# A COMPARISON OF COMPUTER-ASSISTED PROGRAMMED INSTRUCTION AND INDEPENDENT STUDY EFFECTIVENESS IN TEACHING STUDENTS TO SOLVE DRUG AND SOLUTION CALCULATION PROBLEMS

by

Cheryl Verstraete Ratliff

BSN, University of Kansas, 1970

MS, Emporia State University, 1978

Thesis
1984
R187
c.2

Submitted to the School of Nursing and the Faculty of the Graduate School of the University of Kansas in partial fulfillment of the requirements for the degree of Master of Nursing.

Professor
Chairman

Committee Members

Dean, School of Nursing

June 13, 1984
Date Accepted

R00137 30680

## ABSTRACT

The purposes of the study were: (a) to compare the effectiveness of two instructional modalities, computer-assisted instruction and the independent study approach, in teaching junior level baccalaureate nursing students to solve drug and solution calculation problems; (b) to develop and validate a computer-assisted instruction module on the same topic; (c) to assess learning style, attitudes toward the instructional modalities, and the time spent learning by the computer or by the independent study method; (d) to determine whether the individual learning style and/or the attitudes toward the learning modality significantly influenced the knowledge gained and knowledge retained. Data obtained from administration of the following instruments were used to address the purposes of the study: (a) achievement test entitled Drug Proficiency Examination (DPE), (b) the Learning Style Inventory (LSI), and (c) the Adjective Rating Scale (ARS).

A one-way analysis of variance was conducted to compare the knowledge gained and retained when studying by computer-assisted instruction and the independent study approach. No statistical difference was found indicating neither group acquired or retained knowledge significantly better. Both methods of instruction were found to be at least equivalent in effectiveness. A one-way analysis of variance was conducted to compare subjects' attitudes toward the learning modalities. There was no significant difference between the group's attitudes prior to study except with respect to the dullness factor on the ARS. Following

study by the assigned modality there was no significant difference in the groups attitudes toward the CAI or independent study approach. Correlation coefficients indicated no relationship existed between either group's attitudes towards the learning modality and knowledge gained or retained. The time data was not analyzed due to insufficient return of information pertaining to the amount of time spent studying by independent study.

A two-way analysis of variance determined there was no significant main effect of group designation or learning style when posttest scores and retention test scores were the dependent variables. There was a significant interaction at the .05 level of significance between learning mode preference and group designation where retention scores were the dependent variables.

# ACKNOWLEDGEMENTS

In memory of my mother, the thought of her courage and spirit helps me now to complete this investigation and to pursue my dreams.

To my friends and colleagues Barbara Lease and Maisie Kashka, the memories of the grass roots of this investigation shall remain alive with emotions of fondness and appreciation.

To my thesis advisor and mentor Hester Thurston, these experiences have been rich in satisfaction, encouragement, and growth for me.

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# CHAPTER I

## Introduction

The technological advances of modern man have influenced nursing and nursing education. These technological developments applied to education have provided an array of machines and methods for instruction from which to choose. Knowledge and expertise to be acquired may be packaged in print, cassettes, videotapes, and computers.

The microcomputer is perhaps the newest technologic instrument to enter the educational environment. Its use or intended use in the educational setting has become increasingly popular. In 1972, a survey of the use of computer-assisted instruction (CAI) in 561 health sciences schools showed that 78 schools were using CAI and 116 schools expected to use this instructional approach in the future (Brigham & Kamp, 1974). Elmore (1974) employed the survey method to identify computer applications in baccalaureate nursing programs. The data indicated only 1 in 3 nursing students received exposure to clinical computer applications. The majority of computer usage at that time was for data processing, research, and testing capabilities.

Levine and Wiener (1975) performed a similar survey of computer usage in 200 nursing schools. Of the 155 schools which responded, 11 indicated current use of CAI, and 73 indicated they were at various stages of considering computer-assisted instruction. Silva (1973) prophesied, "within the next few decades, institutions of higher education will become deeply involved in computer-based education (CBE). Most, if not all, of the nursing student's knowledge about the technical and cognitive aspects of nursing care will come from computerized curriculums" (p. 94).

Computer capabilities offer a comprehensive educational system which may benefit the teacher and the student. For educational purposes, the computer may be selected to present singularly or in combination a variety of teaching strategies such as drill and practice, tutorial, dialogue, games, and simulations (Kuramoto, 1978).

One kind of tutorial instruction is programmed instruction. The programmed text is automated by the computer permitting the use of branched loops within the text. The branched program design diagnoses the student's learning needs and individualizes the student's route through the program depending upon the learner's responses. Computer interaction with the student compliments the innately responsive design of the traditional programmed instruction itself. To continue to enhance the quality of learning, further research is needed to establish the efficacy of computer-assisted instruction and the effectiveness of the particular computerized teaching strategies.

## Rationale for the Study

As instructional technology invades and influences nursing education, the nurse educator is obliged to determine its effects upon teaching and learning. The educational methods used to teach topics essential to the practice of nursing must be tested and evaluated. Not all methods are appropriate for all topics and learners, so the educator must discern the best method or methods for teaching students.

Decisions to develop or to continue a particular learning approach must neither be made solely upon teacher opinion or preference, nor upon student preference or evaluation. The demands of the educational system upon the teacher's time, skill, and expertise require a time efficient, effective, and rational supported approach to teaching. The advent of technology in the classroom and the current human resource realities justifies the need for educational research which compares the effectiveness, efficacy, and efficiency of various teaching approaches.

## Statement of the Problem

Research comparing the effectiveness of the various instructional approaches in nurse education is limited. Existing nursing literature concerning computer-assisted instruction predominantly described the applications of computers to the teaching/learning process. The limited research to date largely compared CAI to the more traditional teaching approaches (Huckabay, Anderson, Holm, & Lee, 1979; Ptaszynski & Silver, 1981; Spratt, 1968; Taylor, 1978). The study of time efficiency, attitudes of learners, styles of learners, and retention of learning is given brief consideration in CAI related studies (Bitzer & Bitzer, 1973; Bitzer & Boudreaux, 1969; Hoffer, Mathewson, Loughrey & Barnett, 1975; Jenkinson, 1972; Pogue, 1982; Valish & Boyd, 1975).

## Statement of the Purpose

The purpose of the study was fourfold: (a) to compare the effectiveness of two teaching modalities, computer-assisted instruction and the independent study approach, in teaching junior level baccalaureate nursing students to solve drug and solution calculation problems; (b) to develop and validate a computer-assisted instruction modules on the topic, the calculation of drug and solution problems; (c) to assess student's learning style, attitudes toward learning, and the time spent learning by the computer or by the independent study method; (d) to determine whether the student's individual learning style and/or the attitudes toward the learning modality significantly influenced the knowledge gained and knowledge retained.

## Designations of Groups and Hypotheses

### Designations of Groups

In this study, 63 subjects from the proposed fall class roster were randomly assigned to two groups. Fifty-eight students consented to participate and completed the study.

Group A. This group was comprised of 27 junior level baccalaureate nursing students who were exposed to the computer-assisted instruction approach utilizing the instrument developed, Calculation of Drug and Solution Problems.

Group B. This group was comprised of 31 junior level baccalaureate nursing students who were exposed to the independent study approach utilizing the assigned textbook, The Mathematics of Drugs and Solutions With Clinical Applications.

Hypotheses

Hypothesis I. There will be no significant difference between Group A (Experimental) and Group B (Control) in the knowledge gained as measured by the scores on a posttest when pretest score differences are considered.

Hypothesis II. There will be no significant difference between Group A (Experimental) and Group B (Control) in knowledge retained as measured by the scores on a retention test when posttest score differences are considered.

Hypothesis III. There will be no significant difference between the attitudes of Group A (Experimental) and Group B (Control) toward their assigned learning modality preceding study implementation as measured by the Adjective Rating Scale.

Hypothesis IV. There will be no significant difference between the attitudes of Group A (Experimental) and Group B (Control) toward their assigned learning modality following study implementation as measured by the Adjective Rating Scale.

Hypothesis V. There will be no association between the posttest attitudes of Group A (Experimental) and Group B (Control) as measured by the Adjective Rating Scale and (a) the knowledge gained and (b) knowledge retained.

Hypothesis VI. There will be no significant difference between Group A and Group B in the self-reported amount of time spent in interacting/studying the content.

Hypothesis VII. There will be no significant difference in (a) posttest or (b) retention test scores that may be attributable to either learning mode preference as identified in the Learning Style Inventory or group designation.

Hypothesis VIII. There will be no significant difference in (a) posttest or (b) retention test scores that may be attributable to either learning style type as identified in the Learning Style Inventory or group designation.

## Definitions of Terms

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

Adjective Rating Scale (ARS): an instrument which instructs the learner to rate 24 adjectives with respect to the student's perception of the teaching modality's practical value, emotional appeal, dullness, interest level, and difficulty (Kelly, Pascarella, Terenzini, & Chapman, 1976).

Branching Program: a teaching sequence in programmed instruction which allows the learner to choose an answer and routes the learner to information according to the choice which he/she has made (Callender, 1969).

Computer-Assisted Instruction (CAI): a teaching method with a tutorial presentation approach utilizing the computer system. The learner is required to continuously and actively respond to a televised stimulus by typing on a typewriter or keyset. The learner's responses are immediately evaluated and the learner proceeds through the subject matter at his/her own pace. Interchangeable acronyms found in the literature for CAI are CBE (computer-based education), CBT (computer-based training), also CAL and CBL (L refers to learning).

Drug Proficiency Examination (DPE): a 40 point examination which requires the student to calculate drug and solution problems demonstrating written mathematical computations and recording the answer in the appropriate units. The test is designed to measure the student's level of knowledge and competence in accurately calculating drug and solution related problems.

Junior Level Baccalaureate Nursing Student: a student meeting at least the minimum requirements for admission and accepted into the university nursing program. The student is currently enrolled in the initial nursing course, N001 Principles of Nursing and N002 Principles of Nursing: Clinical Laboratory.

Independent Study Method (IS): a planned instructional approach in which the student uses the assigned printed media in a self-directed manner to acquire an understanding of the specified subject matter.

Learning Style Inventory (LSI): a nine item self-description questionnaire created to measure individual learning styles. The LSI measures an individual's relative emphasis on four different learning modes which are identified as Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and Active Experimentation (AE) (Kolb, 1976).

Learning Style Type: an LSI score and description of learning patterns derived from the four identified learning modes. The score and description indicates the extent to which an individual uses a combination of the four basic learning modes. The descriptions of the learning types are Converger (CON), Diverger (DIV), Assimilator (ASS), and Accommodator (ACC) (Kolb, 1976).

Mean Test Score: a score obtained by adding the raw test scores on the Drug Proficiency Examination within each group and dividing by the number of subjects in the group.

Programmed Instruction: a teaching approach in which the subject matter is presented to the learner in sequencial, coaching steps. The learner actively responds to the stimulus and receives immediate feedback which indicates the accuracy of the response. The learner is able to proceed through the subject matter at an individual pace or rate.

Raw Test Score: the number of questions answered correctly on the Drug Proficiency Examination.

## Assumptions

For the purposes of this study, the following assumptions were made:

1. Students learn in different ways and at different rates.
2. Students have diverse capabilities.
3. Students can assume responsibility for their own learning.
4. Students in each group are equally motivated to learn the content.

5. Teaching by computer-assisted instruction and independent study are acceptable strategies for teaching the designated content.

6. Student learning related to the calculation of drugs will not be reinforced by learning experiences in the clinical laboratory setting in the period between $O_1$ and $O_2$.

## Limitations

The following were limitations of this study:

1. A lack of control in Group A over students' access to the printed material used by the students in Group B.

2. An inability to control in Group A and Group B access to additional educational assistance while learning the content by CAI or independent study.

3. Student learning related to the calculation of drugs may be reinforced incidentally by related experiences in the clinical laboratory setting in the period between $O_2$ and $O_3$.

# CHAPTER II

## Review of Literature

The review of literature is presented in seven sections: (a) the historical background of programmed instruction, (b) research pertaining to programmed instruction, (c) the historical background of computer-assisted instruction, (d) characteristics of and issues pertaining to computer-assisted instruction, (e) applications of computer-assisted instruction in nursing and nursing education, (f) research pertaining to computer-assisted instruction in nursing education, and (g) research related to learning style.

### The Historical Background of Programmed Instruction

While the thrust of the developments in programmed instruction occurred in the 1960's, epochal elements of the teaching mode are identifiable in the teachings of early educators. Lysaught and Williams (1963) described Socrates as one of the earliest programmers, "who developed a program for geometry, which was recorded by Plato in the dialogue, Meno" (p. 3).

In the early 1900's, Thorndike proposed the "Law of Effect" which stated that learning associated with success was pleasureful and consequently rewarding. The reward of pleasure or success experienced by the learner reinforced behavior to the degree that repetition of the behavior was likely to occur. Thus, the terms, reinforcement and reinforcer which are frequently used in association with programmed instruction.

In 1926, an Ohio State University psychologist named S. L. Pressey developed the first teaching machine. The machine was an automatic testing device which displayed a question, and the learner was required to press one of four keys corresponding to the learner's choice for an answer. The learner could progress in the program only by pressing the correct answer (Lysaught and Williams, 1963).

Due to the economic and social climate of the 1930's, further research and development of Pressey's device lost impetus until Skinner introduced similar auto-instructional methods in 1954. Skinner's devices were presented when world conditions were ripe for a technological approach to education (Lysaught and Williams, 1963). Skinner's machine was more than a testing device. The learner was required to compose a response, to answer a question, or solve a problem to communicate acquired information. The teaching machine indicated the accuracy of the learner's response and directed the learner to continue or to take corrective action (Lumsdaine, 1962).

Further developments in programmed instruction continued with attention focused on the form or structure of a program. In the late 1950's, Norman A. Crowder developed the branching method of programming (Callender, 1969). Lancaster (1974) compared this type of program stating, "in the linear program, all students follow all frames in the program in the same order; whereas, in the branching program, a student takes different branches (tracks) depending upon his responses" (p. 56).

Research on Programmed Instruction

The learning theory upon which programmed instruction was developed can be traced retrospectively to Skinner. Hilgard and Bower (1975) believed, "there is no doubt either that he [Skinner] arrived at his methods of [programmed instruction] through an attempt to generalize to education what he had learned through the study of operant conditioning in the laboratory" (p. 233).

Prior to the Skinnerian era, an associate of Pressey named, Little, was the first to systematically study the impact of auto-instructional methods and devices on learning. To summarize briefly, the researcher found those in the lower half of the class academically benefitted most from the auto-tutorial method of learning (Lysaught and Williams, 1963). Subsequent studies began to test the theory upon which programmed instruction was based. In teaching second and sixth grade levels, students who learned to spell with the assistance of programmed materials and teaching machines achieved more than students taught by conventional methods. This particular study purported to test reinforcement theory (Lysaught and Williams, 1963).

Schramm (1962) reviewed the literature prior to the publication of his text and found over 100 experiments related to programmed instruction. He enthusiastically concluded:

> This research leaves us in no doubt that programs teach. A great deal of learning seems to take place, regardless of the kind of program or the kind of students. Even a bad program is a pretty good teacher. Programs have been successful at all levels of the educational system, at all levels of ability from learners to the very best students, and to teach a great variety of academic subject matter and verbal and manual skills. (Schramm, 1962, p. 12)

In a book entitled, Four Case Studies of Programmed Instruction (1964), the Denver School System described their experiences constructing and testing programmed materials. Programs were developed in the areas of English correctness, Spanish, and the Constitution. Results of their research revealed accelerated English students learned significantly more from the programmed instruction than from the conventional practice approaches. In testing the effectiveness of the Spanish program, the programmed instruction plus classroom teaching was more effective than either method alone.

Limited research has been conducted which examined student's attributes or personality traits and achievement on a programmed instruction. Lubin (1965) studied the trait of autonomy and programmed instruction. He reported students low in the need for autonomy achieved more in a programmed course than a student high in this need. Student sociability also seemed to affect achievement with programmed instruction. Doty and Doty (1964) reported students scoring high on a sociability test tended to perform poorly with programmed instruction.

The majority of nursing research concerned with programmed instruction was conducted in schools of nursing and evaluated the effectiveness of programmed instruction as compared to other conventional methods of teaching. In 1968, Spratt devised a programmed instruction to teach nursing students how to complete IBM cards used by a visiting nurse service. The researcher found the group which learned by programmed instruction made fewer errors in comparison to the group which learned by the conventional lecture method.

In 1976, Teuscher and Heidecker found self-instruction to be a more efficient method of teaching a large number of patients, allied health students, and medical students the basic nutrition facts related to diabetes. Significant learning was achieved as measured by scores on a pre and posttest for those subjects taught by programmed instruction using what was described as an automatic teaching device. A similar study dealt with the effectiveness of programmed instruction in providing patient education. Rankin (1979) compared the effectiveness of a programmed instruction unit on anticoagulant medication to routine teaching practices on the same subject. The group of patients who received programmed instruction scored significantly higher on a multiple choice test and demonstrated greater retention of information than those patients who received routine teaching.

Guimei (1977) compared a programmed instruction module on oral contraceptives to a lecture-discussion method and to regular classroom instruction concerning the same topic. Thirty-four baccalaureate nursing students receiving clinical experience in obstetrical nursing were divided into three groups of eleven to twelve students. The exact method of group assignment was not denoted but one group was given the linear programmed instruction, one group received lecture-discussion, and a third group received what was described by the researcher as regular classroom instruction. A pre-posttest design (split-plot design) was used to compare the groups. Computations revealed there was no statistical difference between the scores of the group taught by programmed instruction and the group taught by the lecture-discussion method. A *t*-test ($t = 9.91$, $p \leq .01$) was significant when a set of comparisons was made between the weighted average of posttest mean scores of the programmed instruction and the lecture-discussion method to the group receiving regular classroom instruction. In his conclusions, the researcher elaborately speculated the possible reasons that programmed instruction and lecture-discussion were more effective than the regular classroom method.

Taylor (1978) compared the effectiveness of a combination programmed instruction and laboratory exercise approach to the programmed instruction approach without laboratory exercises in teaching diploma students the principles of solving calculation problems. No significant differences in learning were found between the two groups in the pretest, posttest, or retention test scores. The programmed instruction was found to be an effective method of learning the principles of solving calculation problems. The findings also indicated that the laboratory exercise did not significantly add to the information acquired.

