LEARNING/COGNITIVE STYLES AND LEARNING PREFERENCES OF STUDENTS AND INSTRUCTORS AS RELATED TO ACHIEVEMENT IN RESPIRATORY THERAPY EDUCATIONAL PROGRAMS

By

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This work is dedicated to my wife Tina Banner--a gentle and thoughtful lady who is my best friend. Thank you for your love, support, and understanding.

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The purpose of the study was to determine whether a relationship existed between achievement and the degree of matching between students and their instructors based on learning/cognitive style theory or learning preference theory, and whether one of these learning theories was better in predicting student achievement. Learning/cognitive style is the manner in which an individual acquires, perceives, and processes information in the learning situation. Learning preference is the choice that an individual makes for one learning situation over another.

At the conclusion of a major course in the respiratory therapy curriculum, students and their instructors from 11 respiratory therapy programs completed Kolb's Learning Style

Inventory (LSI) and Rezler's Learning Preference Inventory (LPI); students also completed an achievement test. Student-instructor discrepancy scores (student's score minus instructor's score) calculated from the LSI and LPI dimension scales were used to determine the degree of matching, i.e., the lower the discrepancy scores the greater the match. Multiple regression was used to analyze the relationships between the degree of matching and the students' achievement test scores.

Higher achievement scores correlated with greater degrees of matching between students and their instructors for the abstract conceptualization and active experimentation dimensions of Kolb's theory and for the concrete learning dimension of Rezler's theory. Using Kolb's typology, students who were the same learning/cognitive style type as their instructor had significantly higher achievement scores than students who were a different learning/cognitive style type. The learning/cognitive style variables, as a group, accounted for a significant amount of variance in predicting student achievement compared to the learning preference variables. Thus, it may be inferred that Kolb's theory of learning/cognitive style was better than Rezler's theory of learning preferences in predicting student achievement.

These data reveal that a learning environment congruent with a student's predispositions for learning should be provided to enhance learning and achievement. A learning/cognitive style-responsive approach to education is recommended.

CHAPTER 1
INTRODUCTION

Knowledge of the ways that individuals perceive and process information and their predispositions for specific types of learning situations is relatively new. Consequently, college faculty members and administrators have not considered using this knowledge as a possible means to improve the quality of higher education. Specific cognitive processes affecting one's learning/cognitive style vary from student to student. Learning/cognitive style is the manner in which an individual acquires, perceives, and processes information in the learning situation (Cahill & Madigan, 1984). Students also have preferences in the ways in which they learn. Learning preference is the choice that an individual makes for one learning situation over another (Rezler & Rezmovick, 1981).

Levine (1978) contended that one of the major problems in higher education is that student differences are not adequately taken into consideration. "Uniform types of instruction produce widely divergent results in different students" (p. 205). Levine stated that

different types of instructor relationships work best for different types of students, and implied that students as well as their instructors have different learning/ cognitive styles and preferences. Cross (1976) made a series of recommendations regarding student differences: that instructors and students should be helped to gain some insight into learning and teaching styles; that most individuals will be happier and more productive when they are studying via a method compatible with their learning/cognitive style and learning preference; that no one teaching method should be regarded as effective for all students in all situations; and that educators should be aware of the cognitive styles of students in order to provide appropriate kinds of support, motivation, and reinforcement.

At least two schools of thought underlie the processes of learning strategies and teaching regarding learning/cognitive styles and learning preferences. One school may be represented by Kolb (1984) and McKenny and Keen (1974). This viewpoint is concerned with the cognitive processes affecting one's learning/cognitive style. The learner has discrete ways of perceiving, organizing, and retaining information that are distinctive and consistent. Two factors identified for human cognitive processing are information gathering and information evaluating (Dixon, 1982). Processing has also

been described as how an individual manipulates, categorizes, and evaluates input information (Dixon, 1982). The basic concept is structuring of the teaching-learning environment in a manner that is congruent with a student's learning/cognitive style rather than forcing the student to accommodate to a given teaching-learning environment. Individual differences and learning/cognitive styles are recognized with this approach.

Kolb (1984) developed the Experiential Learning Theory as a means of identifying learning/cognitive styles. Kolb's model is portrayed as a cyclical process with four cognitive dimensions: (a) concrete experience (learning by feeling), learning from specific experiences, relating to people, sensitivity to feelings and people, and involving oneself fully, openly, and without bias in new experiences; (b) reflective observation (learning by watching and listening), learning by careful observation before making a judgement, viewing things from different perspectives, looking for the meaning of things, and viewing experiences from many perspectives; (c) abstract conceptualization (learning by thinking), learning by logical analysis of ideas, systematic planning, acting on an intellectual understanding of a situation, and creating concepts that integrate one's observations into logically

sound theories; and (d) active experimentation (learning by doing), learning related to the ability to get things done, risk taking, influencing people and events through action, and using previously learned theories to make decisions and solve problems. For fully integrated learning to occur, all dimensional activities eventually must be utilized. Learning/cognitive style type is seen as two-dimensional. One dimension relates to information acquisition which ranges from concrete to abstract. The other dimension relates to information processing ranging from active to reflective. Four learning/cognitive style types have been described: "diverger," "assimilator," "converger," and "accommodator" (see Figure 1-1).

The other school of thought focuses on learning preferences and may be represented by Rezler and Rezmovick (1981) and Dunn and Dunn (1975). Learning preferences refer to a student's preferred choices of methods of instruction and relates to the "likes" and "dislikes" that individuals have for particular modes of learning. This frame of thinking is concerned with affective, environmental, and, to some respect, cognitive aspects of learning. Improvement and individualization of instruction are accomplished by first identifying and then providing methods of instruction that are appealing to the learner. The same content of a course may be taught in

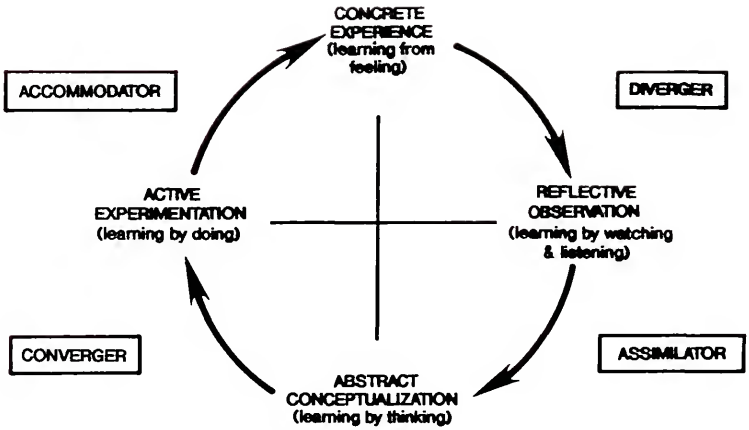

Figure 1-1. Kolb's Experiential Learning Model. Learning is a cyclical process of four cognitive dimensions: concrete experience, reflective observation, abstract conceptualization, and active experimentation (see text). Note. From the Learning Style Inventory (p. 9) by D. A. Kolb, 1985, Boston: McBer and Company. Copyright 1981 by D. A. Kolb. Adapted by permission.

several ways to make it more palatable to the learner. Students have a predilection for specific learning preferences which may influence the degree of learning that occurs. It is believed that efforts should be made to provide methods of instruction that match student preferences in order to promote student satisfaction and achievement in the learning situation.

Rezler's approach consists of identifying a person's learning preference profile based on six dimensions: (a) individual, a preference for learning or working alone, with emphasis on self-reliance and solitary tasks such as reading; (b)interpersonal, a preference for learning or working with others, with emphasis on harmonious relations between students and teacher and among students; (c) student-structured, a preference for learning via student organized tasks, with emphasis on autonomy and self-direction; (d) teacher-structured, a preference for learning in a well-organized teacher-directed class, with expectations, assignments, and goals that are clearly identified; (e) abstract, a preference for learning theories and generating hypotheses with focus on general principles and concepts; and (f) concrete, a preference for learning tangible, specific, practical tasks, with focus on skills. One's learning preference profile is determined by the six dimension scores (see Figure 1-2). It is recommended that appropriate methods of instruction

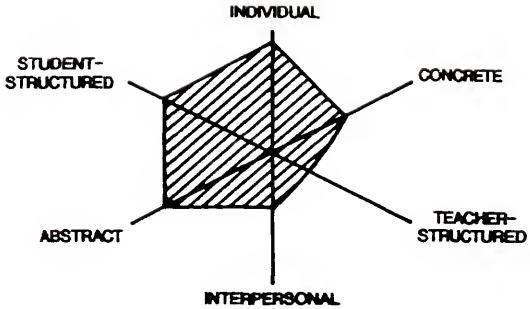

Figure 1-2. A Model of Rezler's Learning Preference Dimensions. Six dimensions are used to identify one's learning preference profile: individual, interpersonal, student-structured, teacher-structured, abstract, and concrete (see text). As an example, the above profile is indicative of a student who prefers learning abstract concepts, learns without the aid of others, and who is independent, autonomous, and learns best with minimal guidance provided by the instructor.

should be provided on the basis of this profile. Because of individual differences in learning preferences, one method of instruction may be effective and please some students but alienate others. Thus, it is felt that learning is facilitated when methods of instruction are provided that are compatible with one's learning preferences.

Instructors Teach in Ways That They Like to Learn

Witkin (1976) suggested that instructors teach in a manner similar to the way in which they prefer to learn. An instructor's teaching style appears to be influenced by his or her learning/cognitive style and learning preferences (Smith, 1982). Teaching style refers to an instructor's characteristic behavior in the teaching-learning situation (Smith, 1982). Smith (1982) contended that teachers conduct instructional sessions with the kinds of learning activities that they prefer when learning. Giunta (1984) noted that instructors' teaching styles were congruent with their own learning/cognitive styles. Brillhart and Debs (1982) evaluated the learning preferences of classroom instructors and reported there was a direct correlation between how instructors taught and how they learned. It would seem, therefore, that the manner by which an instructor acquires, perceives, and processes information in the learning situation (learning/cognitive style) and the choice of a particular

method of instruction (learning preference) are related to how an instructor perceives, processes, interprets, and articulates information in the teaching situation (teaching style).

Using the Myers-Briggs Type Indicator, Lawrence (1982) noted that the kinds of questions and the ways in which they were stated reflected an instructor's preference for sensing (emphasis on sense perception, facts, details, and concrete events) or intuition (emphasis on possibilities, imagination, meaning, and seeing things as a whole). Sensing types asked questions seeking facts and details to which responses were predictable. In contrast, intuitive instructors asked questions which called for synthesis and evaluation, as well as imagination and hypothesis formulation. It was noted also that sensing instructors neglected synthesizing and evaluating, while intuitive types gave little importance to facts and details.

As previously stated, instructors as well as students have different learning/cognitive styles and learning preferences (Levine, 1978). It was noted also that different types of instructor relationships work best for different types of students. In a study involving undergraduate students, Brown (1978) noted that when the instructor's teaching style complemented the learning/cognitive style of the students, achievement

(i.e., grade point average) was greater. Kuchinskas (1979) reported that matches of learning/cognitive style between the instructor and student and complementary methods of instruction resulted in increased achievement, whereas mismatches resulted in the reverse. Blagg (1985) showed that when there was a mismatch between the learning/cognitive styles of students and instructors, students were not sufficiently motivated and the necessary involvement in learning (study/homework time) did not occur. Using a learning preference approach, Adams (1983) reported greater student satisfaction and achievement (i.e., higher grade point average) when the learning preferences of students and their instructors were matched. A priori, this would suggest that the greater the degree of matching or congruency between students and their instructors on the basis of learning/cognitive style theory or learning preference theory, the greater might be the communication and understanding between them. This might subsequently result in greater student involvement, satisfaction, and enjoyment in the teaching-learning situation, and ultimately higher student achievement.

Learning/Cognitive Styles and Learning Preferences in Allied Health Education

Interest in learning/cognitive styles and learning preferences and their impact on the teaching-learning process in allied health education has been described

(Edge, 1988). Educators in allied health professions have focused most of their attention on curriculum design and establishment of educational programs leading to professional certification. Interest has been demonstrated in increasing teacher effectiveness and student learning efficiency. A major problem in allied health education is the lack of knowledge about how people prefer to learn (Llorens & Adams, 1976). In many allied health professions (nursing, occupational therapy, physical therapy, medical technology, dental hygiene, and medical dietetics) formal evaluations of student and faculty learning/cognitive styles, learning preferences, and their relationships to educational outcomes have been conducted (Barris, Kielhofner, & Bauer, 1985; Blagg, 1985; Carrier, Newell, & Lange, 1982; Highfield, 1988; Hodges, 1988; Merritt, 1983; O'Kell, 1988; Payton, Hueter, & McDonald, 1979).

Individuals aspiring to practice in many of the allied health professions generally matriculate into community colleges or four-year college programs. Graduates of such programs are qualified to take state and/or national board licensure examinations to become registered or certified in their respective fields. Respiratory therapy is one allied health profession, for example, in which graduates are qualified to take a national board certification examination in order to

become certified respiratory therapy technicians (CRTT). The examination certifies technical competency in respiratory therapy and allows one to practice at the clinical level.

Reviewing pass/failure statistics from 1977 through 1987 revealed that candidates attempting the respiratory therapy board examination passed at an average rate of approximately 50% (Filippi, 1988). It is disconcerting that a large percentage of graduates of respiratory therapy programs fail the board examination resulting in a shortage of certified respiratory therapy technicians (O'Daniel, 1987). Hospital administrators and medical staffs are in a potentially precarious position, i.e., being forced to consider hiring noncertified respiratory therapy technicians to meet burgeoning manpower demands. It is difficult to assess whether less than optimal patient care will result when administered by non-certified respiratory therapy personnel unable to pass their own societal board examinations. Professional certification achieved through a standardized examination process assures at least a minimal level of competency which is designed to protect the general public. Ideally, all graduates of respiratory therapy programs should be able to pass the board examination to become certified respiratory therapy technicians.

A study of the teaching-learning approaches used in respiratory therapy educational programs and the effects on student achievement may have implications relating to the low pass rate on the board examination. Such a study could result in the identification of problematic areas, according to Dr. Robert M. Kacmarek, Chairman of the National Board for Respiratory Care (NBRC), Clinical Simulation Examination Committee (personal communication, March 9, 1987). A study of this nature had never been conducted, and the results of such a study should indicate weaknesses in respiratory therapy educational programs and provide a basis for redress.

The Problem

The degree of matching between students and their instructors based on Kolb's theory of learning/cognitive styles and Rezler's theory of learning preferences is a factor which may influence student achievement in respiratory therapy educational programs. Various degrees of matching may predispose to differential levels of student achievement. It was contended that the greater the degree of matching, the greater the level of student achievement and vice versa. However, it was not clear whether a relationship between student achievement and the degree of matching between students and their instructors differs when based on learning/cognitive style theory or learning preference theory. The problem centered on two

key questions: (a) is there a relationship between student achievement and the degree of matching between students and their instructors based on Kolb's theory of learning/cognitive styles and Rezler's theory of learning preferences, and (b) which of the two learning theories involving the degree of matching between students and their instructors is a better predictor of student achievement. The study was designed to determine if a significant relationship between student achievement and the degree of matching based on learning/cognitive style theory of learning preference theory would be demonstrated for students enrolled in a major course in respiratory therapy. It may then be hypothesized that greater overall learning for the entire respiratory therapy program might result if efforts are made to teach students in ways that are compatible with their learning/cognitive styles or learning preferences. Pedagogic and administrative implications are that the application of one or both of these learning theories may be appropriate in facilitating and promoting greater learning.

Hypotheses

The following hypotheses were tested in this study:

Hypothesis 1. There is no significant relationship between the actual level of student achievement and the predicted level of achievement as a function of the

weighted linear combination of grade point average (GPA), number of hours of homework per week, program, and the concrete experience, reflective observation, abstract conceptualization, and active experimentation learning/cognitive style dimension discrepancy scores.

Hypothesis 2. There is no significant relationship between student achievement and the student-instructor discrepancy score (degree of matching between student and instructor) on any of the four learning/cognitive style dimensions.

Hypothesis 3. There are no differences in the actual level of achievement for students who are the same learning/cognitive style type ("matched") compared with students who are a different learning/cognitive style type ("mismatched") from their instructor.

Hypothesis 4. There is no significant relationship between the actual level of student achievement and the predicted level of achievement as a function of the weighted linear combination of GPA, number of hours of homework per week, program, and the interpersonal, individual, teacher-structured, student-structured, abstract, and concrete learning preference dimension discrepancy scores.

Hypothesis 5. There is no significant relationship between student achievement and the student-instructor discrepancy score (degree of matching between student and

instructor) on any of the six learning preference dimensions.

Hypothesis 6. There is no significant change in the proportion of explained variance (R^2) in student achievement when the learning/cognitive style set of variables, as a group, are removed from the complete (all variables) regression model.

Hypothesis 7. There is no significant change in the proportion of explained R^2 in student achievement when the learning preference set of variables, as a group, are removed from the complete (all variables) regression model.

Delimitations

This study was confined to students enrolled in Associate of Science and Bachelor of Science respiratory therapy educational programs. A cluster sampling of 143 students and their instructors from 11 respiratory therapy programs in the northern, southern, eastern, and western regions of the United States was studied. The major variables in the study were student achievement and the degree of matching of students and their instructors on the basis of Kolb's learning/cognitive style dimensions and Rezler's learning preference dimensions for a major course in respiratory therapy.

Limitations

1. In this descriptive, correlational, ex post facto study, the researcher identified subjects in whom changes in the independent variables had already taken place and the researcher studied them in retrospect for their possible effects on the dependent variable. The key independent variables were the degree of matching between students and their instructors on the basis of several learning/cognitive styles and learning preference variables. The dependent variable was the level of student achievement for a major course in respiratory therapy theory. The ex post facto design of this study and the fact that learning/cognitive style and learning preference inventories and an achievement test were administered only once, precluded the advantages of an experimentally designed study. The researcher was not able to control all extraneous variables or to manipulate the independent variables.

2. The results of this study were interpreted within the limitations imposed by the validity and reliability of the inventories and the achievement test used in the investigation.

3. Factors that may affect the external validity, generalizability, or representativeness of the data include variations in the data base that could possibly

occur with different groups of students at different colleges and in a different academic year.

Need for the Study

A study identifying factors which may be influencing student achievement in respiratory therapy educational programs and also affecting the low pass rate on the respiratory therapy board examination was needed so that corrective interventions could be made. One may predict, *a priori*, that the degree of matching between students and their instructors based on learning/cognitive style or on learning preference theories may be causal factors affecting the student achievement. The greater the degree of match between students and their instructor on the basis of learning/cognitive style or learning preference theory throughout the entire length of a respiratory therapy program, the greater may be the degree of achievement and possibly the greater likelihood of passing the board examination. Results of this study should be helpful in explaining the low pass rate on the board examination. Respiratory therapy curriculum planners and policy makers at the national and local levels could benefit from the results of this study by using information obtained from learning/cognitive style and preference inventories to match students with appropriate methods of instruction to improve student achievement.

