Fluid Volume Basics Computer Program