A teaching/learning approach studied by Ptazynski (1981) found a six unit module described as self-directing, self-correcting, and self-pacing in conjunction with laboratory sessions for information clarification to benefit learning. The researchers described the teaching and learning strategy as yielding an impact on the baccalaureate students' ability to apply the knowledge to solve drug calculation problems. An analysis of pre and posttest scores was the basis for the above conclusion. The pretest mean was 52 with a range of 48 compared to the posttest mean which was 92.7 with a range of 24.

## Historical Background on Computer-Assisted Instruction

During the 1950's and 1960's, computer-assisted instruction was introduced in education. Until a programming language was developed in 1960 by IBM (Burson, 1982), the majority of the educational programs were designed and written by computer programmers. In the 1960's and 1970's, the programming languages were simplified and the CAI systems were continually changed. The microcomputer was the end result of scaling down large and costly computer systems. With an historical perspective, Barker (1971) succinctly summarized the 50's as the decade for the computer designer, the 60's as the decade for the programmer, and the 70's as the decade for the user.

Characteristics of and Issues Pertaining to Computer-Assisted Instruction

The literature reviewed favorably described the attributes and characteristics of CAI. The CAI mode of instruction was perceived to employ a majority of the principles of learning, to enhance the teaching-learning process, and to possess the characteristics of a competent and expert teacher.

Researchers and users of CAI found this mode of instruction employed the general principles of learning. Computerized learning stresses learner involvement. Learner passivity is discouraged by the interaction required between the student and the terminal. The rapidity of the reciprocal responses and the visual elements of the screen provide the learner with personalized and immediate feedback concerning the correctness of the responses (Kamp & Burnside, 1974; Meadows, 1977; Pogue, 1982; Porter, 1978; Sweeney, O'Malley & Freeman, 1982). These characteristics were thought by some investigators to reward and, thereby, motivate the learner (Huckabay, Anderson, Holm, & Lee, 1979; Levine & Wiener, 1975).

Computer-assisted instruction was declared to shift the emphasis from teaching to learning. The student controls the learning rate and pace. The learner becomes more independent and self-directed as a result of the ability to command the program in a way which focuses on personal information needs (Brigham & Kamp, 1974; Mirin, 1981; Norman, 1982; Pogue, 1982; Porter, 1978). Like the expert teacher, the computer in CAI was praised for an endless, tireless, and always objective response to the learner (de Tornyay, 1970; Meadows, 1977; Norman, 1982; Olivieri & Sweeney, 1980). Silva (1973) stated the computer, when used for instructional purposes, has some of the same characteristics as nursing instructors that students identified as helpful in learning. Like the teacher who promotes learning, the computer is patient, respects privacy and individuality, permits self-paced learning, gives encouragement, and treats all students in a like manner.

The CAI characteristic which seemed most valued by nurse authors was the ability to promote student application and transfer of learning in preparation for a practice profession. The problem-solving, simulation, and game modes of presentation provide an opportunity for exploration and decision-making in realistic patient-centered situations. The CAI exercises are viewed as invaluable in assessing a student's skills in realistic but hypothetical situations without risk of injury or harm to a patient (Burson, 1982; de Tornyay, 1970; Huckabay et al., 1979; Meadows, 1977; Norman, 1982; Olivieri & Sweeney, 1980; Porter, 1978; Silva, 1973). In addition, CAI could permit exposure to clinical situations which are not abundant or found only in certain institutional settings (Olivieri & Sweeney, 1980).

As learner responsibility is emphasized in CAI, the teacher's activities change. The role of educator becomes one of helper, facilitator, consultant, and resource person (Brigham & Kamp, 1974). The computer capabilities permit the teacher to monitor a student's learning approach, decision-making skills, and progress in attainment of the program objectives. The teacher in this manner can diagnose learning problems or deficiencies and plan alternate learning experiences (de Tornyay, 1970; Kuramoto, 1978; Norman, 1982; Olivieri & Sweeney, 1980).

The literature reviewed describes CAI as efficient and economical. A general consensus of opinion existed which found CAI cost effective in the sense that computer-assisted instruction which was developed, tested, and in-place permits the teacher additional time for research, individual student assistance, and curriculum refinements (Burson, 1982; Kuramoto, 1978; Olivieri & Sweeney, 1980). An evaluation of the attributes of CAI in the literature reviewed includes a general expressed concern for the associated expenses, the diversity and complexity of the equipment, the quality of learning, and the nurse educator's role with respect to CAI development-related decisions.

In an era of financial resource scarcity, the issue of cost effectivness in CAI can not be avoided. Cost effectiveness is defined by Burson (1982) as producing," more learning for the same cost or equivalent learning for less cost" (p. 574). Computer-assisted instruction costs are determined by the expenditures associated with hardware procurement and software development. The acquisition of the computer hardware is documented to be the first hurdle to providing computer-assisted instruction (Burson, 1982; Kuramoto, 1978; Levine & Wiener, 1975; Mirin, 1981). Mirin (1981) stated that the acquisition of a microcomputer may be less difficult than acquiring a large computer system which," require s the commitment and resources of an entire school or university system" (p. 501).

Once computer hardware has been acquired the emphasis shifts to software purchase or development. Levine and Wiener proclaimed, "the most difficult limitation is the lack of programs and the cost of developing a course" (p. 1302). According to Mirim (1981), the nurse author has three choices in software development: (a) working with an instructional designer and computer programmer, (b) acquiring basic programming skills and self programming the course, and/or (c) using an authoring language which allows the author to use one computer program to write another.

Estimates of the time required for program development range from one man year to write a full semester course to 100-400 hours to develop one hour of computerized instruction (Kuramoto, 1978; Levine & Wiener, 1975; Norman, 1982).

Several authors foresaw a potential loss of influence and decision making power to computer experts if the nursing profession lacks the necessary technical computer savvy to direct course or program development (Birckhead, 1978; Mirin, 1981; Silva, 1973). Birckhead (1978) urged profession wide caution when she said "my concern is not how to 'get rid of' computers, but how to stimulate thinking and provoke a way (an investigating committee is a beginning) to monitor the effects of technology on nursing practice and patient welfare" (p. 18). Mirin (1981) believed progress would continue and remarked," educators need to ensure that they, not the manufacturers, set the pace in the development of educational software" (p. 505). Silva (1973) questioned, "and who will monitor the total learning program to ensure that decisions related to educational processes and nursing knowledge remain in the hands of learning researchers and content experts in nursing?" (p. 96).

As the role of the educator in the development and use of CAI is scrutinized by critics, so too, must the quality of learning be appraised according to nurse authors. Interaction with an inanimate object has its limitations according to several educators. Kuramoto (1978) viewed socialization with peers and teachers a large part of the learning experience; consequently, CAI should not be the sole mode of learning but a kind of multi-media resource. Silva (1973) examined the issue and said, "although it will allow the student more responsibility in determining her sequences and more flexibility in scheduling her class hours, it may also inadvertently condition her to respond in a limited number of ways to her environment" (p. 98).

While CAI has the potential to be learner-sensitive, it is not necessarily a universal instructional approach best suited for all learners. The literature reviewed stresses the task at hand remains to be answering the question: What type of person learns best by CAI? This seems to be the person who is capable of self-direction. Self-direction, the ability to concentrate, the ability to attend to details, and the abilities to memorize and complete a task have been cited as learner attributes best suited to computer-assisted instruction (Buchholz, 1979; Burson, 1982).

An interesting study, reported by Hopmeier in Electronic Education (1981), utilized an individual personality preference scale to determine how personality characteristics influenced CAI effectiveness. The Myers-Briggs indicator was used by Hoffman, Waters, & Berry to identify individual personality preferences with 120 students at the Naval Training Center, Pensacola, Florida. The indicator identified major personality preferences in four opposite pairs: (a) introvert/extrovert, (b) sensing/intuition, (c) thinking/feeling, and (d) judgmental/perception. Hopmeier concluded from the study data," that the 26 percent drop-out rate in the Navy study was highest in the area of extroverts who were perceptive" (p. 17). Hopmeier further interpreted the data, and said:

> A review of the information obtained confirmed a definite correlation between drop-out rate and effectiveness with certain characteristics of the learner's preference style. As a result of this information, the Navy changed its teaching

> method for the drop-outs. The changes resulted in a marked increase in completion for drop-outs and improved educational effectiveness when measured by the amount of time a student takes to complete a group of educational objectives (p. 16).

Porter (1978) stated the use of CAI for instructional purposes will afford the teacher the time needed to conduct research related to CAI and learner compatibility. Such studies might enable instructional methods to be matched with the learner's preference for instructional methodology.

Applications of Computer-Assisted Instruction in Nursing and Nursing Education

Computer systems perform countless functions which directly and indirectly impact on nursing. The multitudinous uses of the computer in the work places of the nurse are documented in the literature (Barker, 1971; Kasanof, 1970; Porter, 1978; Scholes & Barber, 1976).

In the educational setting the uses of the microcomputer can be divided into two categories: (a) management of the educational environment, and (b) general instructional uses. Kuramoto (1978) stated, "the most visible use of computers in instruction is to provide assistance to learners and to assist teachers, administrators, and educational technologists in helping learners" (p. 10). In the realm of management of the educational environment, the microcomputer has the capability of securing, storing, and processing immense amounts of information and data concerning student performance prior to, during, and following completion of a program of study (de Tornyay, 1970; Meadows, 1977; Mirin, 1981; Porter, 1978). Once entered, the computer bank information is readily retrievable. In addition to the information processing capabilities, the computer has precise calculating abilities for analysis of pertinent data, including the ability to prepare typewritten and graphically represented materials (Dwyer & Schmitt, 1969; Meadows, 1977; Mirin, 1981; Olivieri & Sweeney, 1980).

In the realm of instructional uses, computer-assisted instruction is limited only by the author's capabilities, commitment, and understanding of the system's potential. Milner & Wildberger (1977) identified three basic reasons for using the computer in the learning setting. First, the computer is unequal to other teaching approaches, in that, it provides computer simulation in fields where exposure to real-world phenomena and manipulation are highly desirable for learning. Secondly, the computer is unique for its intangible but difficult to measure benefits such as versatility, responsiveness, and objectivity. Finally, the computer may be considered economical and efficient with respect to teacher and student use of time.

Computer-assisted instruction which provides another mode and multideminsional approach to teaching and learning can be categorized several ways. Milner and Wildberger (1977) conceptualized the instructional uses of the computer on a continuum," arranged in order of increasing use of the computer's potential capability, increasing student control and increasing necessity for computer use" (p. 117). When considering categorization according to content presentation or modes of instruction, the generally accepted categories in order from least to most complex in instructional design are: (a) drill and practice; (b) tutorial; (c) discovery, problem solving, or dialogue; and (d) games and simulations (Collart, 1973; Kuramoto, 1978; Meadows, 1977; Mirin, 1981). Each of the identified categories or modes of instruction has potential applications to nursing education. The drill and practice mode is ideal for providing the opportunity for additional exposure, review, or practice with information previously learned in a conventional manner. More complex than the drill and practice, the tutorial mode presents concepts or information and asks the student to respond to a given question or problem. Reinforcing or coaching teachniques are frequently used in this mode to promote accomplishment of the program objectives. As the terms suggest discovery, problem solving, or dialogue modes encourage more complex and original student responses in learning new information. To accomodate the variety in the students' learning processes and responses, the programs are more complex and aim at higher levels of instructional objectives. More complex than the other modes, the simulation and gaming strategies are applicable to any nursing situation when it is optimal to encourage experimentation or earnest use of decision-making or critical thinking skills (Collart, 1973; Kuramoto, 1978; Meadows, 1977; Mirin, 1981).

In relation to specific nursing content taught by CAI, Levine and Wiener (1975) described the development of a CAI to teach measurement systems. Donabedian (1976) described the development of a program for nursing students which focused on the basic principles and tools of epidemiology. Each program was written using a tutorial case study approach.

Using the more complex modes of instruction, Bitzer and Boudreaux (1969) discussed the development of a branching program dealing with maternity nursing content. The development of another branching-type simulated computer program was described by Sumida (1972). The CAI was used to evaluate the students' capabilities against the terminal objectives of the Associate Degree and Bachelor of Science in Nursing programs. In this CAI one programmed situation was developed for each of four areas of clinical practice. The process for refinement and validation of the instrument was disclosed in the article.

Collart (1973) developed a CAI program about closed drainage systems. The progam was in the simulation mode of instruction and consisted of six modules which dealt with anatomy and physiology, individual case studies, and commercially available drainage systems.

At the graduate education level, Kamp and Burnside (1974) described their efforts to introduce computer-assisted learning into a graduate psychiataric nursing class. The teaching program was described as a frame-oriented CAI with simulated clinical situations and interviews. The program was intended to teach history taking and diagnosis of psychiatric problems utilizing the simulated learning approach.

In the literature reviewed, the computer also was acclaimed for its use in evaluation of student academic performance. Computerized testing permitted the teacher to develop an item bank, to perform an item analysis, to rapidly score a test, and to maintain test security (Porter, 1978; Sweeney, O'Malley & Freeman, 1982).

In the area of evaluation of clinical abilities, Olivieri and Sweeney (1980) described the process by which a computerized simulation was developed to evaluate student clinical expertise. The program was designed as a evaluation tool to help faculty appraise the clinical skills of students they planned to instruct. The tool also provided for a comparison among students. The stimulation dealt with an adult patient in the emergency room experiencing pain. While working at the terminal, the student enters into dialogue with the patient, indicates nursing actions appropriate, and may even request additional data such as lab values, EKG results, or vital signs. The program is designed for use with an evaluation test booklet.

Specific examples of larger scale computer usage for instructional and administrative purposes at various levels of nursing education were available for review in the literature. Lidz (1974) summarized the grant funded development of an associate degree nursing program which was described as self-paced and mastery oriented by means of computer-managed instruction. Specifically, the computer was said to manage the student's progress by administering and scoring tests and by directing the student to areas of study to achieve mastery.

Sister Grace Henke (1977) described a similar computerized curriculum approach in which a computer-based learning system was utilized. The system, described as a multimedia student response system, was designed to perform three tasks: (a) to utilize and control other audiovisual devices for learning, (b) to control and administer an evaluation or testing system which yielded immediate knowledge of results to the student and instructor, and (c) to store data to permit analysis of individual student progress and test items. Student responses to the system were reported as "overwhelmingly positive."

Computer-assisted instruction also was identified as useful and pertinent to the continuing education process in nursing. Pogue (1982) conducted an experimental study to evaluate the effectiveness of computer-assisted learning concerned with cardiovascular medications. Hoffer, Mathewson, Loughrey, & Barnett (1975) conducted a similar study utilizing a computerized teaching program about cardiopulmonary resuscitation as a means of providing inservice education. Both authors cited the self-paced, flexible features of CAI as compatable with the characteristics and needs of adult learners.

## Research Pertaining to Computer-Assisted Instruction in Nursing Education

Literature which described the development of computer-assisted programs and its use in the teaching/learning process was more abundant than descriptions of research testing the effectiveness of the CAI. While there are several studies pertaining to medical education for reference, this review is focused on research related to nursing (Feurzeig, Munter, Swets & Breen, 1964; Murray, Barber, & Dunn, 1978; Teuscher & Heidecker, 1976).

The majority of authors purported the efficacy of the CAI by faculty evaluation of the teaching strategy or documentation of student response to the CAI experience (Bitzer & Boudreaux, 1969; Hoffer et al., 1975; Kamp & Burnside, 1974; Levine & Weiner, 1975; Olivieri & Sweeney, 1980). This literature seemed to indicate that the evaluative information was obtained in a manner secondary to the CAI development and validation process.

Numerous reports of the use of experimental designs to establish the effectiveness of the teaching mode were available for study. The subjects were students in nursing programs or nurses participating in some form of postgraduate education. Each of the studies summarized includes conclusions drawn with respect to the effectiveness of CAI, retention of learning, learners' attitudes, and characteristics.

Most studies compared CAI to the more traditional teaching strategies. Bitzer's (1966) study compared a computer-controlled simulated teaching system to the classroom lecture. The topic was care of the patient with a myocardial infarction. The subjects were a class of 14 nursing students divided into two groups of seven. A pretest-posttest design was used in which a _t_-test of the difference between posttest mean scores was significant at the nine percent level by a two-tailed test ($t$ = 1.19). The study also determined the subject's cognitive style or general approach to problem-solving by administering a cognitive style instrument designed by Jerome Kagan at Fels Research Institute. With this instrument the subjects were asked to group two of three objects. The subjects categorized objects into one of three types: (a) relational or associative response, (b) analytical response, or (c) inferential response. The researchers found there was no significant correlation (-.23) between the subjects measured ability to solve problems and their posttest scores, however, there was a significant correlation (.70) between measured problem solving ability and pretest scores.

Bitzer and Boudreaux (1969) studied a class of 100 nursing students enrolled in a maternity nursing course. A group of students reported with matched ability were divided into two groups. The experimental group received the course content in twenty-two computerized lessons in the tutorial or inquiry mode of instruction via PLATO (Programmed Logic for

Automatic Teaching Operations). The remainder of the students, the control group, were given the same course content by conventional classroom instruction. Posttest scores were used to evaluate learning achieved. The researchers reported the posttest scores indicated a significant gain by all students. A comparison of final examination grades between the two groups showed no significant difference. The time data in this study are more specific than test score data. The total time required to complete the twenty-two computerized lessons ranged from 28 to 40 hours. The students in the control group spent 84 hours in the classroom. In conclusion, the group learning by CAI acquired the same amount of information in one-third to one-half the time as the students in the classroom setting.

Bitzer & Boudreaux's (1969) documentation of the students' response to the CAI learning experience was more specific than in other studies. Generally, the responses of the students became more favorable as the interaction time with the computer increased. The gradual change in reactions to CAI suggested a period of adaptation to the computer was required. Other responses documented included a student tendency to attribute human characteristics to the computer and an ability to concentrate on the material presented despite concern with the mechanical aspects of the computer's operations. In final judgment, one-half of the students rated CAI as the mode of learning preferred to lecture, textbook, film, or television; 1 in 25 students rated CAI as the worst medium for learning.