Kolb's learning/cognitive style theory and Rezler's learning preference theory were evaluated in this study. A comparison of these related, but different viewpoints could have important academic and practical implications. Academically, such a study contributes to the scholarly knowledge in the area of teaching-learning strategies used in higher education. First, the relationship between the degree of matching of students and their instructors, based on Kolb's and Rezler's theories, and student achievement had not been compared. If the degree of matching based on one of these theories is associated with greater student achievement, it could then be identified. Second, if student achievement is favorably influenced by matching students and instructors on the basis of learning/cognitive style or learning preference theory, then it may be possible to predict academic achievement using multiple regression analysis. Predicting academic achievement using Kolb's learning/cognitive style or Rezler's learning preference variables is a novel approach that heretofore had not been researched. Third, another unique aspect of this research was the use of discrepancy scores derived from the learning/cognitive style and learning preference dimension scale scores as a means of determining the degree of match between students and their instructors. This technique allowed for various degrees of matching to be recorded as a continuous variable based

on the discrepancy score, i.e., the smaller the discrepancy score, the better the match (discrepancy score = student's score on each dimension scale minus instructor's score on each dimension scale). A fourth point is that it may be possible, using step-wise regression analysis, to select dimensions from Kolb's and Rezler's theories which are significantly related to student achievement. Thus, by combining select dimensions from these two schools of thought, a new model may be developed that is better than using either theory alone in predicting student achievement. A fifth point was that there was no reference in the literature describing the learning/cognitive styles and learning preferences of respiratory therapy students and their instructors and the relationship these factors might have on student achievement. In other allied health professions, learning/cognitive styles and learning preferences had been documented, but not in this major allied health profession. Practically speaking, if student achievement in respiratory therapy educational programs is related to the degree of matching between students and their instructors on the basis of learning/cognitive style or learning preference theory, then application of one or both of these approaches could have educational implications. Such information would be useful in evaluating current instructional practices and assessing

student achievement and the overall learning outcome in respiratory therapy educational programs (i.e., pass/fail rate on the national board examination).

Assumptions

The assumptions for this study were as follows:

1. The testing of the hypotheses relied on self-reported data and it was assumed that subjects answered all questions honestly. Systematic error caused by method bias, therefore, may have affected any relationships that were questioned.

2. It was assumed that the learning/cognitive style and learning preference inventories used in this study were appropriate for use with respiratory therapy personnel and were applicable to this sample.

3. It was assumed that the published validity and reliability data for the above inventories were correct.

4. It was assumed that, because of the study design, generalizations to all students in the programs represented could be made.

Definition of Terms

Allied health personnel are specially trained individuals representing a variety of health related professions who fulfill necessary functions, including those of assisting, facilitating, and complementing the work of physicians and other specialists in health care systems.

The American Association of Respiratory Care (AARC) is a national association of respiratory therapy personnel formed to encourage, develop, and provide educational programs for those persons interested in respiratory therapy and diagnostics; advance the science, technology, ethics, and art of respiratory care through institutes, meetings, lectures, publications, and other materials; facilitate cooperation and understanding among respiratory care personnel, allied health professions, hospitals, service companies, industry, government organizations, and other agencies interested in respiratory care; and provide education of the general public in pulmonary health promotion and disease prevention.

The American Medical Association (AMA) is a national association of medical practitioners and concerned individuals which functions to promote standards of medical and general health care. One function authorized to this national association is to evaluate and approve or disapprove graduate medical and undergraduate allied health care educational programs.

Certification/registration is the process by which states and professional bodies recognize the particular competence of individual practitioners.

A certified respiratory therapy technician (CRTT) is a graduate of an AMA accredited associate or bachelor of science degree respiratory therapy program who has

successfully written the CRTT examination provided by the National Board for Respiratory Care.

Degree of matching on the basis of learning/cognitive style and learning preference dimensions refers to the various degrees of matching between a student and his or her instructor which are recorded as a continuous variable based on the learning/cognitive style and learning preference dimension discrepancy scores (discrepancy score = student score on each dimension scale minus instructor score on each dimension scale, i.e., the smaller the discrepancy score, the better the match and vice versa).

Learning preference refers to the choice that an individual makes for one learning situation over another.

The learning preference dimensions, as posited by Rezler, refer to six dimension scales which describe an individual's learning preferences: individual, interpersonal, student-structured, teacher-structured, abstract, and concrete.

The Learning Preference Inventory (LPI) is an inventory developed by Rezler (1981) designed specifically to identify the learning preferences of allied health students. Results from the LPI may be used to match learner preferences with learning conditions. An individual's learning preferences are measured on six scales representing three bipolar dimensions: individual and interpersonal, student-structured and teacher-

structured, and abstract and concrete (see Figure 1-2 and Appendix B).

Learning/cognitive style is the manner in which an individual acquires, perceives, and processes information in the learning situation.

The learning/cognitive style dimensions, as posited by Kolb, refer to four dimension scales which describe an individual's learning/cognitive style: concrete experience, reflective observation, abstract conceptualization, active experimentation.

The Learning Style Inventory (LSI) is an inventory developed by Kolb (1985) to assess individual learning/cognitive styles and is derived from Experiential Learning Theory. The inventory measures an individual's relative emphasis on four learning abilities: concrete experience, reflective observation, abstract conceptualization, and active experimentation (see Figure 1-1 and Appendix A).

Learning/cognitive style type is determined on the basis of an individual's learning/cognitive style dimension scale scores. Each person's learning/cognitive style type is a combination of the four basic learning modes of learning/cognitive style dimensions. Four dominant learning/cognitive style types described by Kolb are seen as two-dimensional: Diverger (concrete and reflective), Assimilator (abstract and reflective),

Converger (abstract and active), and Accommodator (concrete and active) (see Figure 1-1).

Licensure is the process by which states authorize individuals to practice an otherwise restricted profession.

"Matched" and "mismatched" on the basis of learning/cognitive style types refer to either those students who are of the same learning/cognitive style type as their instructor and are thus classified as "matched," or those who are a different learning/cognitive style type than their instructor and are classified as "mismatched."

The National Board for Respiratory Care (NBRC) is the national certifying agency established by the AARC in charge of administering the CRTT examination to graduates of AMA accredited associate and bachelors in science degree respiratory care programs.

Respiratory therapy (occupational description) is an allied health specialty employed with medical direction in the treatment, management, control, diagnostic evaluation, and care of patients with deficiencies and abnormalities of the cardiopulmonary system.

CHAPTER 2
REVIEW OF THE LITERATURE

Introduction

The notion that people learn differently is not a new idea (Fizzell, 1984). Over 2,500 years ago, the ancient Hindus viewed people as active or passive and as emotional or thoughtful. Based on these characteristics, the Hindus speculated that individuals needed four ways of practicing religion that were congruent with their personality types--the four yogas or pathways--which are described in the Bhagavad Gita. In the early 1900s, psychologists in Germany were exploring the concept of cognitive style. Carl Jung's work on "psychological types" was described in 1921. Gordon Allport used the word "style" to refer to consistent patterns in individual behavior (Guild & Garger, 1985). Allport (1937) described attitude, interest, concept, and ideal as forms of mental organization that result in and affect learning. In the early 1940s, "concrete" and "abstract" styles of cognitive functioning were described by Goldstein and Scheerer (1941). Witkin and Asch (1948) postulated the bipolar characteristic of being dependent or independent of

structure when discriminating figures against a background relief as the manner in which individuals perceive and relate to the world. Thurstone (1948) and later Guilford (1959) recognized individual perceptual abilities and flexibility as important factors in the teaching-learning process.

In the 1920s Thorndike reported that a student's achievement was highly correlated with intelligence (Henson & Borthwick, 1984). Yet the conditions set for these studies were such that all students were given the same type of instruction and the same amount of time to learn. Years later, in 1963, John B. Carroll provided students with a variety of teaching approaches and as much time as they needed (Henson & Borthwick, 1984). The results were that students' aptitudes proved not to be a major factor in determining academic achievement. A major implication of Thorndike's and Carroll's data is that given sufficient time and correct teaching methods, most students can learn or master the material set before them and achieve at a high level (Henson & Borthwick, 1984). This approach to learning recognizes that individual learners have their own learning/cognitive style and preferences and that a responsible approach for teachers is to modify their teaching styles to accommodate students' learning/cognitive styles and preferences so as to promote academic achievement.

Learning/cognitive style is the manner in which an individual acquires, perceives, and processes information in the learning situation (Cahill & Madigan, 1984; Rezler & Rezmovick, 1981). Learning preference is the choice that an individual makes for one learning situation over another (Cahill & Madigan, 1984; Rezler & Rezmovick, 1981). Learning/cognitive styles and preferences are the result of personality characteristics that distinguish individuals in a teaching-learning situation. Such characteristics include a variety of attitudes and values individuals have about learning, how they think, and how they want information presented. One approach to individualizing instruction is to accommodate the learners' styles and preferences for various instructional methods. It is useful to determine whether learners with different styles prefer different instructional activities. Such information might be helpful in modifying instructional activities in order to optimize the teaching-learning environment. Within a course, for example, two or three options might be provided to accommodate different preferences.

Congruency between student and faculty learning/cognitive styles and preferences for methods of instruction are thought to improve the learning experience. Thus, the learning/cognitive styles and preferences of students appear to be relevant factors that

should be considered in the development of a curriculum. When there is a mismatch between the learning/cognitive styles or preferences of students and faculty, students are not sufficiently motivated and the necessary involvement in learning does not occur (Blagg, 1985).

Learning/Cognitive Styles

Learning/cognitive styles or thinking styles are information-processing regularities that are related to underlying personality traits (Corno & Snow, 1986; Messick, 1984). As Corno and Snow (1986) pointed out, learning/cognitive styles are conceptually at the overlap between individual differences in intellectual abilities and personality characteristics. When a person demonstrates a predisposition to favor a particular cognitive strategy while learning, then he or she is manifesting a learning/cognitive style. Because a cognitive strategy is defined as a pattern of information-processing activities that a person engages in when confronted with a learning task, then learning/cognitive style refers to cognitive strategies that one uses with some cross-situational consistency (Schmeck, 1986). A variety of learning/cognitive styles have been investigated (e.g., convergence-divergence and assimilation-accommodation, field independence-dependence, deep and surface processors, etc.).

Learning/cognitive style is the unique way each individual gathers and processes information, i.e., how an individual manipulates, categorizes, and evaluates input information (McKenny & Keen, 1974). Learning/cognitive style differs from ability or intelligence. One style is not presumed better than another. When using scores from intelligence tests, it is obviously preferable to have a higher score. This is not true with learning/cognitive style instruments. For example, a high score on a scale of "independent learning/cognitive style" is not presumed to be better than a high score on a scale of "dependent learning/cognitive style" (Fuhrmann & Jacobs, 1980).

The notion of learning/cognitive style attempts to integrate learning theory in such a way as to make it applicable to the educational process. Hilgard and Bower (1966) discussed the concept of learning/cognitive style and provided a means for integrating and differentiating the major learning theories, i.e., cognition, motivation, personality, and stimulus-response theories. Principles emphasized in cognitive theory that apply to the learning process include the following: (a) perceptual features, how the individual takes in information from the environment; (b) organization of knowledge for the learning situation; (c) learning with understanding (believed to be more permanent and more transferable than rote learning by formula); (d) cognitive feedback, needed

to confirm whether knowledge is correct and to correct faulty learning; (e) goal setting by the learner (important motivator for learning, with successes and failures determining future goals); and (f) divergent and convergent thinking (divergent thinking leads to inventive solutions to problems, while convergent thinking leads to logically correct answers).

Hilgard and Bower (1966) pointed out that from motivation and personality theory, these principles apply to the learning process: (a) learners' abilities are important and provisions must be made for differences in these abilities; (b) postnatal development may be as important as hereditary and congenital determiners of ability and interest, the learner must be understood in terms of the influences that have shaped the individual's development; (c) learning is culturally relative; (d) anxiety level may affect the learner's ability to learn; (e) the same situation may tap different motives for learning from one learner to another (situation dependent); (f) organization of motives and values within the learner are relevant to the learning situation; and (g) atmosphere of learning, whether by competition versus cooperation, authoritarianism versus democracy, or individual versus group identification--affects both learning satisfaction and the products of learning.

Concepts emphasized in stimulus-response theory, as explained by Hilgard and Bower (1966), that may be observed in the learning process follow: (a) active and passive learning environments, whereby the learner is an active doer rather than a passive listener; (b) repetition, whereby the learner needs repetition to acquire skill to a level that guarantees retention; (c) reinforcement, whereby the learner needs reinforcement to promote learning and retention; (d) practice, whereby practice is needed in a variety of situations in order to develop the ability to generalize and discriminate; (e) models, whereby the learner needs models to imitate; and (f) drive, whereby the intrinsic drive conditions of the learner are important for the learning.

Jung (1976) explored the differences in the way people perceive and process information. He defined four categories: (a) feelers, transfer value for themselves to what they experience; (b) thinkers, are more classically rational, they engage in direct thinking and arrange what happens and what they perceive into rational categories; (c) sensors, they perceive consciously, but beyond reason, and they apprehend the world by what they sense, see, know, feel, smell, and reason; and (d) intuitors, they are the reverse of sensors in that they unconsciously impose control on perceptions, and also understand what they see and feel in a whole and complete way.

Kolb, Rubin, and McIntyre's (1974) model of learning/cognitive styles (see Figure 1-1) is based on Experiential Learning Theory and is composed of four dimensions or abilities: (a) concrete experience (learning by feeling), (b) reflective observation (learning by watching and listening), (c) abstract conceptualization (learning by thinking), and (d) active experimentation (learning by doing).

Experiential Learning Theory provides a model that conceptualizes the learning process in such a way that allows users to identify differences among individual learning/cognitive styles and corresponding learning environments (Kolb, 1984). The model is founded on the Jungian concept of styles or types. The model's core is a simple description of the learning cycle, showing how experience is translated into concepts that, in turn, guide the choice of new experiences. In this model learning is conceived as a four-stage cycle. Immediate concrete experience forms the basis for observation and reflection. These observations are assimilated into concepts from which new implications for action can be deduced. These implications or hypotheses then serve as guides in creating new experiences which the learner can then test in more complex situations. The result is another concrete experience, but this time at a more complex level. Thus, the Experiential Learning Theory

model may be thought of as a "helix," with individuals having new experiences, reflecting on them, deducing generalizations about the experiences, and then using the experiences as guides to further action at higher levels of complexity (Claxton & Murrell, 1987).

The Experiential Learning Theory model may also be viewed as a means to distinguish between what Kolb describes as the two key elements in the learning process (Kolb, 1984). The first is acquiring or grasping information. Some people prefer acquiring information in concrete ways (e.g., relating to people), while others prefer abstract ways (e.g., logically sound concepts and theories). The second element is processing or transforming the information. Some people prefer to reflect on experiences (e.g., contemplation, evaluation, and judgment), while others transform experiences through active experimentation (e.g., practical, "hands-on," doing approach).

Kolb (1984) found that the four abilities described combine to form four learning/cognitive style clusters. Individuals who acquire information by relying on abstract conceptualization and then process it through active experimentation are classified as "convergers." They are called convergers because such individuals like to find specific, practical answers, and when presented with a task they move quickly (converge) to find an answer. They

are relatively unemotional and prefer dealing with things rather than people. "Assimilators" acquire information through abstract conceptualization and process it through reflective observation. Such individuals are called assimilators because they like to assimilate disparate pieces of information into a logical and integrated whole. They are more interested in theoretical concerns and have little interest in the practical application of ideas and concerns about people. Their primary strength is their ability to create conceptual and theoretical models. Individuals who like to acquire information through concrete experience and process it through reflective observation are classified as "divergers." These individuals are called divergers because they are good at generating ideas and brainstorming. Their major strength is their imaginative ability. Such individuals enjoy working with people and tend to be emotional. Divergers excel at examining concrete situations from many perspectives and at generating ideas. Finally, "accommodators" acquire information through concrete experience and process it through active experimentation. These individuals are called accommodators because they do well in situations where they must adapt to meet new experiences. These individuals are risk-takers, focus on doing things, and having new experiences. They are intuitive and often use a trial-and-error strategy when

solving problems. They are often impatient, and even pushy, when confronted with a theory that does not match the facts as they see them, whereby they tend to discard theory (see Figure 1-1).

Kolb (1984) found that specific learning/cognitive style types tend to gravitate to certain career fields. He asserted that occupational disciplines attract individuals with learning/cognitive styles congruent with the structure of knowledge within the discipline. Convergers typically have rather narrow interests and often specialize in careers in technology, e.g., engineering, medicine, computer science, and physical science. Assimilators are particularly good at research and planning activities and usually gravitate toward careers in science, e.g., teaching, mathematics, physical sciences, and biology. Because of their people orientation and ability to generate ideas, divergers enter careers in service organizations, e.g., social work, psychology, nursing, police, personnel management, and organization development. Accommodators like a "hands-on" approach and prefer action-oriented jobs such as careers in business and promotion, e.g., marketing, government, business, and retail.

These learning/cognitive style types suggest that certain classroom procedures will fit certain student types better than others (Baker & Marks, 1981; Baker,

Wallace, Bryans, & Klapthor, 1985; Carrier, Newell, & Lange, 1982; Wunderlich & Gjerde, 1978). Convergers probably would find laboratory experiments and problems that have specific answers satisfying learning experiences. Assimilators may make observations of concepts in naturalistic settings, watch role plays and simulations in class, and then generate concepts that describe and tie together what has occurred. Divergers may benefit more from discussion groups and working on group projects. Accommodators may prefer problem-solving activities and be good candidates to participate in classroom role plays and simulation.

Kolb (1985) developed the learning style inventory (LSI) (see Appendix A) to assess the four modes of learning defined in his model of learning/cognitive style. He suggested that the degree to which a person favors particular stages of the cycle, indicated the learning/cognitive style of that individual. Kolb's LSI has been used extensively as the preferred learning/cognitive style inventory for assessing the learning/cognitive styles for both medical and allied health personnel. The Kolb LSI has been examined as a predictor for medical students' specialty choices (Plovnick, 1975; Wunderlich & Gjerde, 1978) and has also been used to determine the instructional preferences of family practice physicians and internists (Leonard &

Harris, 1979; Sadler, Plovnick, & Snope, 1978; Whitney & Caplin, 1978), as well as describing the learning/cognitive styles of surgeons (Andrassy & Torma, 1982). Analyses of the learning/cognitive styles of anesthesiologists have been reported in several reports (Baker & Marks, 1981; Baker, Wallace, & Cooke, 1987; Baker, Wallace, Cooke, Alpert, & Ackerly, 1986; Eisenkraft, Reed, Eisenkraft, & Kaplin, 1985).