Bitzer and Bitzer (1973) conducted a similar study using the same twenty-two lessons in maternity nursing described above and 11 additional pharmacology lessons. This study was broader in scope, in that teaching effectiveness, retention, and attitudes were evaluated in addition to student achievement. One aspect of the study included a determination of the effectiveness of branching versus non-branching programs on student achievement. Twenty-six students participated in this related group study which found both branching and non-branching treatments highly significant ($p < .001$) when pretest, posttest, and 28 week posttest scores were evaluated. Furthermore, the researchers stated:

> It is concluded that there is marginal (11 percent of the variance in gain scores was accounted for by the difference in forms of the lesson) evidence that the added use of branching and 'help' sequences has a beneficial effect on learning of this material and that the relative gains produced are retained during normal forgetting (p. 196).

To test retention in this study successive multiple posttests were administered at approximately one month intervals. To evaluate retention the ratio of number of wrong answers on the posttest to the number of wrong answers on pretest was determined. The percentage of the variance of scores on the last test accounted for by the treatment ranged from 86 to 95 percent. Details concerning the number of subjects and the time spent learning were not mentioned with respect to this aspect of the study. To assess quality of learning in the same study, two lessons containing content considered difficult for students were taught by CAI. A criterion test was administered as a pretest, posttest, and retention test to 26 students. Twenty-one of the subjects completed the study. Bitzer and Bitzer (1973) reported that the CAI was highly significant and accounted for a major part of the test score variance.

Student attitudes toward CAI in the Britzer and Britzer (1973) study were assessed by a one-page evaluation form which evaluated possible difficulty in use of the computer, capability to teach, and acceptability and effectiveness of CAI as compared to other forms of instruction. Like the results of the previous study, the researchers found opinions changed in favor of CAI with increased exposure. Technical difficulties also decreased with increased time at the computer terminal. At the conclusion of the course, 50 percent of the subjects rated CAI as the perferred mode of learning, while 0 to 15 percent favored more traditional forms of learning.

Ronald (1979) also studied student attitudes in evaluating an undergraduate elective nursing course designed to acquaint students with the impact of computers on health care. This research found similar results in that negative attitudes were more prevalent than positive attitudes at the outset of the course. With actual hands on experience the students indicated the computer lost its dehumanizing and unfriendly characteristics.

A study by Kirchhoff and Holzemer (1979) attempted to study in further depth learning charcteristics and attitudes. The study examined the effectiveness of a computer-assisted instructional program on postoperative nursing care. A modified posttest only design was used. The investigators reported the 100 subjects did learn, but no conclusive statement could be drawn since a control group was not utilized. Most unique in this study were the instruments used to determine how learning styles influenced learning and to measure attitudes towards CAI. The Learning Style Inventory reported four learning modes. The researchers reported," students with high scores on Active Experimentation (doing) also had high scores on learning, the statistically significant increase in the multiple R was judged not to be educationally significant in these results" (p. 28). With the use of the Adjective Rating Scale, the researchers found the subjects learning was significantly related to the degree to which they found the CAI program not to be dull. Dullness was one of five major factors in the 24 adjective scale consisting of the adjectives such as loving, irrelevant, dull, a waste, and useless.

Concerning students attitudes, Jenkinson (1972) conducted a descriptive study of 63 English nursing students' familiarity with computers and their knowledge of its potential uses in the hospital. One-half of the students had seen a computer but few had any formal teaching or computer usage. Only one-third of the students could see no advantages to computer usage in the hospital. Those students who perceived the computer as advantageous were able to cite various applications.

A number of investigations using experimental designs dealt with nurses participating in postgraduate courses or learning endeavors. Hoffer et al., (1975) conducted a study pertaining to teaching cardiopulmonary resuscitation (CPR) at a community hospital sixty miles from the computer site. As reported, 34 subjects were randomly assigned to a control group of 12 and to a user group of 22 subjects. No rationale was offered for the disparity in the group size. While the experimental group interacted with the CAI, the control group participated in the traditional program on the same topic. Student achievement was measured by scores on a pre and posttest. The test scores revealed the experimental group significantly increased their scores ($4.68 \pm 2.52$ to $5.93 \pm 1.97$), while the control group did not ($5.96 \pm 1.69$ to $5.58 \pm 1.96$). Computer usage ranged from 13 minutes to 2 hours and 22 minutes. Five of the 22 nurses used the computer less than 30 minutes, seven used it 30 to 60 minutes, and 10 nurses spent over one hour at work on the computer. Nine of the 22 nurses returned for additional work at the computer terminal after the initial encounter. No time data for the control group were mentioned. The experimental group's attitudes or satisfaction was reported as "generally high." The control group's attitudes and satisfaction with the mode of learning was not reported.

The purpose of another study by Valish and Boyd (1975) was to determine whether CAI programs when administered to registered nurses, "would produce observable evidence of verification and augmentation of previously learned clinical knowledge in nursing" (p. 17). In addition, the researcher hypothesized that educational preparation, age, and years of clinical experience would exert an affect on the nurse's performance. The sample consisted of 124 registered nurses randomly chosen from the staff of a medical center. The research method used was the experimental posttest-only control group. The CAI course on septic shock, intravenous therapy, leadership, and management was identified as the independent variable. The performance of the subjects on the posttests or criterion measures were the dependent variables. The results of the study determined by the t-test demonstrated no significant difference in the group with respect to clinical knowledge at the .05 level of significance. In addition, no support was found for the second hypothesis which stated educational preparation, age, and years of clinical experience would exert an affect on the nurse's performance.

Huckabay et al., (1979) studied the effects of CAI versus lecture-discussion on cognitive learning, transfer of learning, and affective behaviors with 31 nurse practitioner students. Again, a pre and posttest experimental design was used. The following hypotheses were not supported when the *t*-test was used to analyze the data: (a) CAI students will learn significantly more than the control group, (b) CAI students will transfer what they have learned to similar situations significantly more than the control group, (c) CAI students will demonstrate affective behaviors at a significantly higher level than the control group. Though statistical significance was not found, the observed trend was in the predicated direction for all hypotheses. In this same study an instrument consisting of 10 questions constructed on Likert-type rating scale assessed the subject's feelings about the method of instruction. The reliability of the instrument was .6310 ($p = .01$). When the results were evaluated, it was determined the subjects preferred CAI but not significantly. The researchers' opinions were that the novelty of the approach influenced the responses.

Similar in design to the Huckabay et al., (1979) study, Pogue (1982) evaluated the effectiveness of a CAI on cardiovascular drugs in teaching nurses in an orientation program. Thirteen nurses in the experimental group interacted with the computer, while 14 nurses attended lectures. A pre-posttest design consisted of a 49 item exam with 5 subtests. A *t*-test analysis on the adjusted scores (adjusted for differences in pretest scores) in each subtest indicated the experimental group score were higher, but not significantly. The adjusted scores of the total test of the experimental group were statistically significant at the $p = .001$ level.

## Research Related to Learning Style

Interest and study about learning has extended beyond examination of modes of learning to include the study of an individual's manner of acquiring knowledge or meaning. Cognitive style or learning style are terms used to describe an individual's manner of learning. Ehrhardt (1983) defines cognitive styles "one's preferred way of learning or of gaining meaning from one's environment" (p. 569).

Cognitive or learning style is different from one's ability to learn, to perform, or to achieve. Ehrhardt (1983) maintained cognitive style indicates a preference for learning which cannot be quantified; consequently, comparison of the difference preferences of learners is the only means of evaluating or making a statement about the cognitive styles of a group of individuals.

Ehrhardt (1983) further described the concept of cognitive style as value free. For learning by CAI is no better than learning by reading if learning indeed occurs by both methods. Cognitive style is established and distinguishable early in life. Style of learning is stable throughout the developmental stages. Changes in state of health or learning capabilities do not alter one's preferred way of learning (Ehrhardt, 1983; Villetoe, 1983).

Investigations pertaining to cognitive style have not been as prevalent as studies associated with ability, performance, or achievement.

Ehrhardt stated, "We have accepted that people perform at different levels and produce at different rates. We have not been as aware of the differences in the cognitive style of those with whom we communicate, train, or work" (p. 569).

The cognitive styles of students in the health fields have been examined. Villetoe (1983) reported the results of five investigations in which different research tools were used to assess the learning or cognitive styles of learners in the health field. The instruments which had been used in research with students in the health fields were the Kolb Learning Style Inventory, the Canfield-Lafferty Learning Styles Inventory, and the Rezler-French Learning Preference Index. Villetoe reported Plovnick (1975) Sadler, Plovnick & Snope (1978), Carrier, Newell & Lange (1982) used the Learning Style Inventory and found the majority of learners were Acommodators. Several other investigations were cited in which other learning style instruments were used. Villetoe (1983) found the research convincing and generalized:

> Even though different instruments were used for data collection, all of the studies cited above indicate the learning preferences or styles of these populations, on the average, are in the direction of concrete learning activities with hands-on experience and active experimentation (p. 662).

Ihlenfeldt (1981) described the use of a 27 item cognitive-mapping inventory in a post-secondary institution to determine students' preferred style of learning. Inventory analysis yielded a computerized cognitive map and prescription which indicated students' learning strengths, limitations, and preferred learning styles. The advantages of the diagnostic technique cited were early detection and avoidance of potential learning problems, improved student performance, and orchestration of student learning styles with courses and study modes, and reduced attrition in educational programs.

In summary, a review of the literature does not indicate that computer-assisted instruction is superior to other modes of learning, only that it is competitive with respect to effectiveness in teaching and learning. The time data indicated that CAI was efficient and economical but in numerous cases no comparison was made to the other mode of learning represented in the study. Student attitudes and appreciation for CAI seemed consistently higher, especially with increased exposure. However, the attitudes reflect responses to relatively brief exposure and certainly one could not generalize these responses to entire courses or curricula. The newest dimension in CAI research is the assessment of learner characteristics and which characteristics equip the learner with a preference for learning via CAI. The studies are sufficiently limited that one should demonstrate caution in drawing conclusions at the present.

CHAPTER III

Methodology

## Design

A quasi-experimental approach of pretest, posttest, and retention test experimental design was used in this study. The dependent variables were knowledge gained, knowledge retained, amount of time spent studying, individual learning styles, and attitudes of the subjects tested. The independent variables were computer-assisted instruction (CAI) and the independent study method (IS).

The quasi-experimental design diagrammed below illustrates the design used in the study.

| | | | | | |
|---|---|---|---|---|---|
| | Group A (Experimental) | $O_{1a}$ | $T_1$ | $O_{2b}$ | $O_3$ |
| | | $O_{1b}$ | | $O_{2c}$ | |
| R | | $O_{1c}$ | | | |
| | Group B (Control) | $O_{1a}$ | $T_2$ | $O_{2b}$ | $O_3$ |
| | | $O_{1b}$ | | $O_{2c}$ | |
| | | $O_{1c}$ | | | |

Group A = Experimental group (junior level baccalaureate nursing students randomly assigned to learn by the computer-assisted instruction approach).

Group B = Control group (junior level baccalaureate nursing students randomly assigned to learn by the independent study approach).

Three tests (LSI, ARS, DPE) were administered as follows:

$O_{1a}$ = The Learning Style Inventory (LSI) administered in the first week of the course prior to random assignment of the subjects to Group A or Group B.

$O_{1b}$ = The Adjective Rating Scale (ARS) administered in the first week of the course after the subjects were notified of random assignment to Group A or Group B but prior to studying the content by the designated methodology and taking the Drug Proficiency Examination (DPE) pretest.

$O_{1c}$ = The 40 point achievement examination administered in the first week of the course prior to subjects studying content related to the calculation of drug and solution problems (DPE pretest).

$T_1$ = Computer-assisted instruction approach.

$T_2$ = Independent study approach.

$O_{2b}$ = The Adjective Rating Scale (ARS) administered at the mid-point of the semester after the subjects had the opportunity to study the content by the designated methodology but prior to the administration of the DPE posttest.

$O_{2c}$ = The 40 point achievement examination administered midsemester (DPE posttest).

$O_3$ = The 40 point achievement examination administered in the last week of the semester (DPE retention test).

## Setting

The setting was a metropolitan university college of health sciences campus. The parent institution is located approximately 40 miles from the health center campus. Approximately 2,000 students attended classes on the health center campus, of which approximately 600 were either part-time or full-time students of nursing enrolled in the undergraduate or graduate nursing courses. Of this student body, nearly 225 were participants in the generic undergraduate nursing program.

## Subjects

The subjects were junior level baccalaureate nursing students enrolled in the introductory nursing course of the program in the fall session of 1982. In order to gain acceptance into the baccalaureate program, these subjects had completed a minimum of 62 semester hours of credit from an accredited liberal arts college with a minimum grade point average of 2.5 on a 4.0 point scale. It was anticipated the subjects would complete the undergraduate program of study in four semesters. Upon program completion, the subjects receive a Bachelor of Science in Nursing and are eligible to write the State Board Test Pool Examination for Registered Nurses.

The sample was one-half of the class of 130 junior level nursing students or 67 students who began courses in the fall semester and were enrolled in N001 Principles of Nursing, N002 Principles of Nursing:

Clinical Laboratory, Statistical Concepts and Research Design, the Emergent Profession, Nursing Pharmacology I, and Human Physiology. The nursing courses were four credit hours (N001) and two credit hours (N002). The students registered in the fall were enrolled for a total of 16 credit hours for 16 weeks. Acquiring the knowledge to calculate drug dosage and solution problems was a part of the theoretical content of N001 Principles of Nursing.

## Instruments

Six instruments were used in conducting the study. The instruments were five computer-assisted instruction modules, printed textbook, achievement tests, learning style inventory, and teaching modality attitude assessment scale. Two methods were used to teach calculation of drug and solution problems: computer-assisted instruction and printed textbook.

### Computer-Assisted Instruction

The purpose of this instrument was to teach Group A subjects in the introductory nursing course to calculate drug and solution problems. The CAI consisted of five modules presented in the tutorial mode. The five module topics were: mathematics review, systems of measurement, oral medication calculations, parenteral medication calculations, and solution calculations. The first two modules were developed by a faculty member teaching in the undergraduate program (Kashka, 1984). The investigator developed the latter three modules. The five modules were programmed by another faculty member in the school of nursing who had experience in computer programming. The CAI module instructional objectives were identical to those formulated for use with the printed textbook. The programming principles of learner response, immediate reinforcement, step-size progression, prompting to insure a high proportion of correct responses, and eventual fading of prompts were employed in creating the CAI modules. Similar to branching programmed instruction, the tutorially designed modules contained branching loops. In each module, the student was required to construct responses and was routed through the program in a manner dependent upon the correctness of learner's responses. For example, when the learner incorrectly set up a drug problem, the program branched to a review and practice on this topic. The student then was returned to the main body or trunk of the program. The computer-assisted instruction modules were designed to require different types of student responses such as fill in the blank, select the right answer, set up a proportion, or solve the calculation problem (see Appendix A).

Each module required approximately 45 minutes to complete; however, the student could spend as much time as needed to complete each of the five modules. Each student's learning pace and correctness of responses influenced the amount of time spent at the computer. The program design did not permit the student to sign out of a module without completion. The student could repeat the modules as many times as required or until he/she felt the topic had been mastered.

Printed Textbook

In this investigation the textbook used was entitled, The Mathematics of Drug and Solutions With Clinical Applications, (1980) by Richardson and Richardson. This instrument was used to teach Group B subjects in the introductory nursing course to calculate drug and solution problems. The book was divided into six chapters which included mathematics review, systems of measurement, oral medications, parenteral medications, pediatric medications, and preparation of solutions. The chapter concerned with pediatric medications was not assigned. The authors designed the text to provide students with a guided, step-by-step approach to the mathematical calculation of drug and solution problems. The preface of the book instructed the student to take a pretest in Chapter I for self-evaluation purposes. A score of 85 percent or higher indicated adequate mathematical skills and the student was advised to progress to the next chapter. In the remainder of the chapters the student was encouraged to compute calculations in the text. In one section of the book instructional examples and practice exercises provided step-by-step problem solutions. The authors stated:

> This book has been structured to serve (1) as a supplement to a regular course in pharmacology or drugs and solutions, (2) as a self-study guide for readers wishing to increase their proficiency in working drug problems, and (3) as a text for a short course in drugs and solutions (Richardson and Richardson, 1980, p. vii).

In previous years all students enrolled in the introductory course learned by the independent study method using this textbook.

Achievement Test

The instrument was a 40 point achievement test entitled, the Drug Proficiency Examination (DPE). The purpose of the instrument was to measure the amount of knowledge gained and retained as a result of the different teaching approaches. Three forms of the Drug Proficiency Examination were used as a pretest, posttest, and retention test for Groups A and B (Appendix B). The three forms of the examination required the student to demonstrate the calculation of drug and solution problems without calculator assistance and to express the answers in the appropriate units. Each question was assigned a value of one point. Partial credit was not given for an answer. The score which could be attained ranged from 0 to 40 correct.

When teaching this instructional content in previous semesters, these same forms of the test were administered randomly until the student attained a minimum of 90 percent correct. The 40 item test was constructed by combining five or six problems representing content from each of the assigned text chapters. Prior to this study, the faculty had reviewed the test and assumed face and content validity. For the purposes of this study, the Pearson Product - Moment Correlation and *t* test for small groups was performed to determine the reliability index of the three test forms. Using $< .05$ as an acceptable coefficient of equivalency, test Forms A and C were found to be equivalent, however, Forms A and B, B and C were not found to be equivalent (see Figure 1).

Figure 1. Analysis of Forms A, B, C of Drug Proficiency Examination (DPE).

| Forms | N | value | *t* value |
|---|---|---|---|
| A and B | 8 | .29 | .75 |
| A and C | 8 | .94 | 6.8* |
| B and C | 8 | .52 | 1.45 |

Note. Eight volunteer registered nurse subjects completed all three Forms of the DPE.

* $t = 1.94$, $p \leq .05$

An item analysis of the three forms of the DPE revealed that on Form B three individuals answered the same two test items incorrectly. On all three Forms of the test, no other items were incorrectly answered more than one time. Since these three Forms of the Drug Proficiency Examination had been used previously by faculty, they were randomly chosen to be administered as a pretest, posttest, and retention test in the study.