Highfield (1988) used the LSI to determine the learning/cognitive styles of baccalaureate nursing students. The assimilative style was the most dominant learning/cognitive style type (55%), while a divergent style (31%) was the second most frequently occurring type. In a related study using Kolb's LSI to determine the learning/cognitive style types of nursing students, Laschinger and Boss (1984) found that divergers were the most frequently occurring learning/cognitive style type. Hodges (1988) indicated that the highest percentages of a group of nursing students were divergers and accommodators. O'Kell (1988) used the LSI to identify the learning/cognitive styles of British nursing students. Results indicated that approximately 66% of the students had active learning/cognitive styles, characteristic of accommodators and convergers. In a study designed to assess the learning/cognitive styles of practicing nurses, Christensen, Lee, and Bugg (1979) identified accommodation

and divergence as the predominant styles. The Kolb LSI was used to determine the learning/cognitive styles of nonregistered baccalaureate nursing students and registered nurses enrolled in baccalaureate nursing programs (Merritt, 1983). Results indicated that mean score for reflective observation was significant for both groups, suggesting divergent and assimilative types. Thomas (1986) used the LSI to identify the learning/cognitive style types of nurse administrators as a means of assessing the nursing management team in one institution. The director, associate, and assistant directors of nursing who formed the top management group were mostly convergers with some assimilators. In contrast, the clinical coordinators were predominantly accommodators while the clinical specialists and educators were convergers, accommodators and divergers. In a study of dental hygiene students and dental hygiene faculty, Carrier, Newell, and Lange (1982) used Kolb's LSI to determine the relationship of learning/cognitive styles to preferences for instructional activities. The results indicated that most students and faculty were located in Kolb's accommodator and diverger categories. In a study of occupational therapy students, the LSI was used to examine the relationship between learning/cognitive styles and student performance in academic and in clinical course work (Cunningham & Trickey, 1983). Results showed no

significant correlation between the four learning/cognitive style types and academic course work.

McKenney and Keen (1974) developed a cognitive style model for the purpose of applying it to managerial processes. Problem-solving and decision making are conceptualized in the model. The authors "view problem-solving and decision making in terms of the processes through which individuals organize the information they perceive in their environment, bringing to bear habits and strategies of thinking" (p. 80). McKenney and Keen's model addresses itself specifically to information gathering and information evaluation. The information gathering dimensions refer to individuals who are predominantly perceptive or receptive. Perceptive individuals focus on relationships between items and look for deviations from or conformities with their expectations. Receptive thinkers are sensitive to the stimuli itself and focus on detail rather than relationships. They derive the attributes of the information from direct examination rather than from fitting it into their precepts. The information evaluation dimensions are related to problem-solving and are identified as systematic and intuitive. The systematic individual approaches a problem by structuring it into some logical procedure or method. Intuitive thinkers usually avoid committing themselves to a

formalized structure. They are more sensitive to cues and are willing to jump from one method to another and to discard information if the cues seem to indicate a change would be advantageous.

McKenney and Keen's cognitive style model provides some explanation of the ways individuals perceive and process information in their environment. From a managerial standpoint, the model describes a person's unique cognitive style regarding problem recognition and definition. The authors asserted that, ideally, the style of the manager should "match" with the environment: "There needs to be a fit between the decision maker's cognitive style and the information-processing constraints of his task. Given this fit, the manager is more likely to gather environmental information that leads to successful problem finding" (p. 82). As previously described, "matching" a person's innate style to the appropriate environment facilitates one to perform to his or her full capability.

Regarding learning/cognitive style, an approach was advanced by Pask (1976) who described two types of learners: holists and serialists. Holists learn a topic in a holistic manner or a global approach (seeking an overall understanding). Such learners use a broad framework of understanding into which they can fit more detailed information. Holists study a subject from the

"top down"; i.e., they examine parts of the topic at the higher levels of complexity and make connections between them. Serialists focus their attention more narrowly on pieces of information low in the hierarchial structure and learn in a step-by-step manner (attempting to fully understand each step before proceeding to the next). Such learners use links to relate different aspects of the subject, thus working in a "bottom up" approach so that the overall picture is developed slowly, thoroughly, and logically. The learning curve of the holist shows almost no increase for a period of time and then makes a steep incline as full understanding is achieved. The serialist or step-wise learner has a more gradual and steady increase in the learning curve. As each new understanding builds upon the previous one, the curve gradually rises to full understanding (Pask, 1976).

Witkin's (1977) dimensions of field-independence and field-dependence are also important information processing considerations. Individuals who are relatively uninfluenced by the surrounding environment or field are called "field-independent"; those who are heavily influenced by the surrounding field are called "field-dependent." Field-independent students perceive things clearly from the background, while field-dependents are influenced by the overall background and see parts of the field as "fused" (Keefe, 1986). The field-independent

learner tends to be highly analytic and systematic, while the field-dependent learner is more holistic in his or her approach to learning. Field-dependents are more strongly influenced by authority figures and by peer groups than are field-independents. Witkin (1976) posited that field-independent persons were encouraged at an early age to be autonomous. Thus, child-rearing experiences appear to be important factors causing individuals to be field-independent or field-dependent.

Witkin (1977) developed the Group Embedded Figures Test to identify field-independent and field-dependent information processing types. His research revealed that field-independent persons learned more if allowed to place their own structure on information, while field-dependent persons were dependent on the context in which the material was embedded to provide structure. Thus, a student who is field-independent may have a strong dislike for self-paced modules which allow little room for the learner to reorganize the ideas into his or her framework. As with most learning/cognitive style considerations, individuals who are field-independent are not better learners than those who are field-dependent, although each is more proficient at certain types of tasks.

Witkin (1976) described the concepts of field-independence and field-dependence as important factors in a student's selection of a major area of study, a course,

and a career. Field-independent students favored areas of study that called for analytic skills, such as mathematics, engineering, and science. Whereas field-dependent students favored subject areas that involved extensive interpersonal relations, such as social sciences, humanities, counseling, teaching, and sales. Among nursing students, for example, the more field-independent students chose surgical nursing, while the more field-dependent students chose psychiatric nursing (Witkin, 1976). Regarding careers in teaching, Witkin noted that teachers in the areas of mathematics and science were more likely to be field-independent. Field-independent teachers preferred the lecture method, while field-dependent teachers preferred discussion methods of teaching.

Hill (1976) developed a comprehensive approach to assessing the cognitive components of learning/cognitive styles known as cognitive mapping. This approach is based on the fact that individuals have certain preferences for the processes used to gather information, think and make inferences, and make decisions. The individual's learning/cognitive style includes the following categories: (a) gathering information refers to the sensory modalities that individuals prefer to use; (b) thinking and making inferences refers to how individuals process information; (c) decision making processes is the

extent to which individuals make decisions for themselves, rather than consulting others; and (d) interest in self, others, and objects. These four general categories are expanded into 27 specific cognitive characteristics in Hill's Cognitive Style Mapping Inventory. These aspects have been used to assess classroom procedures and courses compatible with a student's style.

Sims and Ehrhardt used Hill's cognitive style mapping approach on community college students and subsequently informed the students of their results (Claxton & Murrell, 1987). The students felt that their maps had given them helpful information on how they learned, helped them adapt to different teaching approaches, and many had actually changed the way they studied. Using Hill's cognitive style mapping, Fourier (1980) conducted a study to determine whether undergraduate students who were mapped and had their learning/cognitive style explained to them would achieve better grades. The results were that the students who had their learning/cognitive styles explained to them achieved significantly higher grades than students who were not aware of their learning/cognitive styles. Ehrhardt (1983) discussed the possibility of using Hill's cognitive style mapping approach as an aid to medical students experiencing difficulty to help them deal with their studies, and also an aid to the faculty by providing them with a way to counsel the students. In another

study, Flippo and Terrell (1984) applied Hill's cognitive style mapping to undergraduate students and subsequently informed each student of his or her learning/cognitive style type. The students indicated that knowledge of their learning/cognitive styles was useful to them in gaining greater skill in studying and college work in general.

In other studies of student learning/cognitive styles, Marton (1975) found two distinctive learning/cognitive style approaches: deep level and surface processing. The "deep level processing approach" may be characterized as an active search for meaning. For example, users of this learning/cognitive style approach start with the intention of understanding an article; they question the author's arguments and conclusions and try to relate them to previous knowledge and previous experience to enable them to appraise the validity of the author's conclusions. In contrast, users of the "surface level processing approach" try to memorize those parts of the article on which they think they might be questioned. They tend to focus on specific facts which may not be connected and they seem anxious about the conditions of the learning experience. The deep level processing approach was found to be associated with deeper understanding, and even after a five-week interval the users of this approach had better recall of detail than

those who use the surface approach (Marton & Saljo, 1976). Using GPA as an index of academic achievement in college students, Miller, Alway, and McKinley (1987) tried to identify the learning/cognitive styles associated with high academic performance. It was found that the deep processing style (which focuses differences and similarities among subjects, organization of information, and a critical analysis of relationships) and related strategies seem to be the most efficient learning styles in obtaining higher GPAs. An implication of this paper is that programs designed to improve academic achievement should address the relationships between learning/cognitive styles and achievement.

Schmeck (1983) defined a learning/cognitive style model as "a predisposition on the part of some students to adopt a particular learning strategy regardless of the specific demands of the learning task" (p. 233). Similar to Marton's classification, two learning/cognitive styles were identified in terms of how people process information: "deep elaborative" information processors and "shallow-reiterative" information processors. Deep-elaborative information processors spend more of their time thinking and less time repeating. They classify, contrast, analyze, and synthesize information from different sources. They elaborate by thinking of personal examples and restating information in their own words.

They draw upon the depth and breadth of their experiences. Shallow-reiterative information processors spend much of their study time repeating and memorizing information in its original form. They prefer to assimilate information as given rather than rewording, restating, or rethinking it (Schmeck, 1981). In terms of academic achievement, Schmeck (1981) reported that students who were deep-elaborative processors demonstrated faster learning, better memory, and higher grade point averages.

Lawrence (1986) posited that learning/cognitive style is one reflection of personality type. In describing the relationship of personality type and learning/cognitive style, he contended that the key element is the dominant mental process in each personality. Using Jungian theory, Myers (1962) developed an approach for identifying personality types. The Myers-Briggs Type Indicator (MBTI) identifies four matched sets of variables, or bipolar characteristics related to personality type identification, and is used to identify individuals according to 16 different personality types. An "extroversion/introversion" scale indicates the way in which an individual directs interest and attention, whether to the outer world of objects, people, and action or to the inner world of ideas, theorizing, and contemplation. A "sensing/intuitive" scale indicates an individual's preference for perceiving things, either

through input through sensory modalities or through intuition. A "thinking/feeling" dimension provides information as to whether an individual prefers to analyze and apply impersonal logic or prefers to be guided by personal values and feelings. Lastly, a "judging/perceptive" preference reflects one's attitude toward approaching the outer world. Those who demonstrate the judging component prefer to live in an organized, planned, orderly manner; those with a perceptive component prefer a more flexible, spontaneous, and open manner.

Lawrence (1986) described Myers's approach to personality identification as one that can be related to learning/cognitive style. If a student is "thinking" dominant, learning occurs best when activities are organized in a logical manner. In a "feeling" dominant type, a caring relationship with the instructor is essential to maintain motivation and achievement. "Sensing" dominant individuals learn best in environments where the subject matter is presented as practical and functional. Lacking imagination, such individuals may become lost if the instructor omits steps in his or her explanation. These students lack the ability to make conceptual leaps. For such students, concrete learning activities are most appropriate. "Intuitive" dominant individuals desire inspiration from the instructor more than other types. Such students enjoy learning through

new ideas, projects, and planning. "Extrovert" dominant individuals process information predominantly through "thinking" or "feeling," while "introvert" dominant personality types rely on "sensing" or "intuition" (Myers, 1962).

Lawrence (1982) reported that teachers of different Myers-Briggs types are attracted to different levels and different subject matter. Sensing teachers choose lower levels of education and are more likely to teach practical skills with facts and details, while intuitive teachers are more likely to be found in colleges and universities teaching courses rich in abstraction and theory. McCaulley and Natter (1980) stated that "in essence, teachers tend to understand and appreciate students whose minds are like their own" (p. 185).

Neurologic Basis of Learning/Cognitive Styles: Left and Right Brain Hemispheric Differences

The essence of how different people think and solve problems and how individuals differ regarding learning/cognitive styles as influenced by the left and right hemispheres of the brain is captured in Blakeslee's (1986) statement:

> One can have a "feel" for throwing a ball which involves many subtle, and intuitive corrections for movement of the receiver, wind, sloping terrain, etc. This is possible without any verbal or analytical knowledge of the equations or principles involved. On the other hand, the mathematician who programs gunnery computers may be an expert in the left brain knowledge of

> trajectory--yet have no "feel" whatsoever for throwing a ball. (p. 190).

The human brain is a composite of two interacting systems--the left and right hemispheres--each capable of it's own processing approach and mode of memory functioning (Sinatra, 1986). Investigations of brain function in normal people reveal that the two hemispheres may be differentiated on the basis of cognitive processing characteristics (see Table 2-1). The left hemisphere was determined to be inductive, sequential, detailed, and analytical in nature, storing and retrieving information in code such as numbers or words. While the right hemisphere was found to be deductive, observing whole concepts, filling in gaps and storing and retrieving information as images and pictures (Tipps, Sanders, & Languis, 1982). It is felt that the learning process cannot be accomplished by either side of the brain alone, but represents an integrated activity of both hemispheres. Levy (1986) described this style of information processing as "interhemispheric integration." Both hemispheres play critical roles in organizing the perceptual and cognitive processes that are prerequisite to understanding and learning (Levy, 1986). Zenhausern (1986) applied the term "neuroeducation" to that aspect of education that focuses on the interaction of brain behavior in the learning situation.

Table 2-1

Cognitive Characteristics of Left and Right Brain Hemispheres (Keefe, 1986)

Left Hemisphere
sequential processing style (organizes one fact after another)
inductive (going from the parts to the whole)
analytic, parts-specific thinking style and mode of problem solving
logical
reflective
verbal understanding of concepts
field-independent (perceives things clearly from a background field)
Right Hemisphere
parallel processing style (all facts conceptualized at once, as a whole)
deductive (going from the whole to the parts)
global or holistic mode of problem solving
emotional
impulsive
intuitive
nonverbal perceptual understanding (hunches or "feel" for something)
field-dependent (influenced by the overall organization of the background and sees parts of the field as "fused")

There is evidence that individual differences among people exist to the extent that one hemisphere is more differentially aroused or active in the learning situation (Zenhausern, 1986). Physiologic evidence supporting the notion of hemispheric dominance has revealed that people differ in the asymmetry of blood flow to the two sides of the brain, and that those having an asymmetric flow in favor of the right hemisphere perform better in learning situations favoring right hemispheric activities (Levy, 1986). Bradshaw and Nettleson (1981) differentiated the two hemispheres in terms of their respective processing styles: sequential for the left hemisphere (organizes one fact after another) and parallel for the right hemisphere (all facts conceptualized at once, as a whole). The learning/cognitive style of some students may favor sequential processing while parallel processing may be used more frequently by others (Zenhausern, 1986).

Along this line of thinking an indictment of our school system has arisen; the traditional approach to education is geared too much in favor of the left-brained, analytic, inductive learner (Blakeslee, 1986; Brennan, 1986; Levy, 1986; Sinatra, 1986; Zenhausern, 1986). Brennan (1986) noted that in any given classroom there are probably an approximately equal number of left-brained dominant and right-brained dominant students. "We present all parts of a given lesson and expect students to be able

to piece the puzzle together and 'get the picture'" (p. 212). Thus, it is not surprising that right-brained dominant learners fail to develop in such an educational environment. In order to improve the quality of education, consideration should be given to meet the learning predispositions and needs of all students. Hart (1978) stated that on the basis of neurologic studies, all students cannot be expected to learn in traditionally structured classrooms. In another report, Hart (1986) stated that "to expect that the brain is to be comfortable with typical schooling is absurd. We need brain-compatible schools that accept the brain as it is" (p. 199). It has been well established that people do not process information in the same way (Kolb, 1984). A goal of education based on learning/cognitive styles should therefore be to make the teaching strategies of the instructor compatible with the learning/cognitive styles of the students (Zenhausern, 1986).

Blakeslee (1986) pointed out a potential complication of employing an educational approach that attempts to match too closely the teaching strategies and educational environment to the learning/cognitive styles of the student. He contended the possibility of "one-sided development" of the brain using the learning/cognitive styles concept. He stated that

> because a student tends to favor a left- or right-brain approach does not mean that we

> develop only the favored approach. To do so is to reinforce habit. The ideal would be to develop both halves of the brain and their ability to work together. (p. 191)

Further, he posited that educators should not classify students as left-brain or right-brain types and then teach accordingly, for such an approach would allow the weaker mode of brain processing to atrophy--a grievous mistake. Sinatra (1986) contended that "the development of the diverse potential of both brain hemispheres is preferable to the development of one hemisphere" (p. 205). If one accepts this position, then it would seem that if one side of the brain was overlooked, the student may never realize his or her full potential.

Learning Preferences

Learning preference models have been an emerging area in the study of student learning. Investigators in this area have been interested in discovering the preferences that students have for study methods, instructional media, course format, general environmental and sociological learning preferences, and other dimensions of classroom-related learning. The instruments that have been developed to identify these learning preferences are grounded directly in the classroom experiences of the students. Many authors have described student learning preference models by inappropriately referring to them as "learning style" models. Such a designation is misleading

because these authors do not base their theoretical premises on discernable cognitive patterns of information acquisition and processing, but rather on preferred classroom-related learning activities. Thus, the scales on learning preference inventories refer to specific aspects of the classroom and do not have the general nature of the items found in Kolb's, Witkin's, or Hill's models for example.

A learning preference theory developed by Rezler and Rezmovick (1981) gives a specific classroom frame of reference to several learning preference dimensions. Their approach is based on six dimensions or three bipolar pairs of dimensions to register preferences for the following kinds of learning: (a) individual, (b) interpersonal, (c) student-structured, (d) teacher-structured, (e) abstract, and (f) concrete (see Figure 1-2).

Rezler and Rezmovick's learning preference theory is a potentially useful approach whereby health professions educators could identify the learning preferences of their students. Assessment of learning preferences would help to match students with learning conditions that they find rewarding. Health professions educators could also use information about student learning preferences to assign the same task under different conditions to different students. For example, the same problem solving task may

be addressed by some students individually and by others in small groups. By the same token, some students may be given complete freedom in selecting a task while others may prefer highly structured assignments given by the teacher.

The Learning Preference Inventory (LPI) was constructed specifically to measure the affinity for different modes of learning of allied health students (Rezler, 1983; Rezler & French, 1975) (see Appendix B). Rezler and French (1975) used the LPI to assess the learning preferences of students in six allied health professions (i.e., medical art, medical dietetics, medical laboratory sciences, medical record administration, occupational therapy, and physical therapy). The primary conclusion was that it is more important to identify individual differences within a health profession than to identify differences among the professions, if teachers wish to adjust their teaching styles to student preferences in learning. The majority of all six groups preferred to devote their attention to concrete tasks assigned by the teacher. In a related study using a learning preference inventory similar to that described by Rezler, Ostmoe (1984) evaluated the learning preferences of students in various allied health programs. It was found that most students preferred learning strategies which were traditional in nature, teacher-directed, and

highly organized with learning experiences of a concrete rather than an abstract nature. Ferrell (1978) investigated the learning preferences of adult learners returning to school to earn an associate degree in nursing. The findings were that the students preferred traditional strategies of drill, recitation, and lecture. Rogers and Hill (1980) administered Rezler's LPI to students enrolled in bachelor's and master's degree programs in occupational therapy and found that both groups of students preferred learning experiences that were teacher-structured, concrete, and interpersonal. In another study involving baccalaureate students in occupational therapy (Cahill & Madigan, 1984), the influence of curriculum format on the stability of learning preferences was examined. It was found that learning preferences (as identified by the LPI) remained stable over a prolonged period of time, even though the students were exposed to different modes of instruction. Barris, Kielhofner, and Bauer (1985) administered the LPI to undergraduate and graduate occupational therapy students and to undergraduate physical therapy students in order to assess the relationships between learning preferences, values, and student satisfaction. Although all three groups conformed to a profile of preferring teacher-structured, concrete, interpersonal learning, the graduate occupational therapy students appeared to give

greater emphasis to universal social values and to have a stronger preference for abstract learning than both groups of undergraduates. The results revealed that learning preferences of individual students should be considered when designing learning experiences in order to match teaching methods with learning preferences which may result in greater learning and retention.

Dunn and Dunn (1975) advocated matching various student learning preferences with appropriate teaching approaches. When students learned in ways that were natural to them, the outcomes usually were increased academic achievement, improved self-esteem, a liking for learning, improved basic skills, stimulated creativity, and gradually increased learner-independence. Conversely, when students were forced to adjust their learning preferences to whatever teaching approaches were used, learning was made more difficult. This caused frustration and a decrease in students' confidence in themselves. Dunn and Dunn devised a learning preferences model based on student preferences for environmental stimuli (sound, light, temperature, and classroom design); emotional stimuli (motivation, persistence, responsibility, and structure); sociological stimuli (prefers to work alone, with another peer, with a small group of peers, with the teacher or with another adult); and physical stimuli

(perceptual preferences, food intake, time of day, and mobility).

Canfield's (1980) model of learning preferences deals with learners' preferences in formal instructional situations for various aspects of the conditions under which learning takes place and some sensory system modes of learning. Four conditions of learning are seen as influencing individual responsiveness to the teaching-learning situation: (a) affiliation, a desire for friendly relations with peers and instructors; (b) structure, a desire for orderly and well-defined course structure and detailed information relative to requirements; (c) achievement, a desire for freedom to set one's own goals and work independently in a study situation; and (d) eminence, a desire for opportunities to compare one's performance with others, have order strictly maintained, and learn from a knowledgeable instructor. The four sensory modes of learning or learning preferences are defined as (a) listening, a desire to learn through hearing content presented; (b) reading, a desire to learn through examining print media; (c) iconics, a desire to learn through viewing content presented in media such as slides and films; and (d) direct experience, a desire to learn through handling content-related material or active participation in exercises.

Llorens and Adams (1976) used Canfield's model on undergraduate and graduate occupational therapy students and showed that students preferred teaching conditions that permitted more personal relationships with instructors. In addition to having opportunities to set their own objectives and to work alone and independently, the students showed a high preference for working with people and for direct experience in their learning modes.

Using Canfield's model, Ommen, Brainard, and Canfield (1979) compared the learning preferences of older (greater than or equal to 28 years of age) and younger (less than or equal to 23 years of age) college students. Older students preferred traditional instructional formats (listening, reading, organized and detailed materials, and less independence), while younger students preferred iconics and direct experience as learning modes.

Grasha and Riechmann (1974) developed a social-interaction approach to learning preferences based on how students interact with their instructor, other students, and the methods of instruction used. Six types of students were identified: (a) competitive, exhibited by students who learn material in order to perform better in the class, such individuals feel they must compete with other students in class for rewards, they regard the classroom as strictly a win-lose situation in which they must win; (b) collaborative, typified by students who feel

they can learn the most by sharing ideas and talents with others, they cooperate with teachers and peers, such students see the classroom as a place for learning and for interacting with others; (c) avoidant, demonstrated by students who are not interested in learning course content in the traditional classroom, they do not participate with students and teachers in the classroom, (d) participant, manifested by students who want to learn course content and like to go to class, they assume responsibility for learning from classroom activities, such students participate with others when told to do so; (e) dependent, manifested by students who show little intellectual curiosity and who learn only what is required, they see the teacher and peers as sources of structure and support, these students look for authority figures for guidelines, and want to be told what to do; and (f) independent, exhibited by students who like to think for themselves, they prefer to work on their own but will listen to the ideas of others in the classroom, such people learn the content they feel is important and are confident in their learning abilities. Most individuals are seen as having a learning preference profile composed of all roles with some used more often than others.

Subsequently, Riechmann and Grasha (1974) determined classroom activity learning preferences for teaching methods for each student type. Competitive students were

comfortable with a variety of teaching methods, so long as the focus is instructor-centered rather than student-centered. These types of students enjoyed serving as group leaders in classroom projects and discussions. Collaborative students preferred lectures with class discussion in small groups. Avoidant students were generally negative about any classroom activities. Such students preferred self-evaluation and did not like enthusiastic instructors. Participant students preferred lectures with discussions and enjoyed instructors who could analyze and synthesize material well. Dependent students preferred the instructor to outline all assignments and always use instructor-centered classroom methods. Independent students preferred self-paced instruction, assignments that gave them a chance to think for themselves, and a student-centered rather than an instructor-centered classroom setting.

Eison and Moore (1980), using Grasha and Riechmann's model, asked the question whether the learning preferences of traditional college age students (18 to 22 years of age) differed from those of adult students. It was found that younger students were more likely to experience greater tension and anxiety than older students. Adult students were more likely to be oriented toward the pursuit of knowledge than for course grades. Further, traditional age students were more of the avoidant

(uninterested or overwhelmed by what goes on around them) and competitive types (view the classroom as a win-lose situation, in which they must always win). These students generally had lower levels of interest in the course and decreased interest in getting the most out of class. In contrast, adult students scored higher on the participant scale and indicated that they wanted to participate as much as possible in classroom activities. In terms of learning activities, traditional age students preferred short and frequently administered quizzes drawn from clearly specified study questions, graded assignments, and extra credit activities. Adult students were less concerned with the instructor's testing policy, enjoyed less structured learning opportunities, and worried less about grades.

Milton, Polio, and Eison (1986) identified learning preferences in terms of students' attitudes toward learning and grading and devised a typology consisting of four student types: (a) high learning orientation/high grade orientation, such students are highly motivated both to learn and to achieve high grades, e.g., pre-medicine and pre-law students; (b) high learning orientation/low grade orientation, these students are interested in educational enrichment and personal growth; (c) low learning orientation/high grade orientation, the primary interest of these students is to achieve a good grade; and

(d) low learning orientation/low grade orientation, such students attend college to have a good time or to avoid getting a job.

Friedman and Stritter (1981) developed a learning preference inventory focusing entirely on preferences for various types of instructional processes. The Instructional Preference Questionnaire is a 57-item instrument on which students are asked to agree or disagree with certain items or to indicate how beneficial they would be to their learning. Five primary dimensions are measured by the instrument: (a) involvement in determining course content, (b) preferred instructional media, (c) formal course structure, (d) discovery learning, and (e) reality testing.

Gregorc (1979) developed a four-scale dimensional model to determine preferences for learning approaches: concrete sequential, concrete random, abstract sequential, and abstract random. The concrete sequential learning preference is characterized by a finely turned ability to derive information through direct, hands-on experience. These students exhibit a high level of sensory sensitivity, they prefer touchable concrete materials in the classroom and specific step-by-step directions. Such individuals prefer order and logical sequence in the presentation of material. These students prefer workbooks, demonstration teaching, programmed instruction,

and well-organized field trips. The concrete random learning preference is characterized by an experimental trial-and-error attitude in which the individual demonstrates an uncanny ability to make intuitive leaps in exploring unstructured problem-solving experiences. These students do not prefer step-by-step learning methods that deny them opportunities to find their own way. Such individuals work well independently or in small groups and prefer games, simulations, independent study projects, and problem-solving activities. The abstract sequential learning preference exhibits excellent decoding abilities in the areas of written, verbal, and image symbols. These types of learners tend to think abstractly and use conceptual "pictures" as they learn. They prefer to learn through reading and listening and desire orderly, rational presentations. The abstract random learning preference is distinguishable by the attention given human behavior and an extraordinary ability to sense and interpret "vibrations." This type of student is "tuned" to nuances of mood and atmosphere. This type of learner associates the medium with the message in that the speaker's manner of presentation and personality is closely tied to the message being delivered. Thus, these students globally evaluate the learning experience. Such students prefer to learn in an unstructured manner and like group

discussions, question-and-answer sessions, movies, and television (Gregorc & Ward, 1977).

Fuhrmann and Jacobs (1980) developed a model that discriminates three classroom learning preference styles: (a) dependent style refers to the learner's needs for structure, direction, external reinforcement, and encouragement; (b) collaborative style refers to the learner's needs for interaction, practice, probing self and others, observation, participation, peer challenge, peer esteem, and experimentation; and (c) independent style refers to the learner's needs for internal awareness, experimentation, time, and nonjudgmental support. In a situation where students have little or no prior experience, a dependent learning preference style is appropriate. In a course or curriculum that emphasizes group problem solving, a collaborative style is suitable. Students with an independent style may opt for courses where options are available to choose independent means of accomplishing learning objectives. Fuhrmann and Jacobs (1980) stated that individuals learn in all three styles but may prefer a particular style in a given situation, based on personal preferences and the unique characteristics of the subject to be learned or the activity in which to be engaged. In this model, no one style is better than another, although one may be more

appropriate for a given individual or in a given situation.

In addition to describing the learner's needs, Fuhrmann and Jacobs described the instructor's role and the appropriate teaching behavior for each learning preference style (Fuhrmann & Grasha, 1983). For the dependent style learner, the instructor's role is one of expert and the teaching behavior is lecturing, demonstrating, and assigning. For the collaborative style learner the instructor's role is co-learner, environment-setter, and one of participation and the teaching behavior is interacting, questioning, providing resources, modeling, providing feedback, coordinating, evaluating, and managing. Regarding the independent style learner, the instructor's role includes internal awareness and nonjudgmental support and the teaching behavior includes allowing, providing requested feedback, providing resources, consulting, negotiating, and evaluating.

Congruency--Student and Faculty Learning/Cognitive Styles and Preferences

Greater learning appears to result when teaching styles of the faculty are congruent with the learning/cognitive styles and preferences of the students (Eisenkraft, Reed, Eisenkraft, & Kaplin, 1985). Cafferty (1981), using Hill's cognitive style mapping approach, reported a higher GPA for students who were more closely

matched to the learning/cognitive styles of their instructors. Conversely, the greater the dissonance between the two, the lower the GPA. In another study using Hill's cognitive style matching approach, Terrell (1976) found that students whose learning/cognitive style matched the instructional mode tended to achieve higher grades and experienced greater reduction in anxiety than nonmatched students. Fiske (1981) described how "teachers adjusted schooling to fit the students "individuality" by responding to students' learning/cognitive styles. Using this approach, significant gains in reading scores and other traditional measures of academic performance resulted. Others demonstrated that when faculty and students had similar learning/cognitive styles and preferences, the faculty were more attuned to the needs of the students and greater learning resulted (Carrier, Newell, & Lange, 1982). Deep (1988) indicated that when there is a mismatch between the teaching style used and the learning/cognitive styles and learning preferences of students, the result is a loss of motivation (less study/homework time) and a failure to achieve (GPA). Baker, Wallace, Cooke, Alpert, and Ackerly (1986), using Kolb's model, reported that resident physicians (anesthesiologists) enrolled in a formal postdoctoral training program scored higher in clinical skills and knowledge when matched with faculty members of the same

learning/cognitive style type. Hunt (1975) and Witkin (1977), using Witkin's model, indicated that greater learning took place when the learner was matched with the appropriate process, and that time needed for learning was reduced. Witkin (1976) noted that when students and teachers were matched and mismatched in terms of field-dependence and field-independence, the matched students described each other positively, and the mismatched subjects described each other negatively. When the teachers described their students' abilities, they placed greater value on the attributes of students who were like themselves. Similarly, the students felt more positively about the teachers who were like themselves in terms of learning/cognitive styles. Douglass (1979) identified students who favored inductive or field-independent (left hemisphere) and deductive or field-dependent (right hemisphere) processing styles and then matched and mismatched instruction accordingly. When inductive students used inductive materials and when deductive students used deductive materials, achievement increased; when the students and the resources were mismatched, lower academic achievement was realized. Pask (1976) showed that by assessing students' learning/cognitive styles with a learning/cognitive styles inventory and providing complementary materials, that individuals learned more quickly and thoroughly and retained information much

longer. Conversely, when mismatched, learning time was increased and thoroughness and retention decreased. Sadler, Plovnick, and Snope (1978), using Kolb's model, noted that the faculty at one institution had an abstract, more reflective learning/cognitive style while the students preferred learning situations which offered concrete examples and active participation in the learning process. Role-playing, simulation, participation in the clinical area, and learning exercises which place students in positions of active learning appeared to be preferable to the more passive and abstract features of lectures and literature reviews.

The research on learning preference models reveals that matching instructional methods and the learning environment to students' learning preferences leads to improved learning. Rezler and French (1975) posited that students may be more motivated to study (hours study/homework time) and achieve at higher levels (GPA) if given as much opportunity to learn according to their own learning preferences. Evidence has shown that students who appear to be admirably suited to function in a health related field can be deprived of personal and professional fulfillment because the manner in which they are taught and tested is incompatible with their most effective manner of functioning (Rezler & French, 1975). Adams (1983), using Canfield's model, showed that, for a large

group of community college students, those well matched with their instructors on the basis of learning preferences received higher GPAs and fewer lower grades. Ware and Williams (1975) examined the learning preferences of podiatry students and found that higher achievement (GPA) and more satisfaction resulted when instructional methods matched their learning preferences. Pizzo (1981), using Dunn's model, indicated that when students were matched with their learning preferences (their need for either sound or quiet preferences), significantly higher reading and attitude scores resulted, and students who were mismatched achieved significantly below the matched students. Domino (1971), using Dunn's model, demonstrated that when college students were taught in ways they preferred, they scored higher on tests, fact knowledge, attitude, and efficiency than those taught in a manner dissonant from their preferred ways of learning. In a related study, Dunn (1983) noted that academic achievement increased when students took their most difficult courses and study during their preferred time of day. Statistically significant differences in achievement resulted whenever students were taught in ways that complimented their learning preference (Dunn, 1983). Murrain (1983), using Dunn's model, reported that students performed better in a classroom environment that matched their thermal preferences. Dunn, Krimsky, Murray, and

Quinn (1985), using Dunn's model, reported on the validity of students' illumination preferences in the classroom and academic achievement. In this experimental investigation, the effects of matching and mismatching students with their learning preferences for lighting were examined. Results revealed that predispositions for illumination significantly affected the reading achievement of students for whom light was an important learning preference variable.

Using Grasha and Riechmann's model, Andrews (1981) studied the interrelationship of teaching methods, learning preferences, and learning outcomes. College level students in a course were randomly assigned two types of instruction: instructor-centered (the instructor provided mini-lectures, answered questions, worked problems, and questioned students, i.e., the instructor provided a central role in guiding the class), and peer-centered (the instructor served more as a facilitator and a resource, emphasizing student responsibility for presentations and student-to-student teaching). The results were that collaboratively-oriented students learned better using the peer-centered approach, while competitive individuals learned better using the instructor-centered type of instruction. Thus, students learned best and benefited more from classroom methods that closely matched their learning preferences.

Summary

Exhortations to meet the needs of individual learners are commonplace in the educational literature. Evidence reveals that when the learning/cognitive styles and preferences of students and their instructors were matched, greater learning tended to occur and when they were mismatched, students appeared to be at a disadvantage. These studies demonstrated also that for the teaching-learning process to be successful, faculty should be sensitive to the needs of students with different levels of experience and different learning/cognitive styles and preferences.

Students have different learning predispositions, needs, experiences, and abilities. If the educational process is to be successful in helping each student to achieve the maximum possible growth, educators must first recognize individual differences. Specific knowledge of each student is necessary to both individualize and diversify instruction. This knowledge should be available and understandable to both the educator and the student, and should increase the student's awareness of himself or herself as a learner as well as the teacher's awareness of individual similarities and differences among students. The interactions between the teacher and the student are of critical importance, i.e., different kinds of teacher

behavior and instructional methods influence the learning and academic achievement of students.

CHAPTER 3
METHODOLOGY

The purpose of the study was to determine whether a relationship existed between achievement and the degree of matching between students and their instructors based on learning/cognitive style theory or learning preference theory, and whether one of these learning theories was better in predicting student achievement. A relationship among these factors may have implications regarding the low pass rate on the national board examination for graduates of respiratory therapy programs.

This investigation was descriptive, correlational, and ex post facto in design. Descriptive research studies are designed to obtain information concerning the current status of phenomena. Such studies are directed toward determining the nature of a situation as it exists at the time of the study. Correlational studies provide information on the presence and strength of a relation between variables. The ex post facto study starts with groups that are different and tries to determine the antecedents of these differences. Possible cause-and-effect relationships are investigated by observing some

existing consequences and searching back through data for plausible causal factors (Ary, Jacobs, & Razavieh, 1985).

Instrumentation

Kolb's learning/cognitive style inventory (LSI) (Kolb, 1985) was used to identify the learning/cognitive styles of all subjects in the study. This learning/cognitive style inventory was chosen for this study because it has been used extensively for assessing the learning/cognitive styles of medical and allied health personnel (see Appendix A). Kolb's research has revealed four distinct learning/cognitive style types which are labeled as divergers, assimilators, convergers, and accommodators (see Figure 1-1). The LSI is a self-report instrument that can be administered in approximately 5 to 10 minutes. The instrument contains 12 items, each consisting of four words. The respondent is asked to rank order the words according to how well each characterizes his or her learning/cognitive style. One word in each item represents one of the four learning/cognitive style dimensions, i.e., concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation (AE). The LSI was designed to measure the individual's relative emphasis on the four learning/cognitive style dimensions (score range per dimension is 12 to 48) and on two combinations scores that indicate the extent to which the individual emphasizes

abstractness over concreteness (AC - CE) and the extent to which the individual emphasizes action over reflection (AE - RO). The combination scores are then used to determine one's learning/cognitive style type.

Reliability and validity data on the LSI have been determined. Reliability of the four basic scales and the two combination scores all show very good internal reliability as measured by Cronbach's alpha. Reliability coefficients for the scale scores range from .73 to .83, and for the two combination scores, .81 (AE - RO) and .88 (AC - CE) (Kolb, 1985). Acceptable levels of construct and concurrent validities of the LSI have been assessed by studying the relationship between learning/cognitive style and several variables including age, educational level, scores on creativity tests, general aptitude tests, personality tests, preferences for types of learning situations, academic specialization, undergraduate interests, and career choices (Leonard & Harris, 1979).

The Learning Preference Inventory (LPI) devised by Rezler and French (1975) was selected as the instrument for measuring learning preferences because it was constructed with the specific learning requirements of the allied health fields in mind (Rezler, 1983). The LPI is a self-report instrument that can be administered in about 10 minutes and requires the respondent to rank order specific items (see Appendix B). It was designed to

assess an individual's choice for methods of instruction on six dimensions (or three bipolar pairs of dimensions) of learning preferences: individual and interpersonal, student-structured and teacher-structured, and abstract and concrete (score range per dimension is 15 to 90).