Learning Style Inventory

The Learning Style Inventory (LSI) is a nine item self-description questionnaire (see Appendix C). Each item consists of four adjectives describing different abilities. The learner is instructed to rank-order the word sets to indicate which best describe his/her learning style. The LSI yields six scores, four of which indicate an individual's relative emphasis on four separate and different learning modes. The four learning mode preferences are: (a) Concrete Experience (CE), (b) Reflective Observation (RO), (c) Abstract Conceptualization (AC), (d) Active Experimentation (AE). In addition, two combination scores are derived which identify the individual's learning style type taking into consideration combinations of the four learning mode preferences. These scores indicate the degree to which a learner emphasizes abstractness over concreteness (AC - CE) and action over reflection (AE - RO).

The scoring mechanism provides for plotting the combination scores on a graph divided into quadrants. The quadrants are labelled: (a) Accommodator (ACC), (b) Diverger (DIV), (c) Converger (CON), and (d) Assimilator (ASS). For each of the four emphasized learning mode preferences (CE, RO, AC, AE) and the four learning styles (ACC, DIV, CON, ASS), typical learner characteristics and abilities are described in the Self-Scoring Test and Interpretation Book. Figures 2 and 3 display a summary of these descriptions.

Figure 2. Summary of Abilities and Characteristics of Learning Style Inventory (LSI) Learning Mode Preferences.

| Learning Mode Preferences | | | |
|---|---|---|---|
| Concrete Experience (CE) | Reflective Observation (RO) | Abstract Conceptualization | Active Experimentation (AE) |
| Represents receptive experienced-based approach to learning. | Represents tentative reflective, impartial approach to learning. | Represents analytical conceptual approach to learning. | Represents doing approach to learning. |
| Relies on feeling-based judgement. | Relies on careful observation in making judgements. | Relies heavily on logical thinking and rational evaluation. | Relies on experimentation. |
| Tend to be people-oriented, empathetic. | Tend to be introverts | Oriented more to things, symbols than people. | Tend to be extroverts. |
| Learns best from involvement with specific examples, finds theoretical approaches unhelpful. | | Learns best in authority-directed, impersonal learning situations. Oriented to approaches which emphasize theory, systematic analysis. | |
| Oriented more to peers than authority in learning approach Benefits from feedback, discussion with fellow CE learners. | Prefers to take objective observer role in learning e.g., lecture. | Frustrated by "discovery" learning approaches, e.g., exercise, simulations. | Dislikes passive learning situations, e.g., lecture projects, homework, group discussion. |

Note. The descriptions are from LSI Self-Scoring Test and Interpretation Booklet by D.A. Kolb, 1976.

Figure 3. Summary of Characteristics of Learning Style Inventory (LSI) Learning Style Types.

| Learning Style Types | | | |
|---|---|---|---|
| Converger (CON) | Diverger (DIV) | Assimilator (ASS) | Accommodator (ACC) |
| Dominant learning modes AC and AE | Dominant learning modes CE and RO | Dominant learning modes AC and RO | Dominant learning modes CE and AE |
| Strength is in practical application. | Strength is in imaginative ability. Views concrete situations from many perspectives. | Strength is in ability to create theoretical models. | Strength is in doing things, activity in learning, e.g., experiments. |
| | Opposite learning strengths of Converger | | Opposite learning strengths of Assimilator. |
| Performs best in situations where there is a single correct answer, solution. Uses hypothetical, deductive reasoning. | Performs best in situations which call for generation of ideas, e.g., brainstorming. | Excels in inductive reasoning and assimiliating desparate observations into integrated explanations. Little concern with practical application of theory. Theory must be logical and precise. | Excels when required to adapt to immediate circumstances. Discards theory or plan which does not fit facts. Solves problems initiatively or by trial and error. |
| Learner is unemotional. Prefers to deal with things rather than people. | Interested in people. Emotional, imaginative. Broad cultural interests. | Less interested in people than abstract concepts. | At ease with people. May seem "pushy" or impatient. Tends to be risk taker compared to other styles. |
| Learning style is characteristic of engineers. Has narrow technical interests. Often specializes in physical sciences. | Learning is characteristic of individuals in humanities, liberal arts, e.g., counselor. Often specializes in arts. In organizations are development specialties. | Learning style characteristic of basic sciences, mathematics more than applied sciences. This type of individual found in research/planning in organizations. | Learning style is characteristic of individuals in business or administration. Prefers educational experiences which are technical and practical. |

Note: The descriptions are from LSI Self-Scoring Test and Interpretation Booklet by D.A. Kolb, 1976

The Learning Style Inventory takes approximately five minutes to complete. The technical manual for the instrument describes the results of studies testing the internal properties of the instrument. As reported in the Technical Manual (1978), an item analysis of the nine words used in the LSI indicates, "no words correlate less than .45 with its scale total and most correlations fall between .50 and .60" (p. 10). In reference to the combination scores, the authors reported that Concrete Experience (CE) and Abstract Conceptualization (AC) were found to be negatively correlated (-.57, p .001) as were Reflective Observation (RO) and Active Experimentation (AE) (-.50, p .001). Considering instrument reliability, it is reported "thus even if there were no measurement error in the LSI, we would predict test-retest and split-half reliability coefficients less than 1.0" (Technical Manual, 1978, p. 12).

In a study by Kirchoff and Holzemer (1979), this instrument was used to assess nursing student's learning mode preferences prior to learning by computer-assisted instruction.

### Adjective Rating Scale (ARS)

Designed to measure student's attitudes toward a course or program, the Adjective Rating Scale obtains information about students' perception of the assigned teaching modality with respect to its practical value, emotional appeal, dullness (apathy), interest level, and difficulty. These five attributes are titled factors. The learner is instructed to rate 24 adjectives on the following four point scale: (a) extremely, (b) very, (c) slightly, (d) not at all (see Appendix D). Each of the 24 adjectives load on one of five factors: practical value, emotional appeal, dullness (apathy), interest and difficulty (see Appendix E). The instrument was validated with high school and college students using factor analytic procedures (Kelly, Pascarella, Terenzini & Chapman, 1976). In a study by Kirchoff and Holzemer (1979), the Adjective Rating Scale was used to assess students' attitudes toward a computer-assisted instructional program in postoperative nursing care.

## Procedure for Data Collection

The study was concerned with developing and validating the CAI modules. In addition, the study was concerned with assessing achievement considering the two different instructional modalities which were computer-assisted instruction and independent study.

The Assistant Dean and Director of the Undergraduate Nursing Program granted permission to conduct the study (see Appendix F).

Refinement of the CAI Modules. The five CAI modules were written and programmed in the previous semester. To test the modules for clarity, logistics, and technical problems, students volunteered to review the modules and to anonymously record in writing their concerns, problems, and questions relating to both the computer and the modules. Revisions were incorporated into the instrument based upon an evaluation of the student responses. This version of the CAI modules was used in the study.

Validation of the CAI Modules. To establish content validity, three Master's prepared faculty teaching in the Principles of Nursing course reviewed the modules for adequacy and accuracy of content. Revisions were incorporated into the instrument based upon faculty recommendations.

In this current investigation, the subjects were asked to voluntarily participate after being informed of the study purposes and were given a consent form to complete (see Appendix G). Sixty-four of the 67 junior level baccalaureate nursing students who met the minimum program requirements for admission and were identified on the fall class roster as enrolled students were randomly assigned to Group A or Group B using a table of random numbers. Three of the 67 students were excluded from the study because they were repeating the course for a second time. Of the 64 students, one subject assigned to Group A (Experimental) did not report for class and four subjects randomly assigned to Group A requested to withdraw from the study. Withdrawal from the study occurred one week prior to $O_{2c}$ because the subjects had not begun to study by computer-assisted instruction. One student randomly assigned to Group B (Control) did not consent to participate in the study. This student was instructed to study using the printed textbook. The student was not included as a participant in Group B. Fifty-eight students completed the study with 27 subjects in Group A and 31 subjects in Group B.

During an initial class meeting the Learning Style Inventory ($0_{1a}$), Adjective Rating Scale ($O_{1b}$), and Forms A and C of the Drug Proficiency Examination ($O_{1c}$) were administered. The Learning Style Inventory required approximately five minutes to complete utilizing the test forms provided (Appendix C). After notification of assignment to Group A or Group B, the subjects were administered the Adjective Rating Scale. In completing the Adjective Rating Scale, subjects were asked to rate the adjectives with the statement, "I expect to find computer-assisted instruction/the independent study approach to be." (See Appendix D.) In completing the Drug Proficiency Examination pretest no time limit was imposed on the subjects. A conversion table was provided as in subsequent testing situations. No calculator assistance was permitted.

The subjects in Group A (Experimental) attended an orientation session in which they were informed of the location of the computers and the procedure for securing study time at one of the three computers. On their first interaction with the computer the students ran the computer familiarization module entitled, Introduction to the Apple II+ (1984). This module instructed the student on the use of the keyboard, the manner in which to enter responses, and operation of the monitor and disk drive. A faculty member was available (if needed) for the students during this brief computer orientation exercise. Upon completion of this exercise, the subjects were given a computerized mathematics pretest to complete. Thereafter, the subjects independently scheduled time for computer-assisted instruction. The subjects were informed they might repeat the modules as frequently as desired. The subjects required approximately 45 minutes to complete the first four modules. The fifth module required approximately 20 minutes to complete. Upon completion of each module additional paper and pencil practice problems were available. Solutions to the practice problems were posted in the computer room.

During the CAI instruction a faculty member was available. Occasionally, a faculty member was consulted if a technical problem arose with the computer or program. The faculty member recorded the amount of time each subject spent in interaction with the computer. The subjects studying by CAI were informed they were equally prepared to take the Drug Proficiency Examination since the objectives were identical for both modes of learning. They agreed not to purchase or use the printed textbook prior to taking the achievement examinations.

Subjects in Group B (Control) were instructed to purchase the printed textbook and begin independent study in the first week of the semester. The subjects' progress studying independently from the printed textbook was not monitored by a faculty member. The subjects self-reported the time spent studying by this method.

In the eighth week of the semester after completion of the assigned mode of learning and prior to $O_2$ (posttest), the subjects were asked to again complete the Adjective Rating Scale responding to the statement, "I found computer-assisted instruction/the independent study method to be." (See Appendix D.)

Forms A and B of the DPE posttest ($O_{2c}$) were administered under the same conditions as described in the $O_{1c}$ testing episode. The subjects in Group A and B who attained a minimum of 90 percent were permitted to administer medications in the clinical setting. Those subjects who did not attain the 90 percent were administered another Form of the DPE the following week.

The Drug Proficiency Examination retention test ($O_3$) was administered in the sixteenth week of the semester. Forms B and C of the DPE were administered adhering to the same procedures previously described. In the weeks preceding $O_3$, the subjects of both groups had clinical experiences which may have involved the calculation of drug and solution problems as well as the administration of medications. The subjects were advised not to study prior to the retention test. They were informed their achievement would not influence their course grade but that an earnest effort was required in the testing situation.

## Method of Analysis

Three achievement test scores were obtained for each subject. The raw test scores provided the score for $O_{1c}$, $O_{2c}$, $O_3$. In addition, the learning mode preference and learning style type was obtained for each subject using the Learning Style Inventory. The administration of the Adjective Rating Scale yielded five factor scale scores for each subject with each administration. An analysis of variance was applied to the posttest scores to identify any significant differences in knowledge acquisition between the two groups. An analysis of variance was applied to the retention test scores to determine if learning retention was better for either group. A one-way analysis of variance was applied to the ARS factor scale scores obtained preceding study by the assigned modality to determine if attitudes toward the assigned learning modality were significantly different in either group. The same statistical analysis was applied to the Adjective Rating Scale factor scale scores obtained following study by the assigned modality to determine if attitudes were significantly different in either group. After Adjective Rating Scale factor scores were obtained following study by the assigned learning modality, a correlation coefficient was computed to determine if attitudes influenced (a) the knowledge gained and (b) knowledge retained in either group. A mean was calculated to determine if there was a difference in the amount of time spent studying by either modality. A two-way analysis of variance was applied to subject's learning mode preference and group designation to determine the influence of the variables on either group's (a) knowledge gained and (b) knowledge retained. A two-way analysis of variance was applied to learning style type and group designation to determine the influence of these variables on (a) knowledge gained and (b) knowledge retained in both groups. The level of statistical significance for this study was $p \leq .05$.

## Statement of Risk

The entire class of junior level nursing students entering the program in the fall semester were asked to voluntarily participate in the study following explanation of the study purposes.

The subject's performance on the tests in no way affected their course grade or impeded them from meeting the course requirements. Upon completion of the study, all participants had the opportunity to learn the content by computer-assisted instruction or by the printed textbook.

# CHAPTER IV

## Analysis of Data

The purpose of the study was fourfold: (a) to compare the effectiveness of two instructional modalities, computer-assisted instruction and the independent study approach, in teaching junior level baccalaureate nursing students to solve drug and solution calculation problems; (b) to develop and validate computer-assisted instruction modules on the topic, the calculation of drug and solution problems; (c) to assess students' learning style, attitudes toward learning, and the time spent learning by the computer or by the independent study method; (d) to determine whether individual learning style and/or attitudes toward the learning modality significantly influenced the knowledge gained and knowledge retained. Data obtained from administration of the following instruments were used to address the purposes of the study: (a) achievement test entitled Drug Proficiency Examination (DPE), (b) the Learning Style Inventory (LSI), and (c) the Adjective Rating Scale (ARS). Statistical analysis of these data will be described separately relative to each hypothesis.

### Findings/Results

#### Hypotheses

Hypothesis I. There will be no significant difference between Group A (Experimental) and Group B (Control) in the knowledge gained as measured by scores on a posttest when pretest score differences are considered.

A one-way analysis of variance was applied to the posttest scores to determine if knowledge acquisition was better for either group. Posttest scores of the 27 subjects in Group A (Experimental) ranged from 31 to 40 correct with a mean of 36.33 and a standard deviation of 3.64. Posttest scores of the 31 subjects in Group B (Control) ranged from 16 to 40 correct with a mean of 34.87 and a standard deviation of 6.84. Table 1 represents mean achievement scores and the standard deviations on the posttest for both groups. Raw data of Group A and B which includes the pretest, posttest, and retention test scores are presented in Apendix H.

The p value for the Drug Proficiency Examination scores computed by one-way ANOVA was .22 which was not at the .05 level of significance required by this study. These data indicated neither Group A or B acquired knowledge significantly better than the other group. Statistical analysis supported the hypothesis which stated there will be no significant difference between Group A and Group B in knowledge gained as measured by scores on the DPE posttest. Table 2 illustrates these data.

Table 1

Mean Achievement Scores and Standard Deviations on DPE Pretest, Posttest, and Retention Test for Group A and Group B

| Subjects | Pretest Mean | Pretest S.D. | Posttest Mean | Posttest S.D. | Retention Test Mean | Retention Test S.D. |
|---|---|---|---|---|---|---|
| Group A | | | | | | |
| (Experimental) | 15.15 | 8.69 | 36.33 | 3.64 | 34.70 | 4.92 |
| *n* = 27 | | | | | | |
| Group B | | | | | | |
| (Control) | 14.87 | 9.3 | 34.87 | 6.84 | 33.45 | 5.70 |
| *n* = 31 | | | | | | |

Note. DPE refers to Drug Proficiency Examination. Maximum Score = 40.

Table 2

One-Way Analysis of Variance for DPE Posttest Test Scores

| Source of Variance | D.F. | Sum of SQ. | Mean SQ. | F-Value | Prob |
|---|---|---|---|---|---|
| Equality of Cell Means | 1 | 30.86 | 30.86 | 1.51 | 0.22 |
| Error | 56 | 1147.48 | 20.49 | | |

Note. DPE refers to Drug Proficiency Examination

Hypothesis II. There will be no significant difference between Group A (Experimental) and Group B (Control) in knowledge retained as measured by scores on a retention test when posttest scores are considered.

A one-way analysis of variance was applied to the retention scores to determine if learning retention was better for either group. The 27 subjects in Group A (Experimental) had retention test scores ranging from 24 to 40 correct with a mean of 34.70 and a standard deviation of 4.92. The 31 subjects in Group B (Control) had retention test scores ranging from 20 to 39 correct with a mean of 33.45 and a standard deviation of 5.70. The mean achievement scores and standard deviations for both groups on the retention test were displayed in Table 1. Retention test raw scores for Group A and B are presented in Appendix H.

The p value for the Drug Proficiency Examination scores computed by one-way ANOVA was .27 which was not at the .05 level of significance required by this study. These data indicate neither Group A nor Group B retained knowledge significantly better than the other group. In conclusion, statistical analysis supported the hypothesis which stated there will be no significant difference between Group A and Group B in knowledge retained as measured by scores on the DPE retention test. Table 3 illustrates these data.

Table 3

One-Way Analysis of Variance for DPE Retention Test Scores

| Source of Variance | D.F. | Sum of SQ. | Mean SQ. | F-Value | Prob |
|---|---|---|---|---|---|
| Equality of Cell Means | 1 | 22.62 | 22.62 | 1.22 | 0.27 |
| Error | 56 | 1037.30 | 18.52 | | |

Note. DPE refers to Drug Proficiency Examination

Hypothesis III. There will be no difference between the attitudes of Group A (Experimental) and Group B (Control) toward their assigned learning modality preceding study implementation as measured by the Adjective Rating Scale.

Analysis of the data collected from administration of the Adjective Rating Scale prior to study by the assigned learning modality indicates differences between Group A (Experimental) and Group B (Control) means on each of the five factors assessed in the instrument namely, practical value, emotional appeal, dullness, interest value, and difficulty. Table 4 illustrates these data. Appendix I graphically displays the mean factor scores for the Adjective Rating Scale for Group A and Group B.