Reliability and validity data for the LPI have been performed. Internal consistency reliabilities for the six scales range from .72 to .88. The six scales of the LPI have been supported by factor analysis, thus establishing content validity. Construct validity has been demonstrated in studies with allied health and pharmacy students (Rezler & Rezmovick, 1981).

Finally, an achievement test was devised to assess the level of student achievement for a major course in respiratory therapy theory. The theory and operation of mechanical life-support ventilators was the subject matter of the test. (This subject area constitutes a major section of the respiratory therapy board examination.) The test consisted of 40 multiple-choice items with five possible choices per item (see Appendix C).

Content validity for the achievement was assessed by a group of experts, i.e., two physicians (medical directors of the respiratory therapy departments at two university hospitals) and three faculty members of a community college respiratory therapy program. This group agreed that the achievement test represented the content

of interest and was content valid for a course on mechanical life-support ventilators. Test reliability was determined using the Kuder-Richardson 20 method on a group of respiratory therapists who were recent graduates of accredited respiratory therapy programs; the reliability coefficient was .74.

Pilot Study

A pilot study at a community college respiratory therapy program (Santa Fe Community College, Gainesville, Florida) was conducted, in 1988, to assess the relationship between student achievement and the degree of matching of students and their instructor based on Kolb's learning/cognitive style theory and Rezler's learning preference theory. Whether learning/cognitive style and/or learning preference variables could be used to predict academic achievement through multiple regression techniques was also determined.

The course instructor and participating students (N = 17) of a major course in respiratory therapy (theory and operation of mechanical life-support ventilators) completed the LSI and LPI instruments; the students also completed the aforementioned achievement test at the end of the course. For all subjects, the learning/cognitive style and learning preference dimension scores, as well as the learning/cognitive style types, were determined. The discrepancy scores for each student were calculated for

all learning/cognitive style and learning preference dimension scales. The achievement tests were scored and the student's overall college GPA and number of hours of homework per week devoted to the course on mechanical life-support ventilators were obtained. Data were analyzed using multiple regression and an unpaired *t*-test. Alpha level was set at .05 for all tests of significance.

Two multiple regression models were evaluated: one model used the four learning/cognitive style dimension discrepancy scores; the other model used the six learning preference dimension discrepancy scores as variables. Both models used the variables college GPA and the number of hours homework per week for the course. The learning/cognitive styles regression model was significant ($p < .01$), while the learning preferences regression model was not significant. Inspection of the beta coefficients that were significant for the learning/cognitive style and learning preference dimension discrepancy scores in both regression models indicated relationships between student achievement and the degree of matching between the students and their instructor. (The <u>lower</u> the dimension discrepancy score between the student and the instructor, the better the degree of matching.) Thus, the more negative the beta coefficient between student achievement (Y axis) and a dimension discrepancy score (X axis), the better the relationship between student achievement and

the degree of matching between the students and the instructor.) The beta coefficients for the "active experimentation" and "abstract conceptualization" dimensions in the learning/cognitive styles regression model were -1 ($p < .01$) and -.35 respectively.

The relationship between the predicted and actual levels of student achievement was calculated using the learning/cognitive styles regression model. When the predicted and actual values for student achievement were regressed the relationship was positive and highly significant ($r = .87$, $p < .0001$).

Regarding the learning/cognitive style types, the course instructor as well as six students were the "diverger" type (an individual who acquires new information in a concrete manner and processes it by observation and reflection). The remainder of the students were of the "accommodator" ($N = 2$), "assimilator" ($N = 3$), and "converger" ($N = 6$) learning/cognitive style types. Those students who were the same, or of a different learning/cognitive type from the instructor were labeled "matched" and "mismatched" respectively. The achievement scores for students in the "matched" and "mismatched" groups were compared (unpaired t-test). Students who were the same learning/cognitive style type as their instructor scored significantly higher (87.3 $\pm$

4.3) than those who were of a different learning/cognitive style type from their instructor (80.3 $\pm$ 7.3) ($p < .048$).

The results can be viewed as suggesting that students having similar learning/cognitive styles as their instructor learned more and performed better on tests than students having dissimilar learning/cognitive styles as their instructors. Moreover, the greater the degree of matching between students and their instructors on the basis of Kolb's learning/cognitive style theory, the greater student achievement. Specifically, the greater the degree of matching for the active experimentation learning/cognitive style dimension, the greater was the level of achievement. From these data it may be inferred that students may not achieve or develop to their full potential when taught in ways that are different from the manner in which they innately perceive and process information (i.e., learning/cognitive style). Based on the results of the pilot study, it was deemed appropriate that a study utilizing a larger sample size be conducted.

Subjects and Study Design

Subjects for this study included students and their instructors from associate and baccalaureate degree respiratory therapy programs in the United States (accessible population). A sample size of 115 students was required to achieve a 95% confidence interval. This

sample size was calculated using the method described by Marks (1982).

Over 250 respiratory therapy programs based in community colleges and universities operated in the United States at the time of this study. In order to obtain the calculated sample size, 11 institutions (cluster sampling) from various regions of the country participated in the study. These 11 institutions were the following:

1. Macomb Community College, Michigan
2. Washtenaw Community College, Michigan
3. Mayo Clinic, Minnesota
4. Jefferson Community College, Kentucky
5. Santa Fe Community College, Florida
6. Valencia Community College, Florida
7. Miami-Dade Community College, Florida
8. Tallahassee Community College, Florida
9. Louisiana State University Medical Center, (Shreveport and New Orleans campuses), Louisiana
10. Loma Linda University, California
11. Pueblo Community College, Colorado

In each program, students in their final year of study and their instructor from a major course in respiratory therapy theory answered the LSI and LPI instruments. (Final year students were selected since at that stage of the curriculum they were enrolled in major courses in respiratory therapy theory.) A major course in

respiratory therapy (i.e., the theory and operation of mechnical life-support ventilators) that was common to all programs was selected and an achievement test specific to that subject matter was prepared. At the end of the course, students in all programs answered the multiple-choice achievement test.

Collection of Data

All data were collected in the Fall semester of 1988 and Spring semester of 1989. Near the end of the semesters, the LSI, LPI, and achievement test forms were mailed to the directors of all programs. (Prior approval to use the LSI and LPI in this study was obtained from the authors of the instruments.) A letter explaining the purpose of the study and guaranteeing anonymity to all subjects participating in the study was included (see Appendix D). The director of each program distributed the LSI and LPI inventories to all final year students and their instructor for the major course in respiratory therapy theory and then collected these materials when completed. The program director also distributed the aforementioned achievement test to the students and collected the tests when completed. The directors then returned all completed materials to the investigator for collation and analysis. A data base was developed using the results from the learning/cognitive styles and learning preferences inventories and the achievement test.

CHAPTER 4
RESULTS

Population

Directors of 13 respiratory therapy programs in the United States were contacted and 11 respondents agreed to participate for an overall response rate of 84%. The study population consisted of 143 students and their instructors (one instructor per program). There were 84 males and 59 females in the study. The majority of the students were white (78.3%), while black, hispanic, and oriental students comprised the remainder of the study population (see Table 4-1). Student ages ranged from 18 to 42 years, with a mean age of 24.5. Traditional college age students (18-22 years) represented 30.8% of the population; 35% were between 23 and 27 years, while the remaining 34.2% were 28 years of age or older (see Table 4-1).

Analysis of Data

All data were analyzed using the data analysis software SAS (SAS Institute, 1985). Multiple regression was performed to analyze the data unless indicated

otherwise. Step-wise regression was performed to determine the best prediction model.

Table 4-1

Student Demographic Data

Category	Count	Percent
Gender		
Male	84	58.7
Female	59	41.3
Race		
White	112	78.3
Black	16	11.2
Hispanic	12	8.4
Oriental	3	2.1
Age		
18-22 years	44	30.8
23-27 years	50	35.0
28-32 years	32	22.4
33-37 years	11	7.6
38-42 years	6	4.2

(Mean age $\pm$ 1 standard deviation was 24.5 $\pm$ 4.3)

From the data base, all hypotheses were tested.

Hypothesis 1. There is no significant relationship between the actual level of student achievement and the predicted level of achievement as a function of the weighted linear combination of GPA, number of hours of homework per week, program, and the concrete experience, reflective observation, abstract conceptualization, and active experimentation learning/cognitive style dimension scores.

This was a test to determine if there was a relationship between the actual level of student achievement (Y) and the predicted level of student achievement based on the learning/cognitive styles (Y'L/CS) multiple regression model. (Using SAS and the General Linear Model procedure, this hypothesis was tested using the *F*-test for the multiple regression model. The *F*-test for the hypothesis was that $R^2 = 0$.) The following variables constituted the learning/cognitive styles multiple regression model:

Y'L/CS = B_1 (GPA) + B_2 (Number of hours homework per week for the course) + B_3 (Program) + B_4 (Concrete experience discrepancy score) + B_5 (Reflective observation discrepancy score) + B_6 (Abstract conceptualization discrepancy score) + B_7 (Active experimentation discrepancy score)

In addition to the learning/cognitive style variables, other variables examined in this study were college GPA and the number of hours of homework per week. College GPA is frequently selected as an index and predictor of student achievement. The number of hours of homework per week was chosen as an assessment of motivation in a course. It was contended that the more enjoyable the student found the teaching-learning environment, the greater the motivation to study the subject matter in the course. There may have been other intervening variables affecting student achievement in addition to the degree of matching between students and their instructors based on learning/cognitive styles or learning preferences, e.g., IQ, level of cognitive development on entering the program, motivational factors, personal study habits, previous experience, and the type of respiratory therapy degree program (e.g., more emphasis on theory than practice). These variables were not evaluated because the purpose of this study was to focus on select variables in the teaching-learning process, i.e., student and instructor learning/cognitive styles and learning preferences. Regarding the variable "program," because 11 respiratory therapy programs were involved in the study, the programs were coded as a dummy variable in the model.

Using this model, the correlation (r) for the actual and the predicted levels of student achievement was determined. Based on results from this analysis, decisions were made to either accept or reject the null (Ho) hypothesis (Ho: r Y Y'L/CS = 0).

There was a significant relationship between the actual level and the predicted level of student achievement based on the learning/cognitive styles multiple regression model (F = 30.5, p < .0001). The coefficient of multiple correlation (R) for the model was .897; the model explained 80.5% of the variance (R^2) in predicting student achievement (see Table 4-2). Four of the seven regressors in the model were highly significant (p < .0001): GPA, program, and the student-instructor discrepancy scores for the abstract conceptualization and active experimentation dimensions. The learning/cognitive styles regression equation was:

Y'L/CS = 61.6 + (10.8) GPA + (.49) Number of hours homework per week for the course) + (-1) Program + (.03) Concrete experience discrepancy score + (-.02) Reflective observation discrepancy score + (-.76) Abstract conceptualization discrepancy score + (-.67) Active experimentation discrepancy score

Based on these findings, hypothesis 1 was therefore rejected (r Y Y'L/CS ≠ 0).

Table 4-2

Multiple Regression of Learning/Cognitive Styles Model (Reduced Model--Omitting Learning Preference Dimensions)

Sources of Variation	Sums of Squares	Degrees of Freedom	Mean Squares	F Value	Level of Significance	R^2
Model	39648.60	17	2332.30	30.50	< .0001	.805
Error	9558.17	125	76.46			
Corrected Total	49206.80	142				
GPA	2114.70	1	2114.70	27.60	< .0001	
Homework	112.30	1	112.30	1.47	.22	
Program	3442.40	11	322.00	4.21	< .0001	
C.E.	1.24	1	1.24	0.02	.89	
A.C.	2809.30	1	2809.30	36.70	< .0001	
R.O.	11.36	1	11.36	0.15	0.7	
A.E.	1246.80	1	1246.80	16.30	< .0001	

Hypothesis 2. There is no significant relationship between student achievement and the student-instructor discrepancy score (degree of matching between student and instructor) on any of the four learning/cognitive style dimensions.

This was a test of whether there was a relationship between student achievement and the individual learning/cognitive style dimension discrepancy scores. By examining the beta (B) coefficients for the concrete experience (B_4), reflective observation (B_5), abstract conceptualization (B_6), and active experimentation (B_7) variables in the learning/cognitive styles multiple regression model, student achievement based on the degree of matching between students and their instructors for each learning/cognitive style dimension was assessed. For example, if a beta coefficient for a particular learning/cognitive style dimension and student achievement was negative and significant, then for that dimension a greater degree of matching was associated with a greater level of student achievement. Based on these data, decisions were made to either accept or reject this hypothesis (Ho: B_4, B_5, B_6, $B_7 = 0$).

There was a significant relationship between achievement and the student-instructor learning/cognitive style discrepancy scores for abstract conceptualization and active experimentation, while the scores for concrete

experience and reflective observation were not significant. The beta coefficients for the student-instructor discrepancy scores for abstract conceptualization and active experimentation were -.76 and -.67 respectively (see Table 4-3). Thus, the greater the degree of matching between students and their instructors on the basis of these two dimensions, the greater the students' achievement. Conversely, the greater the degree of mismatching between students and their instructors on the basis of abstract conceptualization and active experimentation, the lower the students' achievement scores (see Figures 4-1 and 4-2). Hypothesis 2 was therefore rejected for the learning/cognitive style dimensions of abstract conceptualization (B_6) and active experimentation (B_7) and retained for concrete experience (B_4) and reflective observation (B_5), i.e., B_6, $B_7 \neq 0$ and B_4, $B_5 = 0$.

Hypothesis 3. There are no differences in the actual level of achievement for students who are the same learning/cognitive style type ("matched") compared with students who are a different learning/cognitive style type ("mismatched") from their instructor.

This analysis indicated whether different levels of achievement resulted when students were paired with instructors of identical or different learning/cognitive style types. Students who were the same or of a different

learning/cognitive type as their instructor were labeled "matched" or "mismatched" respectively. The achievement scores for students in the matched and mismatched groups were then compared using an unpaired t-test. Based on these results, decisions were made to either accept or reject this hypothesis (Ho: Achievement "matched" group = Achievement "mismatched" group).

Table 4-3

Beta Coefficients for the Learning/Cognitive Style Dimensions

Parameter	Beta Coefficient	Level of Significance
Concrete experience discrepancy score	.03	.84
Reflective observation discrepancy score	-.02	.83
Abstract conceptualization discrepancy score	-.76	<.0001
Active experimentation discrepancy score	-.67	<.0001

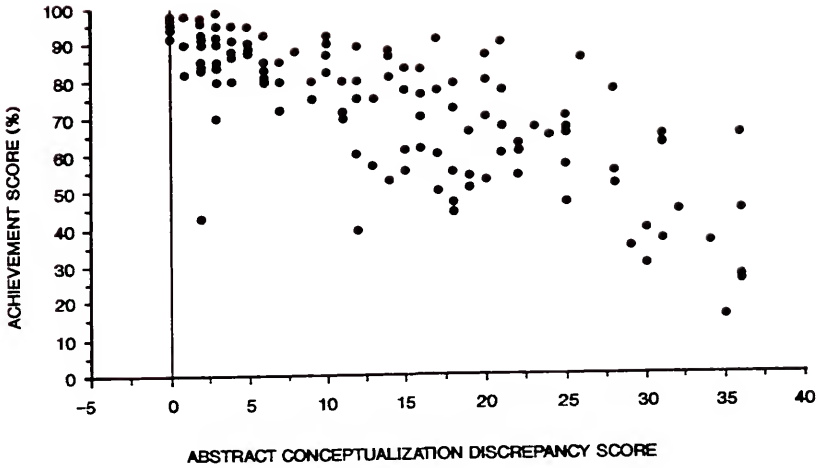

Figure 4-1. Relationship Between Student Achievement Score and Abstract Conceptualization Discrepancy Score (B = -.76, $p < .0001$).

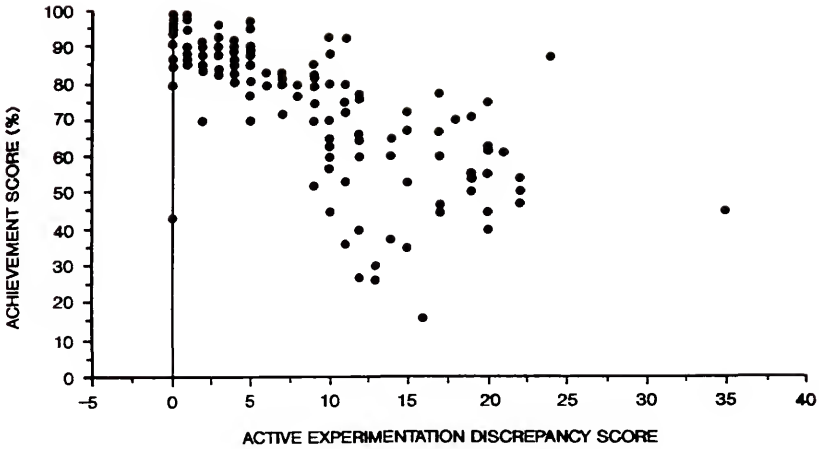

Figure 4-2. Relationship Between Student Achievement Score and Active Experimentation Discrepancy Score ($B = -.67$, $p < .0001$).

Students who were the same learning/cognitive style type as their instructor (matched, $N = 53$) had significantly higher achievement scores compared with students who were a different learning/cognitive style type than their instructor (mismatched, $N = 90$) ($t = 6.13$, $p < .0001$, see Figure 4-3). Thus, hypothesis 3 was therefore rejected (i.e., achievement of matched students $\neq$ achievement of mismatched students).

Approximately equal numbers of assimilator and converger learning/cognitive style types were identified. Collectively, assimilator and converger types accounted for 66% of the students, while the remainder were diverger and accommodator types (see Figure 4-4). In the learning situation assimilators and convergers acquire or grasp information in the same way, by abstract conceptualization. The two types differ in that assimilators prefer to be more reflective and like to learn by watching and listening whereas convergers are more active and like to learn by doing things. The large majority of the instructors were also assimilator and converger learning/cognitive style types (i.e., 82%).

Hypothesis 4. There is no significant relationship between the actual level of student achievement and the predicted level of achievement as a function of the weighted linear combination of GPA, number of hours of homework per week, program, and the interpersonal,

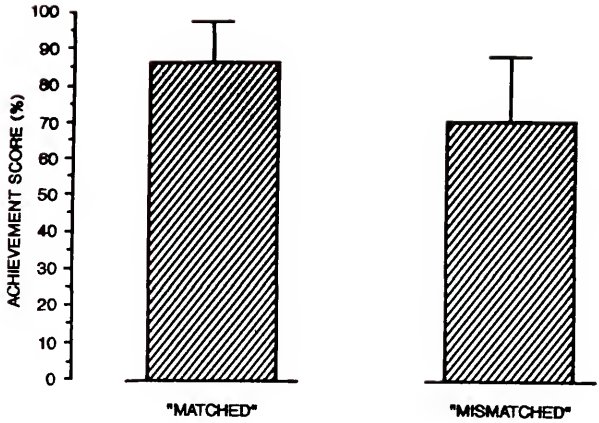

Figure 4-3. Students who were "Matched" and "Mismatched" with Their Instructor's Learning/Cognitive Style Type. (Data are mean values ± 1 standard deviation.)