Table 4

Group A and Group B Mean Scores on Adjective Rating Scale Prior to Study by the Assigned Modality

| Factor | Group | |
|---|---|---|
| | A (Experimental) | B (Control) |
| Practical Value | 1.87 | 1.70 |
| Emotional Appeal | 2.68 | 2.83 |
| Dullness (Apathy) | 3.51 | 3.26* |
| Interest Value | 0.72 | 0.84 |
| Difficulty | 2.33 | 2.31 |

Note. Adjective Rating Scale Range is 1.0 to 4.0 for each factor. Extremely = 1.0. Very = 2.0. Somewhat = 3.0. None At all = 4.0.

*$p \leq .05$.

A one-way analysis of variance was applied to each of the five factors or dimensions to determine if the attitudes of Group A and B toward their assigned method of study were significantly different. Findings demonstrated there was no significant difference between Group A or B with respect to the factors practical value, emotional appeal, interest value, and difficulty. It should be noted, however, that a significant difference in attitude was found at $0_1$, prior to exposure to the learning modality with respect to the dullness or apathy factor. Table 5 illustrates these data.

Hypothesis IV. There will be no significant difference between the attitudes of Group A (Experimental) and B (Control) toward their assigned learning modality following study implementation as measured by the Adjective Rating Scale.

Analysis of the data collected from administration of the Adjective Rating Scale following exposure to the assigned learning modality and prior to posttest administration indicates the differences between

Table 5

Comparison of Group A and B Attitudes by Analysis of Variance Prior to Exposure to Assigned Learning Modality

| Factor | Source | DF | SS | MS | F Value | p Value |
|---|---|---|---|---|---|---|
| Practical Value | Equality of Cell Means | 1 | 0.38 | 0.38 | 1.27 | 0.26 |
| | Error | 56 | 17.05 | 0.30 | | |
| Emotional Appeal | Equality of Cell Means | 1 | 0.28 | 0.28 | 1.45 | 0.23 |
| | Error | 56 | 11.03 | 0.20 | | |
| Dullness (Apathy) | Equality of Cell Means | 1 | 0.90 | 0.90 | 6.38 | 0.01* |
| | Error | 56 | 7.90 | 0.14 | | |
| Interest Value | Equality of Cell Means | 1 | 0.16 | 0.16 | 0.90 | 0.35 |
| | Error | 56 | 10.07 | 0.18 | | |
| Difficulty | Equality of Cell Means | 1 | 0.00 | 0.00 | 0.01 | 0.91 |
| | Error | 56 | 17.97 | 0.32 | | |

*Note*. Attitudes measured using Adjective Rating Scale.

* $p \leq .05$.

Group A (Experimental) and Group B (Control) means on each of the five factors assessed in the instrument namely, practical value, emotional appeal, dullness, interest value, and difficulty. Table 6 illustrates these data. Appendix J graphically displays the mean factor scores for the Adjective Rating Scale for Group A and Group B.

Table 6

Group A and Group B Mean Scores on Adjective Rating Scale Following Study by the Assigned Modality

| Factor | Group A (Experimental) | Group B (Control) |
|---|---|---|
| Practical Value | 2.12 | 1.78 |
| Emotional Appeal | 2.57 | 2.78 |
| Dullness (Apathy) | 3.17 | 3.29 |
| Interest Value | 0.92 | 0.83 |
| Difficulty | 2.70 | 2.84 |

Note. Adjective Rating Scale Range is 1.0 to 4.0 for each factor. Extremely = 1.0. Very = 2.0. Somewhat = 3.0. None At all = 4.0.

A one-way analysis of variance was applied to each of the five factors or dimensions to determine if Group A (Experimental) and Group B (Control) attitudes toward the learning modalities were significantly different after the course of study. Findings demonstrated there was no significant difference between Group A or B with respect to the factors practical value, emotional appeal, dullness (apathy), interest value, and difficulty. It should be noted that a significant difference in attitude with respect to the dullness (apathy) factor did not persist after exposure to the assigned modes of study. Table 7 illustrates these data.

Hypothesis V. There will be no association between the posttest attitudes of Group A (Experimental) and Group B (Control) as measured by the Adjective Rating Scale and the (a) knowledge gained and (b) knowledge retained.

A coefficient of correlation between the five factors of the Adjective Rating Scale (ARS) and the (a) Drug Proficiency Examination (DPE) posttest scores and (b) retention test scores for Group A and Group B were obtained. Group A (Experimental) coefficients of correlation between the ARS factors and (a) DPE posttest scores and (b) retention test scores ranged between -.12 to -.31, and .03 to .09 respectively. Table 8 represents these data. Group B (Control) coefficients of

Table 7

Comparison of Group A and B Attitudes by Analysis of Variance Following Exposure to the Assigned Learning Modality

| Factor | Source | DF | SS | MS | F Value | p Value |
|---|---|---|---|---|---|---|
| Practical Value | Equality of Cell Means | 1 | 1.72 | 1.72 | 3.00 | 0.09 |
| | Error | 56 | 32.16 | 0.57 | | |
| Emotional Appeal | Equality of Cell Means | 1 | 0.62 | 0.62 | 1.08 | 0.30 |
| | Error | 56 | 31.95 | 0.57 | | |
| Dullness (Apathy) | Quality of Cell Means | 1 | 0.20 | 0.20 | 0.24 | 0.63 |
| | Error | 56 | 45.78 | 0.82 | | |
| Interest Value | Equality of Cell Means | 1 | 0.14 | 0.14 | 0.62 | 0.43 |
| | Error | 56 | 12.16 | 0.22 | | |
| Difficulty | Equality of Cell Means | 1 | 0.30 | 0.30 | 0.40 | 0.53 |
| | Error | 56 | 42.26 | 0.75 | | |

Note. Attitudes measured using Adjective Rating Scale.

correlation between the ARS factors and (a) DPE posttest scores and (b) retention test scores ranged between .10 to .34 and -.02 to .29 respectively. Table 8 represents these data.

Table 8

Coefficients of Correlation Between ARS Factors and DPE Posttest Scores and Retention Test Scores: Group A (Experimental) and Group B (Control)

| | Group A (Experimental) | | Group B (Control) | |
|---|---|---|---|---|
| Factor | DPE Posttest Scores | DPE Retention Test Scores | DPE Posttest Scores | DPE Retention Test Scores |
| Practical Value | - .17 | .08 | .26 | .12 |
| Emotional Appeal | - .31 | .03 | .34 | .29 |
| Dullness (Apathy) | - .30 | .09 | .29 | -.02 |
| Interest Value | - .12 | .03 | .27 | .15 |
| Difficulty | - .24 | .07 | .10 | .25 |

Note. ARS refers to Adjective Rating Scale. Factors represent attitudinal attributes. DPE refers to Drug Proficiency Examination.

N = 58

A coefficient of .40 to .60 or greater would indicate a significant relationship. Thus the correlation coefficients of this study indicate no relationship exists between either group's attitudes and the (a) knowledge gained or (b) knowledge retained. The hypothesis is supported as stated.

Hypothesis VI. There will be no significant difference between Group A (Experimental) and Group B (Control) in the self-reported amount of time spent in interacting/studying the content.

A one-way analysis of variance was not conducted to test the hypothesis due to insufficient data collected from Group B. Sixteen of the 31 Group B subjects did not self-report the time spent studying. Those subjects who did report the time spent in independent study indicated a range from 120 to 900 minutes. The calculated group mean of those 51 percent who reported the time spent in independent study was 322.9 minutes.

Group A (Experimental) time data was available for each subject since an instructor recorded the subjects' study time at the computer terminal. The time spent learning by the computer-assisted instruction method ranged from 100 to 325 minutes. The calculated group mean was 214.8 minutes. Due to insufficient data the hypothesis can neither be supported nor rejected as stated.

Hypothesis VII. There will be no significant difference in (a) posttest or (b) retention test scores that may be attributable to either learning mode preference as identified in the Learning Style Inventory or group designation.

The Learning Style Inventory (LSI) was administered to Group A and Group B subjects prior to their knowledge of the learning modality to which they had been randomly assigned. The subjects' LSI scores were computed to determine the individual's emphasis on four learning mode preferences: (a) Concrete Experience (CE), (b) Reflective Observation (RO), (c) Abstract Conceptualization (AC), and (d) Active Experimentation (AE). Table 9 identifies the number and percent of the four learning mode preferences among subjects in Group A and Group B.

Table 9

The Learning Mode Preference as Determined by the Learning Style Inventory by Frequency and Percentage in Group A and Group B.

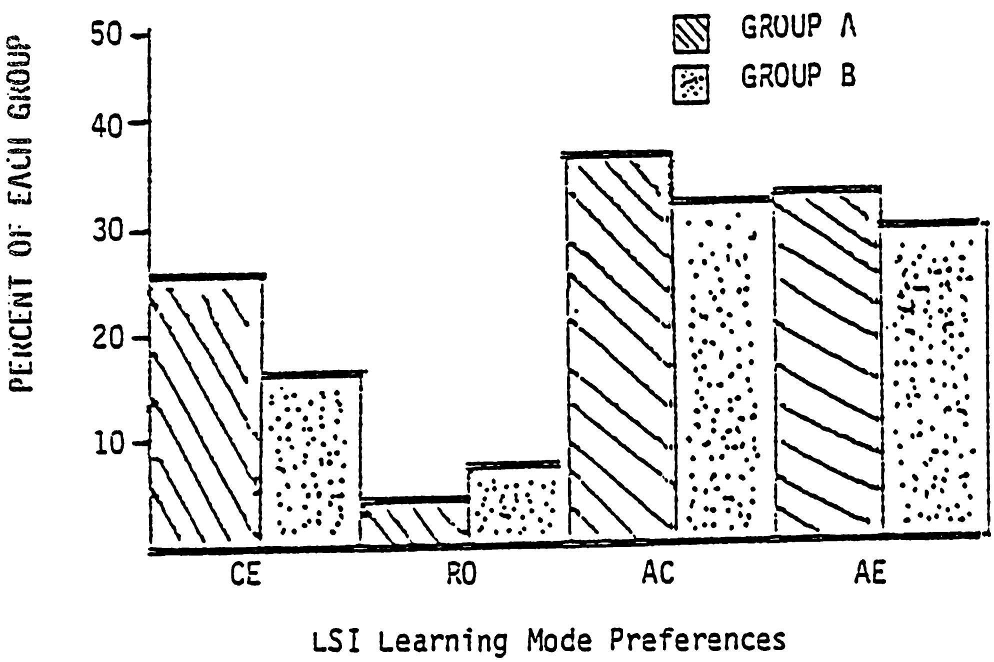
| | Group | |
|---|---|---|
| Learning Mode Preference | A (Experimental) | B (Control) |
| Concrete Experience (CE) | 7 (26%) | 5 (16%) |
| Reflective Observation (RO) | 1 ( 4 %) | 7 (23%) |
| Abstract Conceptualization (AC) | 10 (37%) | 10 (32%) |
| Active Experimentation (AE) | 9 (33%) | 9 (29%) |

Figure 4 illustrates by the use of a bar graph the predominant learning mode preferences in Group A and Group B. Profiles of the LSI four learning mode preferences were described in Chapter III, Figure 1.

A two-way analysis of variance was conducted to test the hypothesis. The independent variables were arranged in a 2 x 4 factorial design. The first variable, or main effect group designation consisted of the experimental group (Group A) and the control group (Group B). The second variable, or main effect the LSI learning mode preference , consisted of the four learning modes: (a) Concrete Experience (CE), (b) Reflective Observation (RO), (c) Abstract Conceptualization (AC), and (d) Active Experimentation (AE).

The results of the ANOVA testing the attributability of the (a) posttest scores or (b) retention test scores to learning modality disclosed there was no significant main effect of group designation. In addition, the main effect of learning mode preference was not significant. There was a significant interaction between learning mode preference and group designation with respect to retention test scores ($p = .0551$). Tables 10 and 11 display these data.

Figure 4. Bar Graph of Percent of Learning Style Inventory (LSI) Learning Mode Preferences in Group A and Group B.




CE Concrete Experience RO Reflective Observation
AC Abstract Conceptualization AE Active Experimentation

Table 10

Two-Way Analysis of Variance for the Dependent Variable: Posttest Mean Scores

| Source | SS | DF | MS | F Value | p Value |
|---|---|---|---|---|---|
| Group Designation | 50.74 | 1 | 50.74 | 2.42 | 0.13 |
| LSI Learning Mode Preference | 73.84 | 3 | 24.61 | 1.17 | 0.33 |
| Interaction | 28.52 | 3 | 9.51 | 0.45 | 0.72 |
| Within Error | 1049.67 | 50 | 21.99 | | |

Table 11

Two-Way Analysis of Variance for the Dependent Variable: Retention Test Mean Scores

| Source | SS | DF | MS | F Value | p Value |
|---|---|---|---|---|---|
| Group Designation | 27.83 | 1 | 27.83 | 1.59 | 0.21 |
| LSI Learning Mode Preference | 20.06 | 3 | 6.69 | 0.38 | 0.77 |
| Interaction | 142.11 | 3 | 47.37 | 2.71 | 0.05* |
| Within Error | 832.36 | 50 | 16.65 | | |

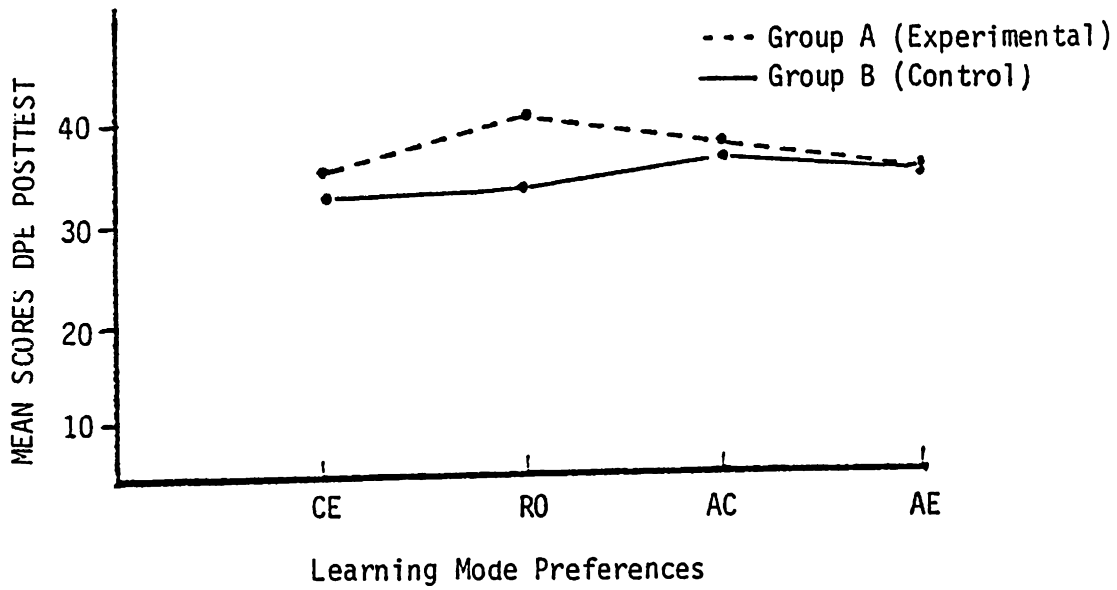
* $p \leq .05$

Figures 5 and 6 further display the interaction of the main effects on the DPE posttest scores and retention test scores respectively.

Hypothesis VIII. There will be no significant difference in (a) posttest or (b) retention test scores that may be attributable to either learning style type as identified in the Learning Style Inventory or group designation.

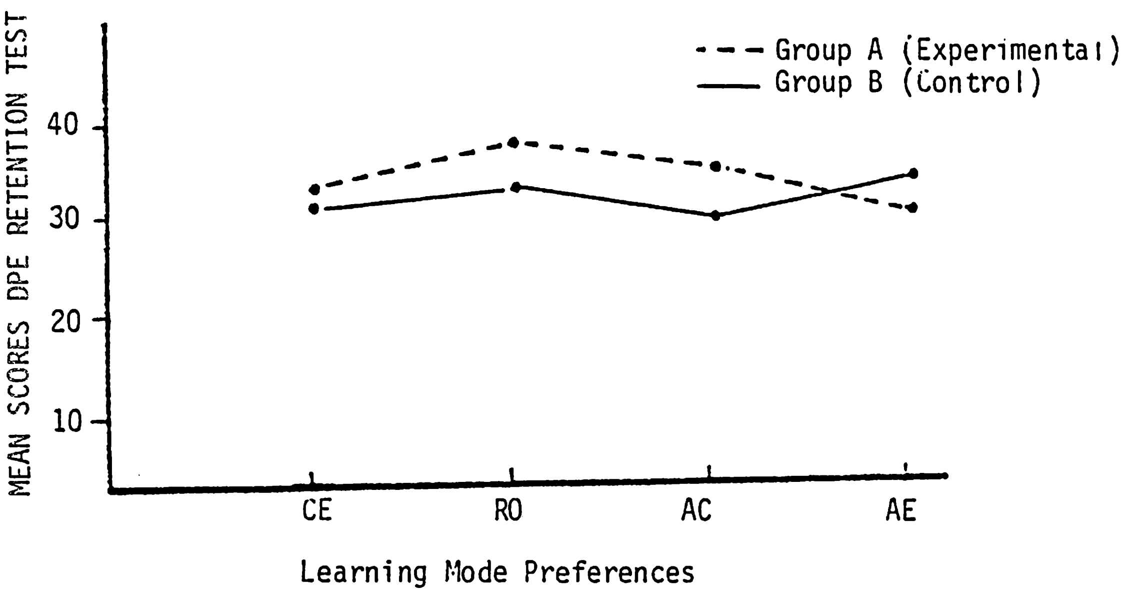
The Learning Style Inventory yields another description of learning styles using a combination of the four basic learning modes (AC, CE, AE, RO). These descriptions are determined by using two combination scales, AC - CE and AE - RO, which indicate the degree to which a learner emphasizes abstractness over concreteness and action over reflection respectively. The learning style types derived from the combination scores are Accommodator (ACC), Diverger (DIV), Converger (CON), and Assimilator (ASS). Table 12 identifies the number and percent of the four learning styles among subjects in Group A and Group B.

Figure 5. Interaction of Learning Style Inventory (LSI) Learning Mode Preferences and Group Designation on Drug Proficiency Examination Posttest Scores.