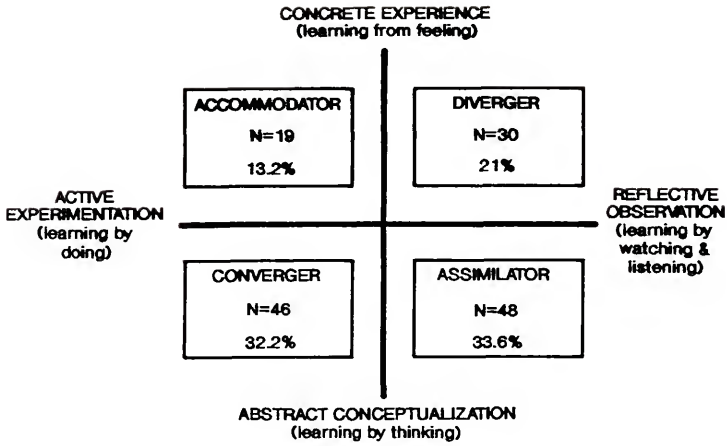

Figure 4-4. Distribution of Student Learning/Cognitive Style Types.

individual, teacher-structured, abstract, and concrete learning preference dimension discrepancy scores.

This was a test to determine if there was a relationship between the actual level of student achievement and the predicted level of student achievement based on the learning preferences (Y'LP) multiple regression model. (Using SAS and the General Linear Model procedure, this hypothesis was tested using the F-test for the multiple regression model. The F-test for the hypothesis was that $R^2 = 0$.) The following variables constituted the learning preferences multiple regression model:

Y'LP = B_1 (GPA) + B_2 (Number of hours homework per week for the course) + B_3 (Program) + B_4 (Interpersonal discrepancy score) + B_5 (Individual discrepancy score) + B_6 (Teacher-structured discrepancy score) + B_7 (Student-structured discrepancy score) + B_8 (Abstract discrepancy score) + B_9 (Concrete discrepancy score)

The variables, GPA, number of hours per week, and program, were included in the learning preferences regression model for the same reasons as mentioned above for the learning/cognitive styles regression model. Using this model, the correlation for the actual and the predicted levels of student achievement was determined. Based on results from this analysis, decisions were made

to either accept or reject this hypothesis (Ho: r Y Y'LP = 0).

There was a significant relationship between actual level and the predicted level of student achievement based on the learning preferences multiple regression model (F = 17.49, p < .0001). The coefficient of multiple correlation for the model was .85; the model explained 72.9% of the variance in predicting student achievement (see Table 4-4). Three of the nine regressors in the model were highly significant (p < .0001): GPA, program, and the student-instructor discrepancy score for concrete learning preferences. The learning preferences equation was:

Y'LP = 43 + (15.8) GPA + (.84) Number of hours per week for the course + (-1.4) Program + (-.04) Interpersonal discrepancy score + (.21) Individual discrepancy score + (-.08) Teacher-structured discrepancy score + (-.14) Student-structured discrepancy score + (-.02) Abstract discrepancy score + (-.73) Concrete discrepancy score

Based on these findings, hypothesis 4 was therefore rejected (r Y Y'LP ≠ 0).

Hypothesis 5. There is no significant relationship between student achievement and the student-instructor discrepancy score (degree of matching between student and

Table 4-4

Multiple Regression of Learning Preferences Model (Reduced Model --Omitting Learning/Cognitive Style Dimensions)

Sources of Variation	Sums of Squares	Degrees of Freedom	Mean Squares	F Value	Level of Significance	R^2
Model	35913.5	19	1890.18	17.49	<.0001	.729
Error	13293.3	123	108.1			
Corrected Total	49206.8	142				
GPA	3760.1	1	3760.1	34.79	< .0001	
Homework	511.8	1	511.8	4.74	.07	
Program	5956.3	11	541.48	5.01	< .0001	
Inter-personal	248.3	1	248.3	2.30	.13	
Individual	321.4	1	321.4	2.97	.09	
Abstract	176.0	1	176.0	1.63	.20	
Concrete	3454.9	1	3454.9	31.97	< .0001	
Teacher-Structured	140.74	1	140.74	1.3	.25	
Student-Structured	63.08	1	63.08	0.58	.44	

instructor) on any of the six learning preference dimensions.

This was a test of whether there was a relationship between student achievement and the individual learning preference dimension discrepancy scores. By examining the beta coefficients for the interpersonal (B_4), individual (B_5), teacher-structured (B_6), student-structured (B_7), abstract (B_8), and concrete (B_9) variables in the learning preferences multiple regression model, student achievement based on the degree of matching between students and their instructors for each learning preference dimension was assessed. Based on these data, decisions were made to either accept or reject this hypothesis (Ho: B_4, B_5, B_6, B_7, B_8, B_9 = 0).

There was a significant relationship between student achievement and the student-instructor discrepancy score for concrete learning preferences, while there were no significant relationships for the interpersonal, individual, teacher-structured, student-structured, and abstract learning preference scores. The beta coefficient for the student-instructor discrepancy score for the concrete learning preference was -.73 (see Table 4-5). Thus, the greater the degree of matching between students and their instructors on the basis of this dimension, the greater the students' achievement. Conversely, the greater the degree of mismatching between students and

their instructors on the basis of concrete learning preferences the lower the students' achievement scores (see Figure 4-5). Hypothesis 5 was therefore rejected for the concrete learning preference dimension only (B_9) and retained for the interpersonal (B_4), individual (B_5), teacher-structured (B_6), student-structured (B_7), and abstract (B_8) learning preference dimensions, i.e., $B_9 \neq 0$ and B_4, B_5, B_6, B_7, $B_8 = 0$.

Table 4-5

Beta Coefficients for the Learning Preference Dimensions

Parameter	Beta Coefficient	Level of Significance
Interpersonal discrepancy score	-.04	.67
Individual discrepancy score	.21	.11
Abstract discrepancy score	-.02	.85
Concrete discrepancy score	-.73	<.0001
Teacher-structured discrepancy score	-.08	.35
Student-structured discrepancy score	-.14	.19

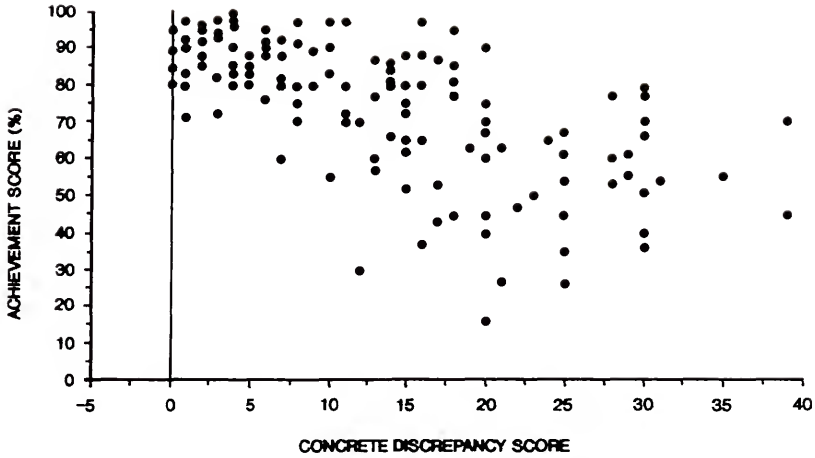

Figure 4-5. Relationship Between Student Achievement Score and Concrete Discrepancy Score (B = -.73, p < .0001).

Hypothesis 6. There is no significant change in the proportion of explained variance (R^2) in student achievement when the learning/cognitive style set of variables, as a group, are removed from the complete (all variables) regression model.

This was a test of whether the learning/cognitive style set of variables, as a group, accounted for a significant proportion of variance in student achievement. An F test was used to determine if there was a significant increment in R^2 that resulted from adding the learning/cognitive style set of variables to the regression model (Pedhazur, 1982). Complete and reduced (omitting the learning/cognitive style set of variables) multiple regression models were used for this analysis. The complete multiple regression model incorporated the learning/cognitive style and learning preference sets of variables, plus GPA, program, and number of hours of homework. Based on the results of this analysis, decisions were made to accept or reject this hypothesis (Ho: R^2 complete model - R^2 reduced model = 0).

There was a significant relationship between actual and the predicted level of student achievement (Y') based on the complete multiple regression model ($F = 22.76$, $p < .0001$). The coefficient of multiple correlation for the model was .902; the complete model explained 81.5% of the variance in predicting student achievement (see Table 4-

6). Four of the 13 regressors in the model were highly significant: GPA, program, and the learning/cognitive styles student-instructor discrepancy scores for abstract conceptualization and active experimentation. The learning preference student-instructor discrepancy score for concrete learning preferences was not significant (p = .08) in this model. The regression equation for the complete model was:

Y' = 68 + (9.8) GPA + (.37) Number of hours homework per week for the course + (-1.2) Program + (.01) Concrete experience discrepancy score + (-.02) Reflective observation discrepancy score + (-.67) Abstract conceptualization discrepancy score + (-.56) Active experimentation discrepancy score + (-.01) Interpersonal discrepancy score + (.1) Individual discrepancy score + (-.05) Teacher-structured discrepancy score + (-.07) Student-structured discrepancy score + (-.08) Abstract discrepancy score + (-.21) Concrete discrepancy score

The learning/cognitive style set of variables, as a group, accounted for a significant proportion of variance in student achievement when removed from the complete regression model. The F-test for this analysis was the following:

$$F = \frac{(R^2 y\ 1\ 2\ \ldots\ k_1 - R^2 y\ 1\ 2\ \ldots\ k_2) / (k_1 - k_2)}{(1 - R^2 y\ 1\ 2\ \ldots\ k_1) / (N - k_1 - 1)}$$

Table 4-6

Multiple Regression of Complete Learning/Cognitive Styles and Preferences Model

Sources of Variation	Sums of Squares	Degrees of Freedom	Mean Squares	F Value	Level of Significance	R^2
Model	40092.80	23	1743.16	22.76	< .0001	.815
Error	9114.01	119	76.58			
Corrected Total	49206.80	142				
GPA	1615.05	1	1615.05	21.09	< .0001	
Homework	91.69	1	91.69	1.20	.27	
Program	3320.80	11	301.89	3.94	< .0001	
C.E.	3.13	1	3.13	0.04	.84	
A.C.	1696.90	1	1696.90	22.16	< .0001	
R.O.	14.82	1	14.82	0.19	.66	
A.E.	723.30	1	723.30	9.44	< .002	
Inter-personal	89.90	1	89.90	1.17	.28	
Individual	101.10	1	101.10	1.32	.25	
Abstract	95.90	1	95.90	1.25	.26	
Concrete	114.70	1	114.70	1.50	.22	
Teacher-Structured	44.30	1	44.30	0.58	.44	
Student-Structured	30.18	1	30.18	0.39	.53	

Where $R^2y\ 1\ 2\ \ldots\ k_1$ is the squared multiple correlation coefficient for the complete regression model (see Table 4-6); $R^2y\ 1\ 2\ \ldots\ k_2$ is the squared multiple correlation coefficient for the reduced model (omitting the learning/cognitive styles set of variables (see Table 4-4); k_1 is the number of variables for the complete model; k_2 is the number of variables for the reduced model; and N is the sample size. The F ratio has degrees of freedom (df) for the numerator ($df_{num} = k_1 - k_2$) and denominator ($df_{denom} = N - k_1 - 1$).

$$F = \frac{(.815 - .729) / (13 - 9)}{(1 - .815) / (143 - 13 - 1)}$$

$$F = 15.35\ (df_{num} = 4, df_{denom} = 129)$$

$$\underline{p} < .01$$

Thus, hypothesis 6 was rejected, i.e., $\underline{R}^2$ complete regression model - $\underline{R}^2$ reduced regression model (omitting learning/cognitive style set of variables) $\neq 0$.

<u>Hypothesis 7</u>. There is no significant change in the proportion of explained variance ($\underline{R}^2$) in student achievement when the learning preference set of variables, as a group, are removed from the complete (all variables) regression model.

As in Hypothesis 6, this was a test of whether the learning preference set of variables, as a group, accounted for a significant proportion of variance in

student achievement. An F test was used to determine if there was a significant increment in $\underline{R}^2$ that resulted from adding the learning preference set of variables to the regression model (Pedhazur, 1982). Completed and reduced (omitting the learning preference set of variables) multiple regression models were used for this analysis. The complete multiple regression model was the same as that used to test hypothesis 6. Based on the results of this analysis, decisions were made to accept or reject this hypothesis (Ho: $\underline{R}^2$ complete model - $\underline{R}^2$ reduced model = 0).

The learning preference set of variables, as a group, failed to account for a significant proportion of variance in student achievement when removed from the complete regression model. The F-test for this analysis was the same as that used in hypothesis 6. Where $R^2y\ 1\ 2\ \ldots\ k_1$ is the squared multiple correlation coefficient for the complete regression model (see Table 4-6) and $R^2y\ 1\ 2\ \ldots\ k_2$ is the squared multiple correlation coefficient for the reduced model (omitting the learning preference set of variables (see Table 4-2); k_1 is the number of variables for the complete model; k_2 is the number of variables for the reduced model; and N is the sample size:

$$F = \frac{(.815 - .805) / (13 - 7)}{(1 - .815) / (143 - 13 - 1)}$$

$$F = 1.14 \ (df_{num} = 6, df_{denom} = 129)$$

Not Significant

Thus, hypothesis 7 was retained, i.e., $\underline{R}^2$ complete regression model - $\underline{R}^2$ reduced regression model (omitting learning preference set of variables) = 0.

Based on the results of hypotheses 6 and 7, it was inferred whether or not relationships between student achievement and the degree of matching between students and their instructors differed when based on learning/cognitive style theory <u>or</u> learning preference theory.

In the regression models, the variable "GPA" correlated positively with the students' achievement scores (see Figure 4-6). The variable "program" was significant in all models indicating that different levels of student achievement by program resulted (see Table 4-7); this may have been due to other factors in the programs that were unaccounted for by the regression models.

Step-wise regression was then performed on the complete model to identify the important independent variables in the study and to determine a prediction

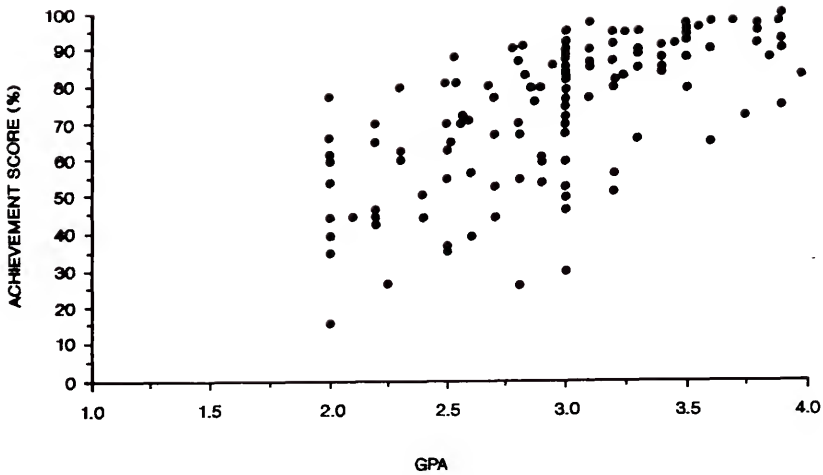

Figure 4-6. Relationship Between Student Achievement Score and College Grade Point Average (r = .67, p < .0001).

Table 4-7

Student Achievement Score by Program

Program	Mean (percent)	Standard Deviation
A	75.0	18.1
B	76.0	16.0
C	76.7	11.5
D	78.3	13.4
E	60.6	20.2
F	84.5	18.7
G	86.5	7.1
H	78.2	18.6
I	77.2	18.3
J	85.8	9.7
K	75.3	17.8
L	71.5	16.3

equation for student achievement using the variables from both learning theories. A regression model was generated that was highly significant ($F = 90.7$, $p < .0001$). The coefficient of multiple correlation for the model was .876; the model explained 76.8% of the variance in predicting student achievement (see Table 4-8). Five regressors were identified as predictors of student achievement: GPA, program, and the student-instructor discrepancy scores for the abstract conceptualization and active experimentation learning/cognitive style dimensions and the concrete learning preference dimension. The stepwise regression equation was

Y' = 66.1 + (10.6) GPA + (-.98) Program + (-.71) Abstract conceptualization discrepancy score + (-.60 Active experimentation discrepancy score + (-.24) Concrete discrepancy score

Table 4-8

Step-wise Multiple Regression Model

Sources of Variation	Sums of Squares	Degrees of Freedom	Mean Squares	F Value	Level of Significance	R^2
Regression	37793.9	5	7558.8	90.7	<.0001	.768
Error	11412.9	137	83.3			
Total	49206.8	142				

Variable	Parameter Estimate	Sums of Squares	F Value	Level of Significance
Intercept	66.1	7808.7	93.7	<.0001
GPA	10.6	2419.1	29.0	<.0001
Program	- .98	1595.1	19.1	<.0001
A.C.	- .71	3360.4	40.3	<.0001
A.E.	- .60	1265.1	15.2	<.0002
Concrete	- .24	390.2	4.7	<.03

CHAPTER 5
SUMMARY

Student differences regarding learning and teaching reflect two lines of research; one group retains interest in the cognitive dimensions of style (learning/cognitive style), while the other is concerned with preferences for applied methods of instruction (learning preferences). The purpose of the study was to determine whether a relationship existed between achievement and the degree of matching between students and their instructors based on learning/cognitive style theory or learning preference theory, and whether one of these learning theories was better in predicting student achievement.

Because instructors teach in ways that are similar to their own learning/cognitive style and preferences it was felt that students having similar learning/cognitive style and preference characteristics as their instructor were, in a sense, "matched" to the educational environment. It was equally logical to assume that students whose learning/cognitive style and preference characteristics differed from their instructor were "mismatched" to the educational environment. Thus, it was contended that the

greater the degree of matching between students and their instructors on the basis of learning/cognitive style theory or learning preference theory, the greater might be the communication and understanding between them resulting in greater learning and student achievement.

The research problem was formulated to address a possible explanation and to propose a solution for the low pass rate on the respiratory therapy national board examination for graduates of accredited respiratory therapy programs. It was hypothesized that greater academic achievement would result if students were provided with educational environments congruent with their learning/cognitive style and/or learning preferences. Provided with such an educational environment, graduates of respiratory therapy programs might achieve at a higher level and thus have a greater likelihood of passing the board examination.

A pilot study was conducted in a respiratory therapy program to assess the relationship between student achievement and the degree of matching between students and their instructor based on Kolb's learning/cognitive style theory and Rezler's learning preference theory. At the conclusion of a major course int he respiratory therapy curriculum, students and their instructor completed Kolb's Learning Style Inventory and Rezler's Learning Preference Inventory; students also completed an

achievement test. Student-instructor discrepancy scores (student's score minus instructor's score) calculated from the learning style inventory and learning preference inventory dimension scales were used to determine the degree of matching, i.e., the lower the discrepancy score the greater the match. It was found that higher achievement scores correlated with a greater degree of matching between students and their instructor for the active experimentation dimension (i.e., learning by doing) of Kolb's learning/cognitive style theory. In addition, students who were the same learning/cognitive style type as their instructor had significantly higher levels of achievement. No significant relationships between achievement and the degree of matching between students and their instructor on the basis of Rezler's learning preference dimensions were identified.