CE Concrete Experience RO Reflective Observation
AC Abstract Conceptualization AE Active Experimentation

Figure 6. Interaction of Learning Style Inventory (LSI) Learning Mode Preferences and Group Designation on Drug Proficiency Examination Retention Test Scores.




CE Concrete Experience RO Reflective Observation
AC Abstract Conceptualization AE Active Experimentation

Table 12

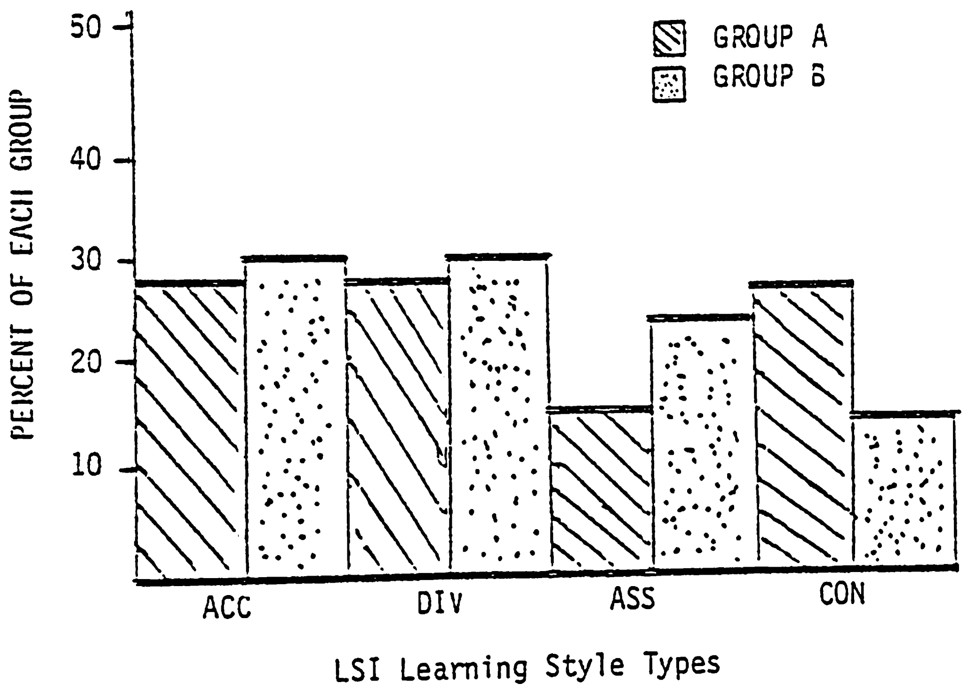
The Learning Style Type as Determined by the Learning Style Inventory by Frequency and Percentage in Group A and Group B.

| | Group | |
|---|---|---|
| Learning Style Type | A (Experimental) | B (Control) |
| Accommodators (ACC) | 7 (28%) | 9 (31%) |
| Divergers (DIV) | 7 (28%) | 9 (31%) |
| Convergers (CON | 4 (16%) | 7 (24%) |
| Assimilators (ASS) | 7 (28%) | 4 (14%) |

Figure 7 illustrates by use of the bar graph the predominant learning style types in Group A and Group B. Profiles of the LSI four learning style types were described in Chapter III, Figure 3.

A two-way analysis of variance was conducted to test the hypothesis. The independent variables were arranged in a 2 x 4 factorial design. The first variable, or main effect group designation consisted of the experimental group (Group A) and the control group (Group B). The second variable, or main effect the LSI learning style type, consisted of the stated learning style types: Accommodator (ACC), Diverger (DIV), Converger (CON), and Assimilator (ASS).

Figure 7. Bar Graph of Percent of Learning Style Inventory (LSI) Learning Style Types in Group A and Group B.




ACC Accommodators
ASS Assimilators
DIV Divergers
CON Convergers

The results of the ANOVA testing the attributability of the (a) posttest scores or (b) retention test scores to learning modality disclosed there was no significant main effect of group designation. In addition, the main effect of learning style type was not significant. There was no significant interaction between learning style type and group designation. Table 13 and 14 display these data. Figures 8 and 9 further display the interaction of the main effects on the DPE posttest scores and retention test scores respectively.

Table 13

Two-Way Analysis of Variance for the Dependent Variable: Posttest Mean Scores

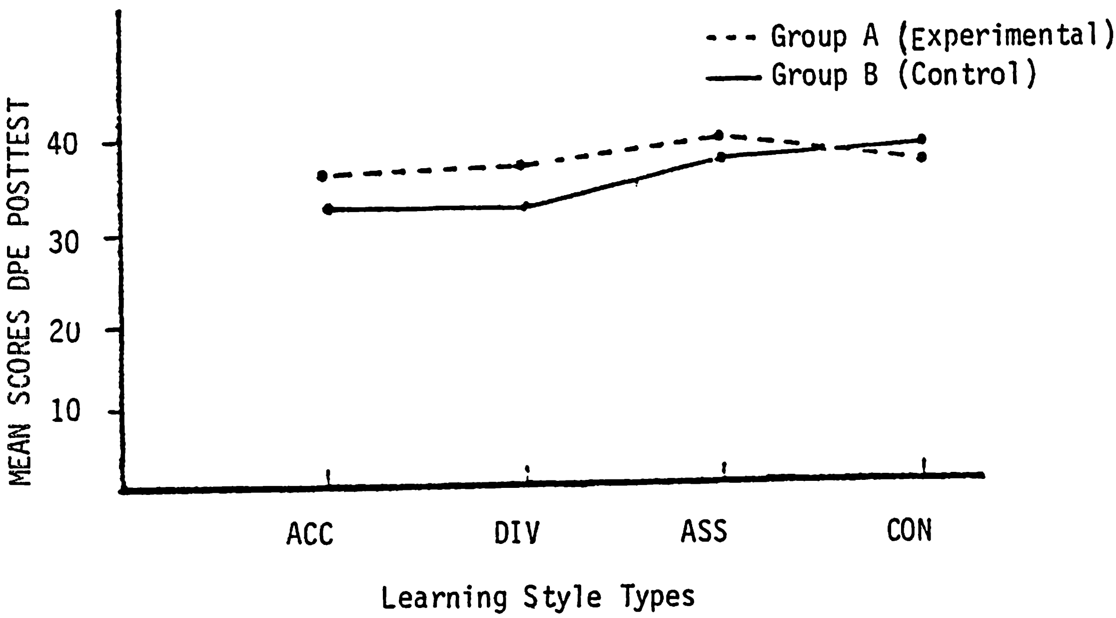
| Source | SS | DF | MS | F Value | *p* Value |
|---|---|---|---|---|---|
| Group Designation | 12.37 | 1 | 12.37 | 0.62 | 0.44 |
| LSI Learning Style Type | 127.32 | 3 | 42.44 | 2.12 | 0.11 |
| Interaction | 43.48 | 3 | 14.50 | 0.72 | 0.54 |
| Within Error | 942.85 | 47 | 20.06 | | |

Table 14

Two-Way Analysis of Variance for the Dependent Variable: Retention Test Mean Scores

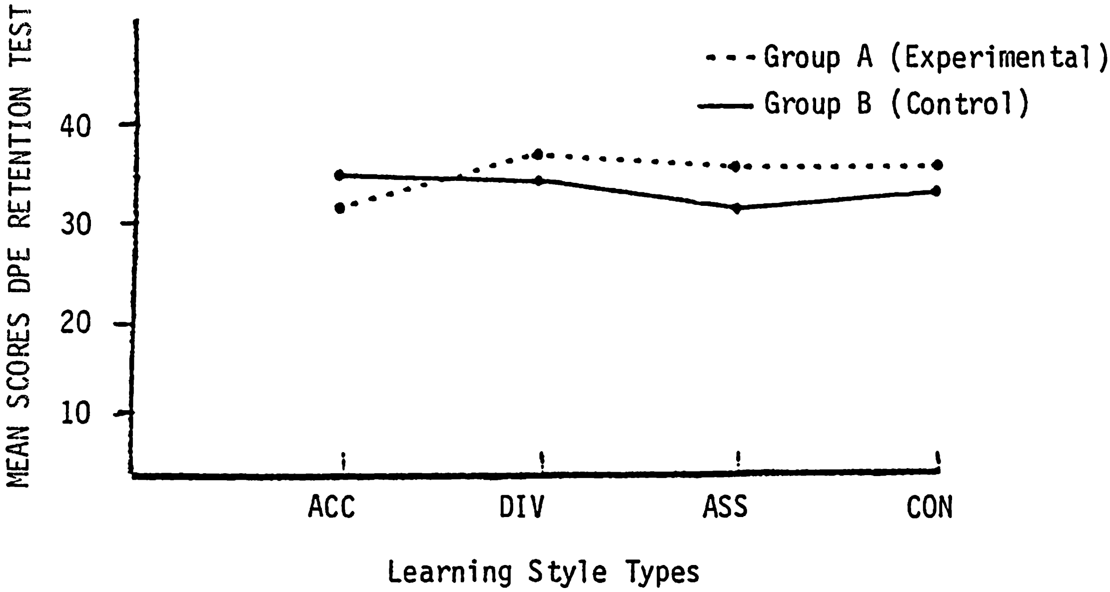
| Source | SS | DF | MS | F Value | p Value |
|---|---|---|---|---|---|
| Group Designation | 28.20 | 1 | 28.20 | 1.53 | 0.22 |
| LSI Learning Style Type | 70.58 | 3 | 23.53 | 1.22 | 0.29 |
| Interaction | 79.03 | 3 | 26.35 | 1.43 | 0.24 |
| Within Error | 865.47 | 47 | 18.41 | | |

Figure 8. Interaction of Learning Style Inventory (LSI) Learning Style Types and Group Designation on Drug Proficiency Examination Posttest Scores.




ACC Accommodators
ASS Assimilators
DIV Divergers
CON Convergers

Figure 9. Interaction of Learning Style Inventory (LSI) Learning Style Types and Group Designation on Drug Proficiency Examination Retention Test Scores.




ACC Accommodators DIV Divergers
ASS Assimilators CON Convergers

# CHAPTER V

## Discussion, Conclusions, and Implications

This chapter includes a summary of the study, the hypotheses, discussion and conclusions about the research findings, recommendations for further study, and implications for nursing education.

### Summary

The purpose of the study was fourfold: (a) to compare the effectiveness of two instructional modalities, computer-assisted instruction and the independent study approach, in teaching junior level baccalaureate nursing students to solve drug and solution calculation problems; (b) to develop and validate computer-assisted instruction modules on the topic, the calculation of drug and solution problems; (c) to assess students' learning style, attitudes toward learning, and the time spent learning by the computer or by the independent study method; (d) to determine whether individual learning style and/or attitudes toward the learning modality significantly influenced the knowledge gained and knowledge retained. Data obtained from administration of the following instruments were used to address the purposes of the study: (a) achievement test entitled Drug Proficiency Examination (DPE), (b) the Learning Style Inventory (LSI), and (c) the Adjective Rating Scale (ARS). Discussion and conclusions of the research findings will be discussed relative to each hypothesis.

Hypotheses

Hypothesis I. There will be no significant difference between Group A (Experimental) and Group B (Control) in the knowledge gained as measured by scores on a posttest when pretest score differences are considered.

Hypothesis II. There will be no significant difference between Group A (Experimental) and Group B (Control) in knowledge retained as measured by the scores on a retention test when posttest score differences are considered.

Hypothesis III. There will be no significant difference between the attitudes of Group A (Experimental) and Group B (Control) toward their assigned learning modality preceding study implementation as measured by the Adjective Rating Scale.

Hypothesis IV. There will be no significant difference between the attitudes of Group A (Experimental) and Group B (Control) toward their assigned learning modality following study implementation as measured by the Adjective Rating Scale.

Hypothesis V. There will be no association between the posttest attitudes of Group A (Experimental) and Group B (Control) as measured by the Adjective Rating Scale and the (a) knowledge gained and (b) knowledge retained.

Hypothesis VI. There will be no significant difference between Group A (Experimental) and Group B (Control) in the self-reported amount of time spent in interacting/studying the content.

Hypothesis VII. There will be no significant difference in (a) posttest or (b) retention test scores that may be attributable to either learning mode preference as identified in the Learning Style Inventory or group designation.

Hypothesis VIII. There will be no significant difference in (a) posttest or (b) retention test scores that may be attributable to either learning style type as identified in the Learning Style Inventory or group designation.

## Discussion

A discussion of the results and conclusions of the investigation are approached by examination of each of the stated hypotheses.

Hypothesis I of this study was supported. Neither Group A (Experimental) nor Group B (Control) acquired knowledge significantly better than the other group. It should be noted that the group mean for Group A ($\bar{X}$ = 36.33) was slightly higher than the Group B mean ($\bar{X}$ = 34.87) although the difference was not statistically significant. The posttest scores of experimental group document that the CAI learning experience was an effective and valid learning modality for this subject matter. One can not overlook the possible influence of the subjects' perceived importance of the topic of drug calculations and course requirements as factors impacting upon Group A and Group B performance and level of achievement.

Hypothesis II was supported in this investigation. Neither Group A nor Group B retained knowledge significantly better than the other group. As calculations performed demonstrated, the mean retention test score for Group A ($\bar{X}$ = 34.0) was slightly higher than the Group B mean ($\bar{X}$ = 33.5) but the difference was not statistically significant.

In summary, both groups demonstrated learning; however, the differences in the amount of knowledge gained and retained by one group when compared to the other group was not statistically significant. The higher mean scores of the experimental group in comparison to the control does permit the investigator to establish faith and credence in the CAI developed for this study as a learning modality. In conclusion, the achievement levels obtained by the CAI and the independent study modalities are at least equivalent in effectiveness.

The results of this investigation uphold the findings of Bitzer & Boudreaux (1969), Hoffer, Mathewson, Loughray & Barnett (1975), Huckabay, Anderson, Holm & Lee (1979); Kirchoff & Holzemer (1979), and Valish & Boyd (1975). In these studies appreciable and comparable learning occurred with computer-assisted instruction and traditional learning modalities, although the amount of learning attributable to CAI was not significantly different.

Hypothesis III and IV which were concerned with attitudinal considerations based on the learning modalities were supported. There was no statistical difference between the attitudes of Group A and

Group B prior to exposure to the CAI and independent study learning modalities except with respect to the dullness or apathy factor in the Adjective Rating Scale. Prior to studying the topic, drug and solution calculation problems, the experimental group anticipated the CAI mode of study would be significantly less dull than the control group. Using the terminology found on the Adjective Rating Scale Profile, both groups perceived the learning modes would be extremely to very practical, very to somewhat exciting (emotion appeal), extremely interesting, and very to somewhat difficult (see Appendix I). Likewise there was no significant difference between the attitudes of Group A and Group B after exposure to the CAI and independent learning modalities. The significant difference in the dullness factor did not persist after exposure to the independent study methodology. Interpreting the group mean scores referencing the terminology on the Adjective Rating Scale, both groups described the learning modes post study as extremely to very practical, very to somewhat exciting, somewhat to not at all dull, extremely interesting, and very to somewhat difficult. This profile is found in Appendix J.

An analysis of the findings associated with subjects' attitudes toward the instructional modalities must take into account the possibility that the responses of the subjects were affected by their attitudes toward the topic of drug calculations and/or their attitudes toward the modes of learning. For example, one might suspect that the subjects were indicating that learning to calculate drug dosages was very practical, in addition to, or instead of indicating that the mode of learning was practical. In essence the attitude appraisal may indicate the attitudes of the subjects toward the subject matter and/or the attitudes toward the learning mode.

In consideration of the outcome of Hypothesis IV, perhaps the short period of time between the attitude assessments (beginning semester and midsemester) limited the possibility of attitude change or differences, or perhaps the students did not find the independent study method as undesirable as they anticipated. Also instructors were on the premises or available to the student when studying by CAI, they were not present or involved with the independent study group. The influence of instructor presence or absence on attitudes toward the modalities is unknown.

This investigation did not encompass an analysis of attitudinal differences within the experimental and control groups prior to and following exposure to the two learning modalities. An attitudinal assessment from this perspective is recommended in future investigations.

The results of this aspect of the study do not uphold the findings of Cavin, Cavin & Lagowski (1981) who studied attitudes toward CAI and chemistry. Their investigation showed a significant difference between the attitudes of subjects studying by CAI and those studying by written homework assignments. Attitudes of students toward the modalities were in favor of learning by CAI.

Hypothesis V tested the relationship between subjects' attitudes toward the assigned learning modality and the (a) knowledge gained and (b) knowledge retained. The absence of correlation coefficients of .70 or greater indicated no relationship existed between the variables. Perhaps, the subjects' perception of the importance of acquiring skills in drug calculation and the course expectations prevailed; consequently, learning was not significantly enhanced or impaired by attitudes toward the method of learning.

Hypothesis VI which was concerned with the time spent studying by the learning modalities could not be tested due to insufficient data. Failure to obtain sufficient data from the control group suggests that alternate data collection methods be recommended in future studies.

Hypothesis VII tested the attributability of (a) posttest scores and (b) retention test scores to learning mode preference and group designation. The comparison of the mean scores for the four learning mode preferences (Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), Active Experimenation (AE)) and the comparison of the mean scores for the group designation or learning modalities (CAI or independent study) are referred to as tests of main effects. Data analysis demonstrated there was no significant main effect for learning mode preference or group designation with respect to posttest scores and retention test scores. Though neither main effect was found to be significant, a significant interactive effect existed with respect to retention test scores ($p = .0551$). The finding suggests the relative effectiveness of the two learning modalities does not remain constant throughout for all four types of the learning mode preferences when retention test scores are considered. Figure 6 clearly shows this interaction. Subjects in Group B (Control) who preferred Active Experimentation (AE) actually scored significantly higher on the retention test than those subjects in Group A (Experimental) with the same learning mode preference. Technically, this interaction is described as disordinal. Learners who score high on Active Experimentation are described as individuals who, "learn best when they can engage in such activities as projects, homework, or small group discussions" (Kolb, p. 62). This description of learning activities seems similar to the learning experiences of subjects in the independent study group, in that the subjects were permitted to study in an environment and manner of their own preference. Based on this statement by Kolb, the findings of this study seem logical and congruent.

Another description of Active Experimentation, however suggests incongruence between the description of Active Experimentation and the findings of this study. The Self-scoring and Test Interpretation Booklet (1976) states, "a high score on Active Experimentation indicates an active 'doing' orientation to learning, which relies heavily on experimentation"

(Kolb, p. 4). This investigator perceives the CAI tutorial mode of learning to require subject participation and permit experimentation. The subjects were required to construct responses such as fill in the blank, select the right answer, set-up a proportion or solve a calculation problem. The student decides if he/she wants to review parts of a program when a response is incorrect or before progressing to new or additional content. Perhaps the tutorial mode of presentation is more passive than problem-solving and simulation modes and does not permit the same degree of active participation or experimentation as CAI programs of the latter instructional design. Additional research with respect to other presentation modes of computer-assisted instruction is recommended.

A determination of subjects' learning mode preference by administration of the Learning Style Inventory verifies that the subjects studied favor learning in a variety of ways. The majority of the subjects from both groups were identified as scoring high on Abstract Conceptualization (34%) and Active Experimentation (30%). To a degree, these findings are consistent with Villetoe (1983), who concluded from a review of learning style related literature that students in the health field favor concrete learning experiences with active participation and experimenation. Of the sample tested in the present study, 30 percent scored high on Active Experimentation.

In summary, those learners scoring high on learning mode preferences Concrete Experience (CE), Reflective Observation (RO) and

Abstract Conceptualization (AC) scored higher on achievement tests studying by CAI, while learners scoring high on Active Experimentation (AE) scored higher on achievement tests when learning by independent studying. Addressing the implications for nurse educators, learners in the categories of Concrete Experience, Reflective Observation and Abstract Conceptualization might be offered a choice of learning by computer-assisted instruction or independent study. The results of this study further suggest that learners scoring high on Active Experimentation would benefit most from studying or learning by the independent study method rather than study by the tutorial CAI.

Hypothesis VIII tested the attributability of (a) posttest scores and (b) retention test scores to learning style type and group designation. Data analysis demonstrated there was no significant main effect for learning style type (Accommodator, Diverger, Assimilator, Converger) or group designation (CAI or independent study) with respect to posttest and retention test scores. Nor was there a significant interactive effect between learning style type and group designation with respect to posttest and retention test scores. These findings suggest the relative effectiveness of the two modalities remains constant for all four learning style types. Figures 8 and 9 show disordinal interaction although it is not of statistical significance at the .05 level.

A determination of learning style type by administration of the Learning Style Inventory further illustrates the variety in learning styles among the subjects. Villetoe (1983) reported study results which found the majority of health field learners were Accommodators. Contrary to Villetoe's (1983) findings, the learners in this study were fairly evenly distributed among the four learning style types.

With the diversity in learning styles documented, it is interesting to note that the posttest mean scores were higher for Accommodators, Divergers, and Assimilators in the Group A (Experimental) while posttest scores were higher for the Convergers who were in Group B (Control). Addressing the implications for nurse educators, these findings suggest that for all four learner types, both teaching modalities are effective when knowledge gained is considered; however, those individuals identified as Convergors may benefit most from use of the independent study approach.

In analyzing the results of the two-way analysis of variance with respect to retention test scores, the Accommodators in Group B (Control) scored higher than individuals of the same learning style type in Group A. Though the difference in group means did not achieve statistical significance, the disordinal interaction suggests the independent study method to be more effective with individuals identified as Accommodators when knowledge retention is considered.

## Recommendations for Further Study

The findings of this study build upon previous research related to learning modalities, especially that research concerned with computer-assisted instruction. In addition the outcomes of this investigation suggest directions for further research. The recommendations for further study included:

1. Replication of this study after modification of the achievement tests and determination of equivalency.

2. Replication of the study using other cognitive style instruments such as the Canfield-Lafferty Learning Style Inventory and the Rezler-French Learning Preference Index to determine their relationship to learning modalities.

3. Replication of the study comparing the attitude differences within the experimental and control group prior to and immediately following study by the assigned learning modality.

4. Replication of the study obtaining information concerning the amount of time spent studying by independent study immediately before administering the posttest.

5. Replication of this study removing the instructor from the computer laboratory while the subjects are learning by computer-assisted instruction.

6. Replication of this study determining subject's previous exposure to the learning modalities.

7. Development of a study which includes assigning subjects to the learning modalities with respect to learning style preference.

8. Development of study which compares the effectiveness of independent study to the simulation or problem-solving modes of computer-assisted instruction.

9. Development of a study which assesses attitudes toward computer-assisted instruction after a period of exposure to the teaching modality intermittently over an entire semester.

10. Development of a study investigating physiological responses to studying by computer considering modular length and ability to concentrate.

## Implications for Nursing Education

Studies which prove the effectiveness of specific learning modalities are important to validation of the teaching-learning process employed in nursing education. This study indicated a newly created computer-assisted instruction module teaching students to solve drug and solution calculation problems was as effective as the previous mode of study which was the independent study approach. Thus, the educator can confidently offer more than one option or approach to learning.

Attitudes toward learning modalities studied can be approached from several points: the student's, the instructor's, and the administrator's. In this study student attitudes were investigated. Learner's attitudes are significant since they are linked to satisfaction, success, and motivation. Few research studies report the use of reliable instruments to measure attitudes prior to and following study. Overall, this study showed no significant differences in attitudes between the learners studying by CAI or independent study. The instrument used provided for an objective appraisal of students' perception, unbiased by instructor or administration input and popular myths or speculations.

Differences in learner's abilities, performances, and attitudes have been investigated by nurse educators. Recently, the use of cognitive style instruments have permitted the educator to discover preferences in the way one learns and to verify the differences among individuals. This study illustrated that a variety of learning styles were manifested in a learner population. Recognizing the diversity in learning styles is the first step toward giving consideration to providing complementary learning modalities, guiding the student to study in a manner compatible with learning preference, and promoting satisfying, meaningful, and successful experiences while learning about the practice of nursing.

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# APPENDICES

APPENDIX A

# APPENDIX A

## SAMPLES OF COMPUTER-ASSISTED MODULES:

## CALCULATION OF DRUG AND SOLUTION PROBLEMS

APPENDIX A

```
]RUN CAI.DRUG3




I SEEM TO HAVE FORGOTTEN YOUR NAME.
WOULD YOU REMIND ME, PLEASE?

?CHERYL
WELL, CHERYL, SINCE YOU HAVE
COMPLETED THE FIRST TWO MODULES OR
PASSED THE PRETEST FOR THEM, LET
ME CONGRATULATE YOU,


ARE YOU READY TO CHALLENGE YOURSELF
WITH NEW INFORMATION?
ENTER YES OR NO, THEN PUSH RETURN!
?YES
YOUR ENTHUSIASM IMPRESSES ME, CHERYL.

PUSH ANY KEY TO CONTINUE!

IN THIS MODULE, CHERYL, WE WILL BE DIS-
CUSSING ORAL MEDICATION, BOTH SOLID
AND LIQUID. YOU WILL LEARN HOW TO CAL-
CULATE PROPER DOSAGES, SO YOU WILL NEED
SCRATCH PAPER AND A PENCIL.
PUSH ANY KEY TO CONTINUE WHEN YOU ARE
READY.
ORAL MEDICATIONS ARE THE MOST COMMONLY
PRESCRIBED MEDICATIONS BECAUSE OF THEIR
EASE AND SAFETY OF ADMINISTRATION. ORAL
MEDICINES ARE AVAILABLE IN SOLID AND
LIQUID FORMS.

SOLID ORAL MEDICATIONS ARE AVAILABLE IN
THE FORM OF PILLS, TABLETS, AND
CAPSULES.

LIQUID ORAL MEDICATIONS ARE AVAILABLE
IN THE FORM OF SYRUPS AND ELIXIRS.

 ** PUSH ANY KEY TO CONTINUE WHEN YOU
HAVE FINISHED READING AND STUDYING THIS
SECTION. **
```

THE MOST COMMON WAY TO GIVE A MEDICA-
TION IS BY:

A. MOUTH.
B. INJECTION.
C. INHALATION.

** ENTER A, B, OR C, WHICHEVER PRECEDES
THE CORRECT ANSWER. **
?A
THAT'S EXCELLENT, CHERYL.
PUSH ANY KEY TO CONTINUE.
SLEEPING PILLS ARE AN EXAMPLE OF AN
ORAL MEDICATION IN:

A. SOLID FORM.
B. LIQUID FORM.

ENTER EITHER A OR B, WHICHEVER PRECEDES
THE CORRECT ANSWER.
?B
SORRY, CHERYL. SLEEPING PILLS AS
WELL AS TABLETS AND CAPSULES ARE ALL
EXAMPLES OF ORAL MEDICATIONS IN SOLID
FORM.
PUSH ANY KEY TO CONTINUE.
WHICH OF THE FOLLOWING KINDS OF MEDICA-
TIONS ARE 'NOT' CLASSIFIED AS SOLID,
ORAL MEDICATIONS?

A. SYRUP
B. TABLET
C. CAPSULE

ENTER A,B, OR C, WHICHEVER PRECEDES THE
CORRECT ANSWER.
?A
THAT'S EXCELLENT, CHERYL.
PUSH ANY KEY TO CONTINUE.

COLD SYRUPS SUCH AS VICK'S AND NYQUIL
ARE EXAMPLES OF MEDICATIONS IN:

A. LIQUID FORM.
B. SOLID FORM.

?A
THAT'S EXCELLENT, CHERYL.
PUSH ANY KEY TO CONTINUE.
THAT IS CORRECT, CHERYL. ON THIS
FIRST SECTION, YOU ANSWERED 3 OF
4 CORRECTLY. NOW, WE WILL BEGIN OUR
DISCUSSION OF MEDICATION DOSAGES.
FREQUENTLY THE PHYSICIAN WILL ORDER AN
ORAL MEDICATION IN A DOSAGE DIFFERENT
THAN THE AMOUNT IN WHICH IT IS MANUFAC-
TURED OR SUPPLIED. TO RESOLVE THE PROB-
LEM AND GIVE THE EXACT DOSE PRESCRIBED
BY THE PHYSICIAN, THE NURSE MUST PER-
FORM MATHEMATICAL COMPUTATIONS SIMILAR
TO THOSE ALREADY PRACTICED IN PREVIOUS
LESSONS. MOST FREQUENTLY, THE NURSE CAN
ACCURATELY SOLVE THE PROBLEM BY SETTING
UP A PROPORTION.

PUSH ANY KEY TO CONTINUE!
THE PHYSICIAN HAS ORDERED AMPICILLIN,
500 MG. (REMEMBER THAT THE MG SHOUD BE
LOWER CASE LETTERS BUT I DO NOT PRINT
LOWER CASE) THE LABEL ON THE CONTAINER
SHOWS EACH TABLET OF AMPICILLIN
CONTAINS 250 MG.

THE QUESTION IS HOW TO DETERMINE HOW
MANY TABLETS TO GIVE THE PATIENT?

PUSH ANY KEY TO CONTINUE

```
TO SOLVE THIS TYPE OF PROBLEM, SET UP A
PROPORTION. REMEMBER, A
     PROPORTION
        IS A
           STATEMENT OF EQUALITY
     BETWEEN
     TWO RATIOS.

PUSH ANY KEY!
RECALL, CHERYL, A RATIO IS CONSTRUCTED
BY CONSIDERING THE DESIRED DOSE AND THE
DOSE ON HAND.

THE DESIRED DOSE IS THE EXACT DOSE
ORDERED BY THE PHYSICIAN.

THE DOSE ON HAND IS THE AMOUNT OF
THE DRUG AVAILABLE AS IT IS SUPPLIED.

PUSH ANY KEY TO CONTINUE.
TO CONSTRUCT A PROPORTION, THE NURSE
MUST KNW THE DESIRED DOSE AND THE DOSE
ON HAND?

ENTER TRUE OR FALSE AND PUSH RETURN.
?TRUE
THAT'S EXCELLENT, CHERYL.
PUSH ANY KEY TO CONTINUE.
```

ABSOLUTELY! A PROPORTION CONSISTS OF
RATIOS CONSTRUCTED BY DESIGNATING THE
DESIRED DOSE AND THE DOSE ON HAND.
THE RATIO IS SET UP AS FOLLOWS:

ON HAND DOSE            DESIRED DOSE

TABLETS/MG              TABLETS/MG

PUSH ANY KEY TO CONTINUE!
TO REMIND YOU OF THE PROBLEM, CHERYL,
THE PHYSICIAN HAS ORDERED AMPICILLIN,
500 MG. (REMEMBER THAT THE MG SHOUD BE
LOWER CASE LETTERS BUT I DO NOT PRINT
LOWER CASE) THE LABEL ON THE CONTAINER
SHOWS EACH TABLET OF AMPICILLIN
CONTAINS 250 MG.

PUSH ANY KEY TO CONTINUE

THEREFORE

1/250 MG    =    X/500 MG

REMEMBER, CHERYL, THE RATIO MUST
BE SET UP SO THAT UNITS IN THE NUME-
RATOR AND THE DENOMINATOR CORRESPOND.

CHERYL, DO YOU UNDERSTAND HOW THE
RATIO WAS SET UP?
ENTER YES OR NO
?YES

THE NEXT STEP, CHERYL, IS TO CROSS-
MULTIPLY. DO YOU REMEMBER HOW TO DO
THAT? ENTER YES OR NO
?YES

RECALL, CHERYL, OUR RATIO IS:
 ON HAND DOSE            DESIRED DOSE

   1/250 MG          X/500 MG

# APPENDIX B

# SAMPLE OF DRUG PROFICIENCY EXAMINATION

# FORMS A, B, C

APPENDIX B

PRINCIPLES OF NURSING

Drug Proficiency Exam

Form A

Name: ____________

# Correct ____________

Pass/Fail

______ 1. You are to administer 5 mg. of Premarin. The drug is dispensed in 1.25 mg tablets. How many tablets will you give the patient?

______ 2. You must give a patient 0.015 Gm. of a certain drug, and the drug is dispensed in tablets of 5 mg. each. How many tablets would you give?

______ 3. You are to give diethylstilbesterol 5 mg. If the drug is supplied in gr. 1/12 tablets, how many tablet(s) will you administer?

______ 4. One ounce of Elixir of Terpin Hydrate contains one grain of Codeine. How many grains of Codeine would a patient receive if he took 15 ml. of the elixir?

______ 5. Ascorbic acid 0.1 Gm. is ordered. If the drug is available in 50 mg. tablets, how many tablet(s) will you give?

APPENDIX B

PRINCIPLES OF NURSING

Drug Proficiency Exam

Form B

Name: ______________

# Correct ______________

Pass/Fail

______________ 1. - - - - A child is given a 2.5 ml. dropperful of Erythrocin four times daily. If each 2.5 ml. contains 100 mg. of medication, he receives __?__ of the drug daily.

______________ 2. To give scopolamine hydrobromide gr. 1/150 when one tablet contains gr. 1/300, how many tablets would you have to administer?

______________ 3. There are 40 mg. of Lasix (furosemide) in one tablet. How many tablets must be given to administer a dose of 60 mg.?

______________ 4. A patient is to receive 4 teaspoonfuls of Maalox four times each day. The drug is supplied in 16 ounce bottles. How many bottles would be needed for a four week's supply?

______________ 5. Chloromycetin is supplied in 250 mg. capsules. How many capsule(s) would you administer if the physician ordered 0.5 Gm. of Chloromycetin p.o., q. 6 h.?

PRINCIPLES OF NURSING

Drug Proficiency Exam

Form C

Name: ____________________

# Correct ____________________

Pass/Fail

____________ 1. A patient is to receive 0.2 Gm. of drug. The drug is available in 100 mg. capsules. How many capsules will you give the patient?

____________ 2. You are to administer 2.5 mg. of Premarin. The drug is dispensed in 1.25 mg. tablets. How many tablets will you give the patient?

____________ 3. You are to give chloral hydrate 1 Gm. You have 500 mg. capsules on hand. How many should you administer?

____________ 4. You are to give aspirin gr. x. You have 300 mg. tablets. How many tablets should you give?

____________ 5. The physician orders Aminophylline 0.6 Gm. If Aminophylline is supplied in 200 mg. scored tablets, how many tablet(s) would you administer?

# APPENDIX C

# LEARNING STYLE INVENTORY

# APPENDIX C

This inventory is designed to assess your method of learning. As you take the inventory, give the highest rank to those words that best describe the way you learn and the lowest rank to the words that least describe your learning style.

You may find it hard to rank these words. But keep in mind that there are no right or wrong answers—all the choices are equally acceptable. The aim of the inventory is to describe your *style* of learning, not to evaluate your learning ability.

## Instructions

There are nine sets of four words listed below. Rank each set of four words, by assigning a "4" to the word that best characterizes your learning style, a "3" to the word that next best characterizes your learning style, a "2" to the next most characteristic word, and a "1" to the word that is least characteristic of you as a learner. *Be sure to assign a different rank number to each of the four words in each set; do not make ties.*

| | | | | |
|---|---|---|---|---|
| 1. | ___ discriminating | ___ tentative | ___ involved | ___ practical |
| 2. | ___ receptive | ___ relevant | ___ analytical | ___ impartial |
| 3. | ___ feeling | ___ watching | ___ thinking | ___ doing |
| 4. | ___ accepting | ___ risk-taker | ___ evaluative | ___ aware |
| 5. | ___ intuitive | ___ productive | ___ logical | ___ questioning |
| 6. | ___ abstract | ___ observing | ___ concrete | ___ active |
| 7. | ___ present-oriented | ___ reflecting | ___ future-oriented | ___ pragmatic |
| 8. | ___ experience | ___ observation | ___ conceptualization | ___ experimentation |
| 9. | ___ intense | ___ reserved | ___ rational | ___ responsible |

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APPENDIX D

ADJECTIVE RATING SCALES

Department of Program Development and Evaluation

APPENDIX D

# State University of New York at Albany

May 21, 1982

Cheryl V. Ratliff, R.N., B.S.N., M.S.
Instructor
The University of Kansas
School of Nursing - College of Health Sciences
39th and Rainbow Boulevard
Kansas City, Kansas 66103

Dear Ms. Ratliff:

What you need is the Technical Manual for the ARS, and this is available as Research Report No. 8, published by the Center for Instructional Development, 115 College Place, Syracuse, New York (Attention - Mr. Ronald Boverat). I believe the cost is approximately $5. Telephone number is 315-423-4571.