Results from the pilot study revealed that a larger study would be appropriate. In this study, in order to obtain an appropriate sample size (N = 143 students), 11 respiratory therapy programs (cluster sampling) from various regions of the United States participated. The methodology used in the larger study was similar to that used in the pilot study, i.e., in each program students completed an achievement test and students and their instructor completed Kolb's Learning Style Inventory and Rezler's Learning Preference Inventory; also student-

instructor discrepancy scores were calculated to determine the degree of matching. Multiple regression was used to analyze the relationships between the degree of matching and the students' achievement test scores.

Seven hypotheses were developed to address the research problem. The hypotheses are stated in a directional form, which are based on the results of the study.

Hypothesis 1. There was a significant relationship between the actual level of student achievement and the predicted level of achievement as a function of the weighted linear combination of GPA, number of hours of homework per week, program, and the concrete experience, reflective observation, abstract conceptualization, and active experimentation learning/cognitive style dimension discrepancy scores.

Hypothesis 2. There was a significant relationship between student achievement and the student-instructor discrepancy score (degree of matching between student and instructor) for the abstract conceptualization and active experimentation learning/cognitive style dimensions.

Hypothesis 3. Students who are the same learning/cognitive style type ("matched") as their instructor had significantly higher levels of achievement than students who were a different learning/cognitive style type ("mismatched") from their instructor.

Hypothesis 4. There was a significant relationship between the actual level of student achievement and the predicted level of achievement as a function of the weighted linear combination of GPA, number of hours of homework per week, program, and the interpersonal, individual, teacher-structured, student-structured, abstract, and concrete learning preference dimension discrepancy scores.

Hypothesis 5. There was a significant relationship between student achievement and the student-instructor discrepancy score (degree of matching between student and instructor) for the concrete learning preference dimension.

Hypothesis 6. The learning/cognitive style set of variables, as a group, accounted for a significant amount of variance in predicting student achievement.

Hypothesis 7. The learning preference set of variables, as a group, did not account for a significant amount of variance in predicting student achievement.

The two key questions posited in the problem statement were answered by the results of this study, i.e., (a) higher achievement scores correlated with greater degrees of matching between students and their instructor for the abstract conceptualization and active experimentation dimensions of Kolb's theory and for the concrete learning dimension of Rezler's theory; and (b)

because the learning/cognitive style variables, as a group, accounted for a significant amount of variance in predicting student achievement compared to the learning preference variables, it was inferred that Kolb's theory of learning/cognitive styles was better than Rezler's theory of learning preferences in predicting student achievement.

CHAPTER 6
DISCUSSION, IMPLICATIONS, AND RECOMMENDATIONS

Introduction

Differences in student performance in the classroom are not so much a function of differences in IQ as they are differences in strategies for acquiring information (Burk, Gillman, & Ose, 1984). Keefe (1986) contended that efforts to explain the underlying processes of student differences regarding learning and teaching reflect two philosophies. One is concerned with the cognitive dimensions of style, while the other is based on preferences for applied methods of instruction. Students have innate predispositions for acquiring, perceiving, and processing information (learning/cognitive style), as well as predilections for particular methods of instruction (learning preferences) in the learning situation. The cognitive processes used and the preferred ways of learning may vary from student to student. Most authorities have agreed that increased academic achievement tends to result when consideration is given to teach students in accordance with their learning/cognitive style and preferences. A growing body of literature

supports the notion that the more congruent the learning environment to a student's learning/cognitive style and preferences, the greater the level of academic achievement. Conversely, academic achievement appears to be compromised when there is dissonance between the learning environment and one's learning/cognitive style and preferences. Thus, a goal of education based on learning/cognitive style and preference theories is to provide teaching strategies that are compatible with the learning/cognitive style and preferences of the students. It is felt that educators should be responsive to student differences in order to better match a student's natural predispositions for learning to the environment.

Hart (1986) asserted that the conventional classroom is in every sense a "high-threat situation" for many students and one that inhibits learning. He contended that if we want students to learn, they must be in a non-threatening and non-intimidating environment. Threat and intimidation oppose learning. A teaching-learning approach based on a student's natural thinking processes--learning/cognitive style and preferences for instruction--would provide a more "user-friendly" environment, i.e., one that would be less threatening and intimidating. In such an environment students may be happier, devote more effort, and be more interested in learning. As Dewey's adage attests--"effort goes where interest is."

Discussion

The regression equation based on the learning/cognitive styles model significantly predicted student achievement, and two of the four learning/cognitive style dimensions were significant predictors (see Chapter 4). It was noted also that the regression equation based on the learning preferences model significantly predicted student achievement, and that one of the six learning preference dimensions was a significant predictor. Thus, by cursory examination, it could be inferred that both learning theories, in and of themselves, predicted student achievement. However, closer examination of all the results indicated that such was not the case.

In both models, the variables "GPA" and "program" were highly significant and accounted for a substantial amount of variance in predicting student achievement. Thus, the presence of these variables contributed in making both models significant. In order to infer whether or not relationships between achievement and the degree of matching between students and their instructors differed when based on Kolb's learning/cognitive style theory or Rezler's learning preference theory, the proportions of variance explained by the learning/cognitive style and learning preference sets of variables were analyzed. The proportion of variance in student achievement explained by

the learning/cognitive style set variables was significant, while the learning preference set of variables, as a group, failed to account for a significant proportion of variance. Thus, within the design limitations of this study, Kolb's learning/cognitive style theory contributed significantly in predicting student achievement, while Rezler's learning preference theory did not. As a result, it may be inferred that Kolb's theory of learning/cognitive styles was better in predicting student achievement than Rezler's theory of learning preferences.

As noted in Chapter 2, using a learning/cognitive style theory, Cafferty (1981) reported a higher GPA for students who were more closely matched to the learning/cognitive styles of their instructors. Conversely, the greater the dissonance between the two, the lower the GPA. A similar relationship was found in this study. The greater the degree of matching between students and their instructor for the abstract conceptualization and active experimentation dimension of Kolb's theory and concrete dimension of Rezler's theory, the higher the achievement (see Figures 4-1, 4-2, and 4-5). Moreover, using Kolb's typology, students who were the same learning/cognitive style type as their instructor ("matched") had significantly higher achievement than students who were a different learning/cognitive style

type ("mismatched"). These findings are consistent with those of Baker, Wallace, Cooke, Alpert, and Ackerly (1986) who reported that resident physicians enrolled in a formal postdoctoral training program scored higher in clinical skills and knowledge when matched with faculty members of the same learning/cognitive style type. Matching students with appropriate learning environments based on Kolb's learning/cognitive style theory appears to facilitate and promote learning.

"Program" was a significant variable in all regression models. As described earlier, different levels of student achievement by program resulted (see Table 4-7). Variations in student achievement by program may have been affected by other extraneous factors which could not be controlled and which were not explained by the variables in the models, e.g., attributes of the instructor or student and program characteristics.

Regarding instructor characteristics, some instructors may have devoted more time and effort in teaching the course relative to instructors in other programs. Motivation and enthusiasm of the instructor to teach the course could have had an impact on student achievement. A highly motivated and enthusiastic instructor could favorably influence student learning, just as a lackadaisical and boring instructor could adversely affect it. Individual instructor-student

interactions could have been another factor. One-on-one meetings between the instructor and student could have a marked effect on student learning. The innate intelligence, level of understanding, and clinical experience (both the type and amount) of the instructor could have been other factors affecting student learning. A more intelligent and knowledgeable instructor with years of clinical experience might be able to impart more information to students than an instructor of lesser abilities and experience. Communication and interpersonal skills of the instructor are other factors that may have affected student learning and achievement. An instructor who could sensibly organize the course material and communicate in a lucid manner versus a disorganized and confusing instructor would no doubt have an affect on learning. Interpersonal skills refer to the instructor's ability to work and get along with others, and whether he or she is genuinely concerned for the students and can empathize with their needs.

Motivation to learn, attitude, persistence, personality, and innate intelligence are some student characteristics that may have affected learning and, thus, achievement. A highly motivated student with a positive and receptive attitude toward learning, who is determined and willing to work, is able to work well with peers and superiors, and is bright and conscientious is more likely

to succeed compared to students who do not have these characteristics. The previous experience of the student is another characteristic that may have been a factor. Students in one program with previous clinical experience relative to students in another program who have not had such experiences have an advantage and may be better able to relate and learn the course material.

Age and sex of the instructors and students in the various programs are other potential variables that may have affected student achievement. An older and more mature student may be more dedicated than a younger and less mature one. Of course, this may not be true in all circumstances. A student who is nearly the same age as his or her instructor may be better or less able to relate to the instructor than a student who, for example, is 20 years younger. Still other students may be better or less able to identify, communicate, and learn from an instructor of the same sex.

Regarding operational characteristics of the programs, several factors could have influenced student achievement. Admission standards of some programs may have been more discriminating than others in terms of SAT and IQ scores and high school or previous college GPA. Students with greater natural abilities are more likely to achieve at higher levels than students who do not possess such abilities. Another characteristic is the type and

amount of clinical learning that the students may have experienced. If a program provided students with clinical experiences at the time the course was taught, which complemented and thus reinforced the classroom instruction, then such students would most likely learn more than students in programs who did not have such experiences.

As previously mentioned, the abstract conceptualization and active experimentation learning/cognitive style dimensions and the concrete learning preference dimension were significant variables. Abstract conceptualization refers to learning by the logical analysis of ideas and concepts, systematic planning, acting on an intellectual understanding of the situation, and creating concepts that integrate observations into ideas to solve problems (Kolb, 1984). A substantial portion of material presented in a respiratory therapy curriculum is conceptual, requiring one to understand physiological and physical relationships. For example, when one inhales, the rate of filling and the distribution of air throughout the lungs is determined by a mathematical concept known as a time constant. By integrating observations of the patient's condition and previously learned concepts such as the lung's time constant, one is able, in part, to solve the problem of deciding on how to set the controls of a life-support

ventilator. Knowledge of this and other conceptual relationships are imperative for the practice of respiratory care. it seems reasonable, therefore, that because respiratory therapy is a scientifically and medically oriented health care profession which requires individuals to logically analyze clinical situations based on previously learned concepts, that the abstract conceptualization dimension was significant.

Based on this argument, one may question why Rezler's abstract learning preference dimension was not significant, yet Kolb's abstract conceptualization learning/cognitive style dimension was significantly related to student achievement. A review of the definitions of both terms would be helpful in understanding the results. Rezler (1983) described "abstract" as a preference for learning theories and generating hypotheses. Kolb's description of "abstract conceptualization" is related more to the logical understanding of ideas and concepts and not a predilection to learn theoretical relationships. Respiratory therapy is a practice profession and therefore not solely abstract and theoretically oriented. This line of reasoning may thus explain why the abstract learning preference dimension was not a significant factor in the study.

Active experimentation is described by Kolb (1981) as learning by doing things and using previously learned

theories to solve problems. Similarly, Rezler (1983) described the concrete learning preference dimension as a preference for learning specific, practical tasks and emphasis on psychomotor skills. Both dimensions relate to a "hands-on" approach to learning. Respiratory therapy is very much a "doing" and "hands-on" profession. Thus, it was not surprising that these two dimensions were significantly related to student achievement.

All four learning/cognitive style types, as described by Kolb, were prevalent in several studies involving nursing personnel (see Chapter 2). Similarly, all four learning/cognitive style types were identified for the respiratory therapy personnel in this study. Kolb (1981) noted that although individuals may share a common profession, variations in learning/cognitive style may occur. Further, he found that, "some fields seem to include within their boundaries considerable variation in the inquiry norms and knowledge structures. Several professions (particularly management, medicine, and architecture) are themselves multidisciplinary, including specialties that emphasize different learning/cognitive styles" (p. 244). Medicine is both a people-oriented as well as a science-oriented profession, thus attracting people of both orientations. Plovnick (1975) reported a significant relationship between learning/cognitive style types and specific career choices of physicians--

accommodators chose family medicine and family care, assimilators chose academic medicine, divergers chose psychiatry, and convergers chose medical specialties (e.g., anesthesiology and radiology). Respiratory therapy, as in medicine and the other allied health professions, requires concern for both human service and scientific knowledge. This may explain why all four learning/cognitive style types were identified in the sample of respiratory therapy students.

Assimilators and convergers were the modal learning/cognitive style types in the study. Assimilators like to learn by thinking as well as by watching and listening; such individuals like to observe and are more reflective (Kolb, 1984). Convergers also like to learn by thinking but prefer to be more active by doing things and seeking practical applications for what has been learned (Kolb, 1984). Approximately equal numbers of both types of students were identified. Sixty-six percent of the students and 82% of the instructors were assimilators and convergers. Both of these learning/cognitive style types acquire or grasp information through abstract conceptualization and have an affinity for scientifically and medically oriented careers. Respiratory therapy is a technical, allied health profession that is suited for individuals who are less focused on people than on ideas (e.g., assimilators) and who prefer to deal with technical

tasks and problems rather than social and interpersonal issues (e.g., convergers). This observation was interesting in that it confirmed Kolb's assertion that specific learning/cognitive style types tend to gravitate to certain career fields. As noted in Chapter 2, Kolb (1984) contended that occupational disciplines attract individuals with learning/cognitive styles congruent with the structure of knowledge within the discipline. Kolb (1981) noted also that when the learning/cognitive style matched the demands of a given career specialization, higher performance resulted.

Kolb (1984) recommended appropriate learning situations for assimilators and convergers. Assimilators may make observations of concepts in naturalistic settings or may observe films, video tapes, and simulations in class and then generate concepts that describe and tie together that which has occurred. Assimilators learn best by reflective, passive activities like lectures and literature reviews. Convergers would find laboratory experiments and problems that have specific answers more satisfying learning experiences. They like to learn by participation in the clinical area and learning exercises which place students in positions of active learning. As mentioned, both learning/cognitive style types acquire or grasp information through abstract conceptualization,

meaning that learning involves using logic and ideas, rather than feelings to understand problems or situations.

As described in Chapter 4, a step-wise multiple regression analysis of the variables was performed to generate a prediction equation for student achievement. In addition to "GPA" and "program," the student-instructor discrepancy scores for the abstract conceptualization and active experimentation learning/cognitive style dimensions and the concrete learning preference dimension were significant predictors in the equation. The coefficient of multiple correlation for the model was .87. This equation could be applied to similar groups of respiratory therapy students for predictive purposes, however, in applying this equation, shrinkage of the multiple correlation should be kept in mind. That is, if a prediction equation based on a set of variables derived from one sample is applied to another sample, and then a correlation of these predicted scores with the observed criterion scores was performed, the resulting coefficient of multiple correlation would almost always be smaller than the coefficient of multiple correlation obtained originally (Pedhazur, 1982).

This study was the first to investigate the possibility of using Kolb's learning/cognitive style and Rezler's learning preference theories as a means of predicting academic achievement. As described in the

foregoing paragraphs, Kolb's learning/cognitive style dimensions contributed significantly in predicting academic achievement, whereas Rezler's learning preference dimensions did not. Predicting student achievement expands the potential usefulness of Kolb's learning/cognitive style theory--an approach that could be applied in future studies. This finding represents a novel approach to using Kolb's theory that heretofore has not been reported.

Implications for Respiratory Therapy Education

As stated earlier, the mean pass rate on the national respiratory therapy board examination for graduates of accredited programs has been approximately 50% for the previous 10 years (Filippi, 1988)--an unacceptable number of failures. It is unclear why so many college trained graduates of this allied health profession are failing; no explanations or possible solutions have been advanced to ameliorate this situation. It is logical to assume that one explanation may be the educational approach used to train respiratory therapy personnel. Carbo (1986) asserted that "when a student's educational program and learning/cognitive style are mismatched for a prolonged period of time, the impact on that student's ability to learn may be profound indeed, causing failure, defeat, embarrassment, and anger" (p. 127). It may be speculated that such could be the case for a large number of students

enrolled in respiratory therapy educational programs. The findings of this study suggest that the traditional teaching-learning approach used in respiratory therapy educational programs (all students taught in the same manner) may be inappropriate for some and thus academic achievement and learning are compromised--which may be a factor contributing to the low pass rate on the board examination. If such is the situation, then an alternative approach to teaching and learning should be considered, i.e., one that is sensitive to individual differences in learning/cognitive styles.

Recommendation for a Future Study

A reasonable question might be--does matching a student's respiratory therapy educational program to his or her learning/cognitive style affect the pass rate on the board examination? An experimental study employing two groups of respiratory therapy students could be used to address this question, e.g., a randomized subjects, posttest--only control group design. At the outset of instruction, Kolb's LSI could be administered to all students in the same program. Two groups of students could be designated, an experimental and a control group. For the duration of the program (e.g., two years) students in the experimental group could be taught in an environment that matched their learning/cognitive style as closely as possible. All students in the control group

could be taught in the same manner and at the same pace (traditional approach) for the duration of the program. Following completion of the program, a comparison of the pass/failure rates for both groups could be obtained. If students in the experimental group passed at a significantly higher rate than students in the control group, consideration could be given to provide educational environments in respiratory therapy programs that are sensitive to the learning/cognitive styles of students. Given these results, a practical concern relates to structuring the educational environment to accommodate the learning/cognitive styles of students.

Accommodating Various Student Learning/Cognitive Styles

Butler (1986) asserted that teaching-learning strategies can be modified to match student style to curricular style. Ideally, the unique needs of each student should be taken into consideration when providing instruction. However, this approach is unwieldy with a large number of students in a common classroom and, thus, is impractical. Another approach is to admit that student differences do exist and that instructors should strive to teach in as many modes as possible in an attempt to teach all students. Although laudable, this approach may also be unrealistic in a classroom with a large number of students. Alternatively, Butler posited that "bridging" techniques could be used to help match the student's style

to the learning environment. It was suggested that such techniques or teaching strategies could be used at any level or in any content area.

Examples of using bridging techniques and Kolb's typology of learning/cognitive style types are presented. Assume that a book critical to the subject matter of a course is required reading for all students. After reading the book the diverger would be asked to brainstorm and prepare a report dealing with related interpersonal issues and his or her individual feelings of the subject matter. An assimilator would be asked to write a critical essay summarizing the theoretical and conceptual constructs presented. The converger student would be given a partial listing of some practical problems on applying the subject matter, for example, and then assigned to define additional problems and deduce solutions to the problems based on theories presented in the book. The accommodator student would be asked to discuss the subject matter of the book with fellow students in the course, elicit their opinions, and then write a critique of the book emphasizing interpersonal and practical issues.

When designing examinations, Kolb's typology of learning/cognitive style types may also be considered (Murrell & Claxton, 1987). The diverger student would prefer open-ended test questions requiring the student to

brainstorm and to think in divergent ways to generate alternative solutions to problems. An appropriate examination for the assimilator would include questions that ask to compare and contrast ideas or theoretical concepts. An examination consisting of questions that ask the student to give specific information or to select the correct answer from alternatives would be appropriate for convergers. Lastly, accommodator students would prefer an examination consisting of questions that called for the practical application of principles.