You may also want to consider the current findings reported by Sarah Barnes Keating in her Ed.D. dissertation in which she studied BSN students at Russell Sage College, Troy, New York where she is an associate professor in the Department of Nursing. Keating's results for the ARS replicate the structures reported in the technical manual and do not support the curious findings that Holzemer and I reported. I believe that the results Holzemer and I observed were due to the narrow sample of students at Chicago but also to the advanced standing of most of them. Keating's results describe a sample of female graduates one year out of program as well as a cohort of graduates sampled out of the last ten years of the program. Her results are almost identical to those reported for undergraduates in the ARS technical manual.

The instrument is available for use at no cost, despite its copyright; however, I would appreciate appropriate citation to its origins in any report made of its use.

If I can be of further assistance, please ask. Good luck.

Cordially,

Edward F. Kell
Associate Pro essor

School of Education, Education 333, 1400 Washington Avenue, Albany, New York 12222, 518/457-8243

APPENDIX D

UNIVERSITY OF ILLINOIS
COLLEGE OF NURSING
DEPARTMENT OF PUBLIC HEALTH NURSING

ADJECTIVE RATING SCALE

I expect to find this course to be:

Mark your responses on the answer sheet.

A = Extremely
B = Very
C = Slightly
D = Not at all

| | | | | | |
|---|---|---|---|---|---|
| 1. | interesting | A | B | C | D |
| 2. | boring | A | B | C | D |
| 3. | relevant | A | B | C | D |
| 4. | informative | A | B | C | D |
| 5. | difficult | A | B | C | D |
| 6. | good | A | B | C | D |
| 7. | stimulating | A | B | C | D |
| 8. | irrelevant | A | B | C | D |
| 9. | worthwhile | A | B | C | D |
| 10. | valuable | A | B | C | D |
| 11. | necessary | A | B | C | D |
| 12. | dull | A | B | C | D |
| 13. | challenging | A | B | C | D |
| 14. | a waste | A | B | C | D |
| 15. | practical | A | B | C | D |
| 16. | demanding | A | B | C | D |
| 17. | different | A | B | C | D |
| 18. | enjoyable | A | B | C | D |
| 19. | enlightening | A | B | C | D |
| 20. | exciting | A | B | C | D |
| 21. | rewarding | A | B | C | D |
| 22. | provocative | A | B | C | D |
| 23. | general | A | B | C | D |
| 24. | useless | A | B | C | D |

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# APPENDIX D

UNIVERSITY OF ILLINOIS
COLLEGE OF NURSING
DEPARTMENT OF PUBLIC HEALTH NURSING

## ADJECTIVE RATING SCALE

I found this course to be

Mark your responses on the answer sheet.

A = Extremely
B = Very
C = Slightly
D = Not at all

| | | | | | |
|---|---|---|---|---|---|
| 1. | interesting | A | B | C | D |
| 2. | boring | A | B | C | D |
| 3. | relevant | A | B | C | D |
| 4. | informative | A | B | C | D |
| 5. | difficult | A | B | C | D |
| 6. | good | A | B | C | D |
| 7. | stimulating | A | B | C | D |
| 8. | irrelevant | A | B | C | D |
| 9. | worthwhile | A | B | C | D |
| 10. | valuable | A | B | C | D |
| 11. | necessary | A | B | C | D |
| 12. | dull | A | B | C | D |
| 13. | challenging | A | B | C | D |
| 14. | a waste | A | B | C | D |
| 15. | practical | A | B | C | D |
| 16. | demanding | A | B | C | D |
| 17. | different | A | B | C | D |
| 18. | enjoyable | A | B | C | D |
| 19. | enlightening | A | B | C | D |
| 20. | exciting | A | B | C | D |
| 21. | rewarding | A | B | C | D |
| 22. | provocative | A | B | C | D |
| 23. | general | A | B | C | D |
| 24. | useless | A | B | C | D |

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# APPENDIX E

# SCORING SOLUTION FOR ADJECTIVE RATING SCALE SHOWING ADJECTIVES TO BE SCORED ON EACH FACTOR SCALE

# APPENDIX E

| Factor Scale Name: | Practical Value | Emotional Appeal | Dullness (Apathy) | Interest Value | Difficulty |
|---|---|---|---|---|---|
| Items to be Summated: | Worthwhile | Exciting | Dull | Informative | Difficult |
| | Practical | Enjoyable | A Waste | Interesting | Demanding |
| | Necessary | Stimulating | Boring | (-) Useless* | Challenging |
| | Valuable | Provocative | Irrelevant | Enlightening | |
| | Rewarding | Different | | (General)** | |
| | Relevant | Good | | | |

Figure 2. Scoring Solution for Adjective Rating Scale Showing Adjectives to be Scored on Each Factor Scale

*Indicates that item should be reversed for scoring.
**The term "general" is usually not scored but is understood to related to "Interest Value."

Note. From The Development and Use of the Adjective Rating Scale: A Measure of Attitude Toward Courses and Programs (Report 8 ) (p. 21) by Kelley et al., 1976, Syracuse, NY: Syracuse University, Center for Instructional Development. Reprinted by permission.

APPENDIX F

ASSISTANT DEAN AND DIRECTOR OF THE UNDERGRADUATE

NURSING PROGRAM

CONSENT FORM

APPENDIX F

Assistant Dean and Director

of the Undergraduate Nursing Program

Consent Form

I give my permission to Cheryl Ratliff to include junior level nursing students enrolled in Principles of Nursing (N 001) as voluntary participants in her master's thesis study. The study compares the effectiveness of two modalities in teaching students to solve drug and solution calculation problems.

I understand this study will not involve any risk to the school or students. I understand individual student names and the school name will not be used in the study. I understand the students will voluntarily sign a consent form to participate in the study.

______________________________

Assistant Dean and Director of the
Undergraduate Nursing Program

5/14/82
Date

______________________________

Witness

# APPENDIX G

# STUDENT CONSENT FORM

APPENDIX G
STUDENT CONSENT FORM

I consent to participate in this study which is being conducted by Cheryl Ratliff.

I understand the purpose of this study is to collect information about methods of teaching students to learn to solve drug and solution calculation problems.

I agree to study the designated content by the method to which I have been assigned. The method by which I will learn the content will not involve a risk to myself, nor affect my grade in this course. Upon completion of the study, I will be given the opportunity to study the content by computer-assisted instruction or the independent study approach.

I understand I will be asked to take several tests during regularly scheduled class periods.

I understand I will not be identified by name in the study, nor will the school name be identified in this study.

I understand I may withdraw from the study at any time.

______________________________
Signature

______________________________
Date

______________________________
Witness

# APPENDIX H

# DRUG PROFICIENCY EXAMINATION

# RAW SCORE DATA

## APPENDIX H

PRETEST, POSTTEST, RETENTION TEST SCORES
ON DPE FOR GROUP A (EXPERIMENTAL)

| | Number of correct items | | |
|---|---|---|---|
| Subject | Pretest($01_C$) | Posttest($02_C$) | Retention Test($03_C$) |
| 01 | 13 | 37 | 30 |
| 02 | 20 | 40 | 39 |
| 03 | 15 | 30 | 29 |
| 04 | 13 | 37 | 27 |
| 05 | 10 | 39 | 37 |
| 06 | 19 | 37 | 38 |
| 07 | 28 | 38 | 36 |
| 08 | 14 | 36 | 35 |
| 09 | 09 | 37 | 36 |
| 10 | 29 | 38 | 37 |
| 11 | 05 | 34 | 37 |
| 12 | 10 | 34 | 37 |
| 13 | 11 | 39 | 37 |
| 14 | 27 | 38 | 38 |
| 15 | 16 | 39 | 30 |
| 16 | 13 | 31 | 34 |
| 17 | 12 | 35 | 36 |
| 18 | 12 | 40 | 37 |
| 19 | 12 | 40 | 38 |
| 20 | 10 | 36 | 24 |
| 21 | 21 | 34 | 34 |
| 22 | 13 | 40 | 35 |
| 23 | 29 | 35 | 40 |
| 24 | 20 | 32 | 34 |
| 25 | 14 | 36 | 31 |
| 26 | 06 | 37 | 34 |
| 27 | 08 | 32 | 37 |

*Note*. DPE refers to Drug Proficiency Examination. Maximum score = 40. $n$ = 27

APPENDIX H

Pretest, Posttest, Retention Test Scores
on DPE for Group B (Control)

| Subject | Number of correct items | | |
|---|---|---|---|
| | Pretest($01_c$) | Posttest($02_c$) | Retention Test($03_c$) |
| 01 | 18 | 35 | 37 |
| 02 | 09 | 20 | 26 |
| 03 | 06 | 31 | 39 |
| 04 | 19 | 36 | 32 |
| 05 | 20 | 37 | 37 |
| 06 | 05 | 37 | 30 |
| 07 | 11 | 36 | 34 |
| 08 | 04 | 35 | 36 |
| 09 | 27 | 37 | 28 |
| 10 | 09 | 36 | 20 |
| 11 | 10 | 36 | 24 |
| 12 | 28 | 40 | 38 |
| 13 | 17 | 38 | 35 |
| 14 | 05 | 28 | 33 |
| 15 | 11 | 38 | 38 |
| 16 | 12 | 33 | 35 |
| 17 | 06 | 34 | 32 |
| 18 | 14 | 29 | 39 |
| 19 | 27 | 38 | 35 |
| 20 | 12 | 40 | 38 |
| 21 | 16 | 39 | 33 |
| 22 | 19 | 37 | 36 |
| 23 | 20 | 40 | 37 |
| 24 | 11 | 36 | 27 |
| 25 | 09 | 16 | 31 |
| 26 | 15 | 38 | 30 |
| 27 | 12 | 28 | 35 |
| 28 | 15 | 38 | 33 |
| 29 | 29 | 38 | 34 |
| 30 | 13 | 37 | 31 |
| 31 | 32 | 40 | 38 |

Note. DPE refers to Drug Proficiency Examination. Maximum score = 40. $n$ = 31

APPENDIX I

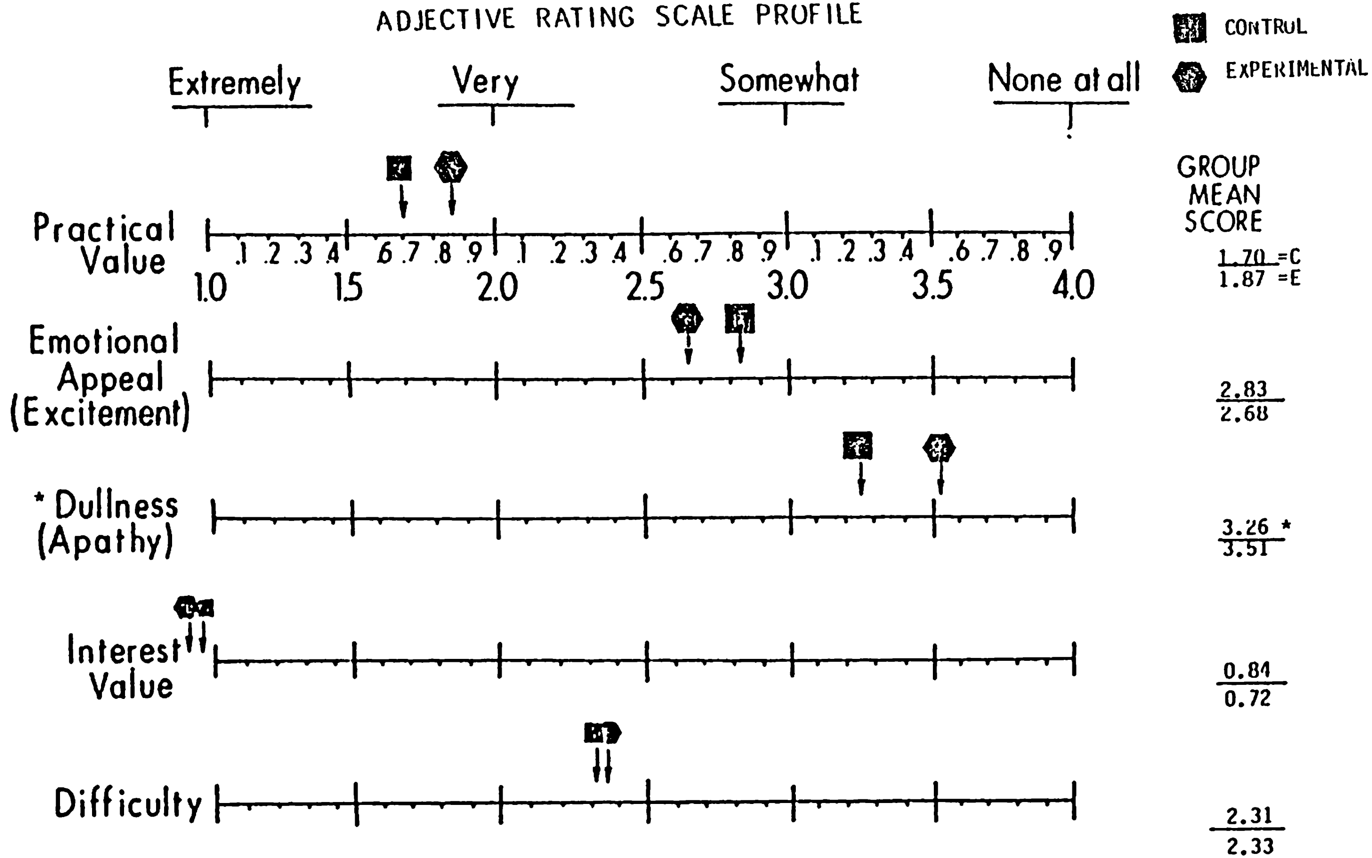
ADJECTIVE RATING SCALE PROFILE

FOR GROUP A AND GROUP B PRIOR TO STUDY

BY THE ASSIGNED LEARNING MODALITY

## APPENDIX I

### ADJECTIVE RATING SCALE PROFILE




Course____________________

Instructor____________________

Date Collected Fall, 1982

Group Size 58

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Syracuse University
1975

APPENDIX J

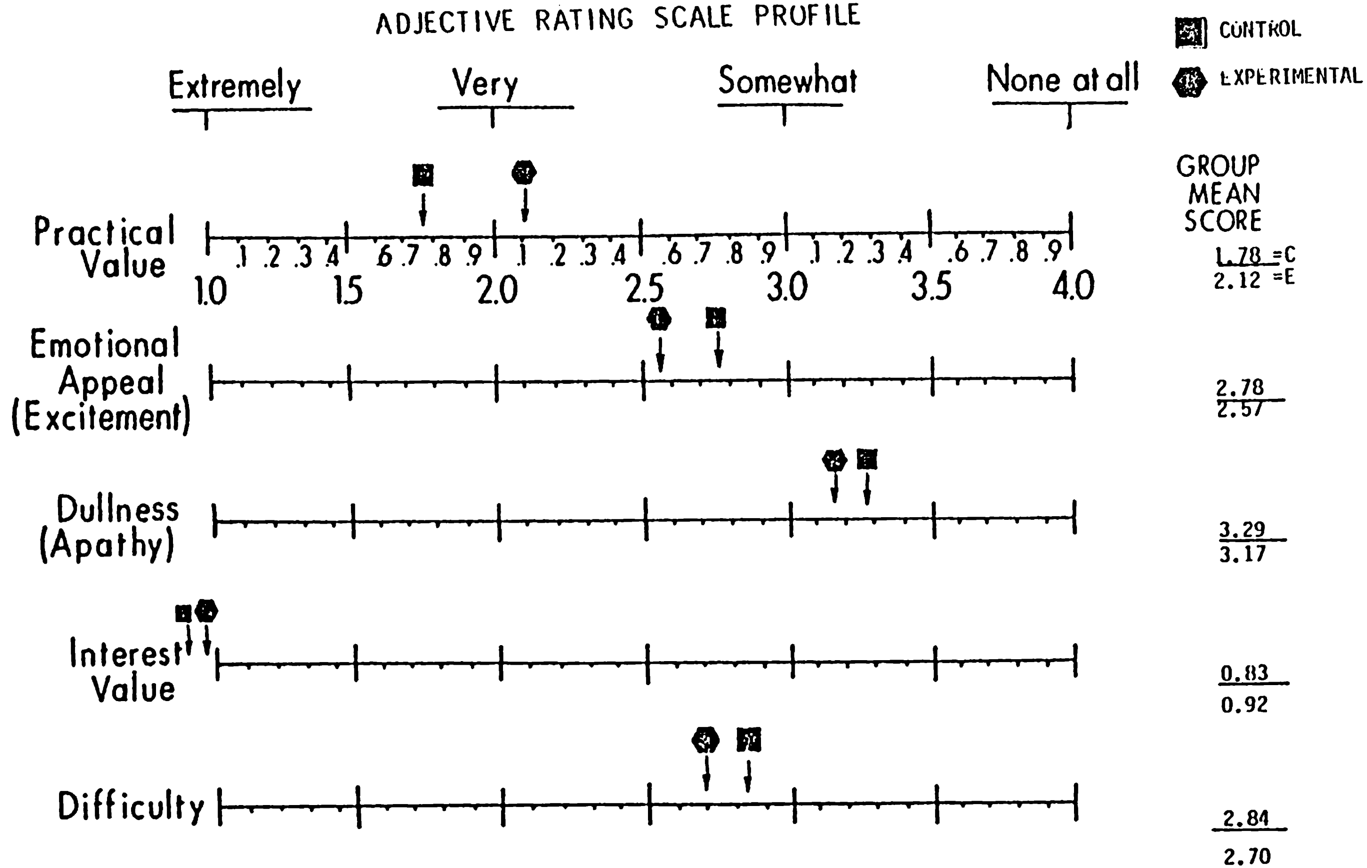
ADJECTIVE RATING SCALE PROFILE

FOR GROUP A AND GROUP B FOLLOWING STUDY

BY THE ASSIGNED LEARNING MODALITY

## APPENDIX J

### ADJECTIVE RATING SCALE PROFILE




Course____________________

Instructor____________________

Date Collected Fall, 1982

Group Size 58

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