Another approach would be to provide appropriate instruction for field-independent and field-dependent student types. Douglass (1979) used Witkin's Group Embedded Figures Test (see Chapter 2) to determine the degree of analytical ability of students at the outset of instruction so that appropriate methods of instruction could be provided to complement each student's thinking style (learning/cognitive style). After administering the test, all scores of students in the class were ranked from highest to lowest. Those scoring above the median were considered field-independent or analytical (left hemispheric dominant--see Table 2-1), while those scoring below the median were considered to be field-dependent or global (right hemispheric dominant--see Table 2-1). Field-independent students were provided with inductive methods of instruction, while deductive methods of

instruction were used with field-dependent students. Inductively sequenced lessons began with examples that led to a major concept. The lessons were structured to permit the students to draw appropriate conclusions. The deductively sequenced lessons began with a summary statement of the concept or principle and then examples were provided. Inductive and deductive lesson modules were prepared on a mastery format. Students were required to master at least 70% of the lesson before moving to the next topic. The same content and objectives were provided using both teaching approaches so that one test could be administered at the end of the course. Using this approach for teaching biology, Douglass (1979) reported that academic achievement increased when students were provided with methods of instruction that matched their thinking style.

Carbo (1986) described various approaches of teaching through individual styles in order to prevent failure and increase enjoyment and achievement. It was felt that global learners (right hemispheric dominant) and analytic learners (left hemispheric dominant) should be identified and taught appropriately. In a sense, two teaching approaches could be applied in the same classroom. When teaching a lesson, for example, the instructor could adjust his or her teaching style for both global and analytic learners by using appropriate examples and

methods of instruction and developing suitable assignments. Another teaching approach was directed to meet the needs of dependent and independent learners. For such learners sufficient structure should be provided as needed. For dependent learners, directions should be clear, time limits should be given for the completion of work, and choices for learning assignments should be limited. For the independent, motivated, and more persistent student who is self-structured, the instructor should give fewer directions, provide more flexible time limits, and allow more choices in selecting learning assignments. A third approach concerns a student's sociological preferences for learning. Some students prefer to learn in groups, with one person, or alone. Games and small group techniques could be used for those who prefer to learn best by interacting with peers, while computerized program materials would be appropriate for those who prefer to work alone.

Lawrence (1986) described appropriate learning environments for students with concrete (feeling oriented) and abstract (thinking oriented) predispositions for learning. He contended that feeling oriented students test the learning environment with two overriding criteria: "Does the instructor care about me? and, Is the subject matter of the course something that I can give my heart to?" (p. 99). It was felt that caring relationships

with the instructor could carry these types of students through many learning tasks that do not interest them. Further, when the above conditions were not met, these students lost their motivation, and modifications in instructional procedures were unlikely to affect student achievement. Regarding thinking oriented types, it was noted that such students were energized by logically organized material. Such individuals thrived on things that could be analyzed and resented learning things that appeared illogical. These students responded best to instructors who were well organized and logical and they resisted and resented instructors who were not.

"Student-Driven" Teaching-Learning Process Model

An approach to accommodate the learning/cognitive styles of students may be an alternative curriculum model (a "student-driven" teaching-learning process model that is sensitive to student differences). With this model, the instructor would first diagnose a student's learning/cognitive style and then prescribe and design the appropriate learning environment--a diagnostic and prescriptive approach to education. As Thomson (1986) contended, "teaching must begin with the student, for the student is the focus of the activity" (p. 220). In terms of learning outcomes, this approach may be better than the traditional "instructor-driven" teaching-learning process model in which there is minimal sensitivity to student

differences and that provides uniform methods of instruction for all students (see Figure 6-1).

A student-driven teaching-learning process model could be applied based on Kolb's learning/cognitive style theory. Kolb (1981) contended that most people have an innate predisposition to acquire or grasp new information in a concrete or an abstract manner, which may be termed one's "information acquisition style." Varying degrees of concreteness and abstractness are present in all individuals, while one of these traits may be more or less dominant. For those individuals whose dominant information acquisition style is concrete (as evidenced by scores on Kolb's Learning Style Inventory), an appropriate curriculum could be designed, i.e., a people/issues oriented approach characterized by a sensitivity to feelings and people in which the learning environment is affiliative, evocative, and qualitative. Abstract and theoretical concepts would not be emphasized. Educational activities would consist of role playing, educational games, peer feedback, group learning exercises, and lectures. Essay and discussion type examinations would be applied using this curricular approach.

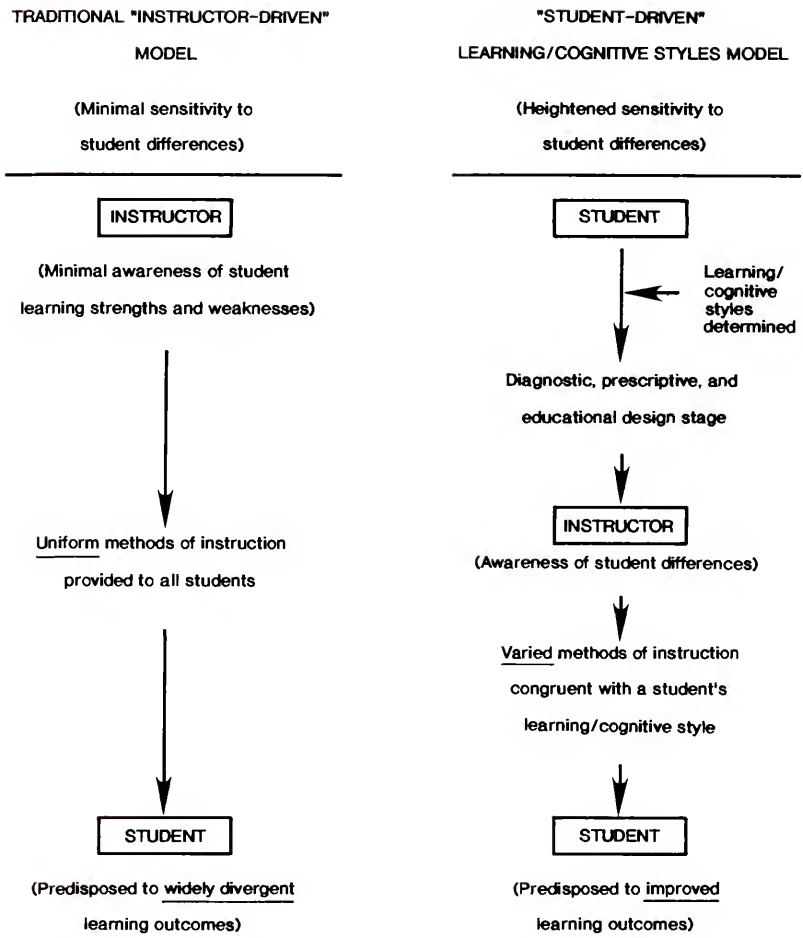

Figure 6-1. Teaching-Learning Process Models.

A curriculum employing an abstract approach to learning would be appropriate for those with an abstract information acquisition style. An abstract curriculum design would be based on the logical analysis of concepts and theoretical relationships as well as on problem solving. In this learning environment, minimal emphasis would be placed on individual feelings and emotions. The elaboration of theories and the development of ideas and new concepts would be emphasized. Educational activities would consist of theory readings, defining and solving problems, and lectures emphasizing conceptual and theoretical relationships. Objective and multiple choice tests would be applied using this curricular design.

Following the acquisition of information, Kolb contended that individuals process or transform new information by either actively applying it to new situations or reflecting on it, which may be termed the learner's "information processing style." The active approach emphasizes active learning, i.e., doing and experimenting, a hands-on approach, and a concern for what works. A reflective approach relies on observing and learning from ideas and situations from different points of view. Patience, objectivity, and careful judgment, but not necessarily action, are characteristic of reflective processing of information in the learning situation (Kolb, 1984).

Using either the concrete or abstract curriculum design, an active or a reflective approach could be applied depending on one's learning/cognitive style. The learning objectives and the core subject matter for both curricular designs would be the same, while the methods of instruction would differentiate the two designs. The rationale for supporting a style-responsive, dual curricular model is that the more congruent the learning environment is to a person's natural learning predispositions, the greater the learning and achievement (Adams, 1983; Cafferty, 1981).

Consideration for dependent and independent learner types should also be given using either curricular design (Fuhrmann & Grasha, 1983; Rezler & French, 1975). This concept refers to the degree of structure a person needs to learn effectively. Dependent students prefer structure and an instructor-directed environment, while independent students prefer less structure and are more autonomous and self-directed. The instructor should be able to differentiate both types of students and appropriately modify the curriculum. For example, the independent student in the abstract curriculum who has an active information processing style would benefit from independent study projects and activities emphasizing theoretical concepts with minimal guidance from the instructor. A dependent learner in the same curriculum

would be given less autonomy and more direction while assigned to similar theoretical and conceptual learning activities.

Keefe (1986) has advanced the concept of a diagnostic and prescriptive model of education patterned after the medical profession by stating that

> learning style diagnosis opens the door to placing individualized instruction on a more rational basis. It gives the most powerful leverage yet available to educators to analyze, motivate, and assist students in school. As such, it is the foundation of a truly modern approach to education. (p. 53)

Along this line of thinking, Thomson (1986) stated that "we can now say with reasonable assurance that instruction should begin with an analysis of the ways a particular student processes information and then build from that point" (p. 218). This type of information would provide faculty and administrators with a more substantive and rational understanding for planning instructional approaches and counseling students than would the traditional instructor-driven approach of teaching all students the same way and at the same pace.

A diagnostic and prescriptive model of education is not a new concept. Although not actually termed diagnostic and prescriptive education, this approach has been used for the education of handicapped students (Kimbrough & Nunnery, 1983). In 1975 Congress passed the "Education for All Handicapped Children Act" (Public Law

94-142) which included provisions for an Individualized Education Plan (IEP) for handicapped students. At the outset of instruction a careful assessment is made of the educational needs of the student and then educators, in collaboration with the parents and, when possible, the student, develop an IEP for the student. The student is then provided with the educational services consistent with the IEP.

The IEP concept is similar to the student-driven teaching-learning model described above. The goal of both approaches is the same--to match the teaching environment to the unique needs of the learner in order to facilitate learning and promote academic achievement. Because a diagnostic and prescriptive approach to education has been used successfully for handicapped students, the logical question then is why not use this approach for all students? Educational research clearly indicates that instructional approaches should not continue to be the same for every student. A sufficient data base and established methods exist to identify the learning proclivities of students and to differentiate learning environments according to one's style.

Students may welcome the opportunity to learn in an environment which is more conducive to natural ways of thinking. They may be happier as well as less anxious and frustrated than if placed in an environment where a

mismatch between their learning/cognitive styles and the methods used for instruction exist. Faculty and administrators may find that approaches like bridging techniques or employing a learning/cognitive style-responsive curriculum model, for example, may be practical and realistic methods of accommodating student differences and facilitate learning.

Recommendations

A key recommendation is that the college curricula for teacher education include courses on learning/cognitive style and preference theory. Butler (1986) noted that "every classroom operates on the energy created by the interaction between the teacher and the students" (p. 61), and further that this interactive process is influenced by the style of learning of the teacher and the student. It was pointed out also that "teacher and student styles act and react together to permit student learning to be more or less successful" (p. 61). Thus, the instructor's style and his or her knowledge of the learning/cognitive style and preferences of students are vital in analyzing classroom dynamics and student achievement. Along this line of thought, Blakeslee (1986) contended that to improve the quality of education, the teacher must understand his or her style of thinking as well as the students' styles of thinking. Schultz (1977) discussed the need to adjust teaching

methods to the different ways in which individuals learn, and further that instructors should become aware of the concept of learning/cognitive styles and prepare themselves to become diagnosticians, prescribers, and educational designers.

Concerning teacher education, Thomson (1986) pointed out that, for the most part, little attention has been focused on the understanding of individual differences of information processing. Given the numerous publications on the subject of learning/cognitive style and preferences, it has been well established that traditional approaches (instructional modalities the same for every student) to education are insufficient. Consideration should therefore be given to include courses in teacher education programs on learning/cognitive style and preference theories. It is advocated that such courses should be structured to teach not only the theoretical concepts but also the practical aspects of applying these learning theories in the classroom. Thomson (1986) stated that teachers should be concerned with questions like,

> What is the student's diagnosed preference for the learning environment? What are his/her underlying strengths for the cognitive processing of information? And, what teaching approaches can be applied to match the learning environment to the student's natural predispositions for learning? (p. 220)

To address such questions teachers need to be knowledgeable of the concepts of learning/cognitive styles

and preferences which can only be brought about by formal education.

Thomson (1986) predicted that competent teachers will, in the future, be able to assess the learning/cognitive styles and preferences of their students and structure the learning environment to match the learning predispositions of their students. Appropriate methods of instruction would not be based on hunches, good intentions, or the vogue, but rather on an objective approach based on one's natural ways of thinking and learning.

A second recommendation involves using student learning/cognitive style and preference data when planning a curriculum. The traditional approach to curriculum planning, however, does not emphasize the importance of identifying a student's learning/cognitive style or preferences. Following a careful needs assessment (an educational need is a discrepancy between what is and what should be) of the educational environment, the traditional curriculum planning process as described by Tyler (1975), for example, included the following major steps: identification of educational goals and objectives, selection and organization of learning experiences, and evaluation and feedback. Unfortunately, this comprehensive process is based on the orthodox approach of teaching all students in the <u>same</u> manner. As noted

earlier, Levine (1978) contended that uniform types of instruction produce widely divergent results in different students. For this reason, Cross (1976) posited that students would be happier and more productive if the curriculum was designed to allow them to learn in a manner that was compatible with their natural ways of learning. Thus, it is advocated that the curriculum building process should be amended to include an additional step, i.e., the identification of the learning/cognitive styles and preferences of students in order to modify the curriculum appropriately to accommodate student differences.

A final recommendation is an educationally administrative one regarding the application of learning/cognitive style theory. Claxton and Murrell (1987) advanced four recommendations for institutions interested in applying the concepts of learning/cognitive styles:

> (1) Conduct professional development activities on the use of learning style in improving teaching and student development. (2) Promote classroom research and make data about learning style an important part of it. (3) Establish curricular experiences that focus on helping students to learn how to learn. (4) In hiring new faculty members, take into account the candidates' understanding of teaching-learning practices that recognize individual differences, including style. (p. 77)

These recommendations could serve as basic guidelines for educational leaders for implementing a teaching-learning approach based on a student's natural learning abilities.

Leadership Implications

Educational leaders as well should be cognizant of the concepts of learning/cognitive styles and preferences and the impact that these factors have on student achievement. Because such individuals are in key positions to influence the planning and advising of teacher education programs, their input would be crucial for implementing courses on learning/cognitive styles and preferences. In addition to teaching these learning theories to prospective teachers, consideration could be given in applying these theories as a possible method to improve learning. At the annual meeting for the American Association for Higher Education in 1987, it was discussed how college teaching could be enhanced with close attention given to how students learn as well as what they learn (Heller, 1987). Teaching to individual learning/cognitive styles and using a variety of indicators to measure how students learn was discussed.

Considering national reports which have decried the unacceptably low levels of student achievement in the United States (e.g., A Nation at Risk), and published data which have shown that academic achievement is favorably influenced by applying the theories of learning/cognitive styles and preferences, leadership is needed to suggest the application of these teaching approaches. A recent report entitled "Science for All Americans," prepared by

the American Association for the Advancement of Science by the National Council on Science and Technology Education, admonished the school system in this country by charging that American students lagged behind their international counterparts in science and mathematics. As a result, the report called for modifications of the methods by which science and mathematics were taught (Hatfield, 1989). A related report entitled "Everybody Counts: A Report to the Nation on the Future of Mathematics Education," charged that mathematics education in the United States was inadequate and in need of an overhaul (Turner, 1989). The report cited that the style and content of mathematics instruction were inappropriate for many students. Brennan (1986) advocated that to effectively teach mathematics, the learning/cognitive style of the students should first be determined and then the appropriate learning environment provided. Vigna and Martin (1986) reported that improved learning in mathematics resulted when student learning/cognitive styles were matched with appropriate instructional methods and programs. Hodges (1985) reported that when taught mathematics in their preferred learning environment, students achieved significantly higher mean test scores and demonstrated statistically greater positive attitudes than those in mismatched conditions. In her discussion of the importance of learning/cognitive styles and preferences,

Hodges (1988) stated that "the opportunity to merge what is known about the cognitive processes in learning, teaching, and technology to provide optimal learning conditions has never been more hopeful" (p. 68).

APPENDIX A
KOLB'S LEARNING STYLE INVENTORY

Name _____

Learning Style Inventory[1]

Instructions:

Below are 12 sentences with a choice of four endings. Rank the endings for each sentence according to how well you think each one fits with how you would go about learning something. Try to recall some recent situations where you had to learn something new, perhaps in your job. Then, using the spaces provided, rank a "4" for the sentence ending that best describes how you learn, down to a "1" for the sentence ending that least describes the way you learn. Be sure to rank all the endings for each sentence unit. Please give each ending a different response (no ties).

Example:

When I learn:

_3_ I am happy.
_4_ I am fast.
_2_ I am logical.
_1_ I am careful.

1. When I learn:
   _____ I like to deal with my feelings.
   _____ I like to watch and listen.
   _____ I like to think about ideas.
   _____ I like to be doing things.

2. I learn best when:
   _____ I trust my hunches and feelings.
   _____ I listen and watch carefully.
   _____ I rely on logical thinking.
   _____ I work hard to get things done.

3. When I am learning:
   _____ I have strong feelings and reactions.
   _____ I am quiet and reserved.
   _____ I tend to reason things out.
   _____ I am responsible about things.

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[1] Adapted from Kolb's (1985) "Learning Style Inventory," and used with author's permission.

4. I learn by:
   _____ feeling.
   _____ watching.
   _____ thinking.
   _____ doing.

5. When I learn:
   _____ I am open to new experiences.
   _____ I look at all sides of issues.
   _____ I like to analyze things, break them down into their parts.
   _____ I like to try things out.

6. When I am learning:
   _____ I am an intuitive person.
   _____ I am an observing person.
   _____ I am a logical person.
   _____ I am an active person.

7. I learn best from:
   _____ personal relationships.
   _____ observation.
   _____ rational theories.
   _____ a chance to try out and practice.

8. When I learn:
   _____ I feel personally involved in things.
   _____ I take my time before acting.
   _____ I like ideas and theories.
   _____ I like to see results from my work.

9. I learn best when:
   _____ I rely on my feelings.
   _____ I rely on my observations.
   _____ I rely on my ideas.
   _____ I can try things out for myself.

10. When I am learning:
    _____ I am an accepting person.
    _____ I am a reserved person.
    _____ I am a rational person.
    _____ I am a responsible person.

11. When I learn:
    _____ I get involved.
    _____ I like to observe.
    _____ I evaluate things.
    _____ I like to be active.

12. I learn best when:
    _____ I am receptive and open-minded.
    _____ I am careful.
    _____ I analyze ideas.
    _____ I am practical.

TOTALS:

_____	_____	_____	_____
CE	RO	AC	AE

AC - CE = _____ AE - RO = _____

APPENDIX B
REZLER'S LEARNING PREFERENCE INVENTORY

Name _____

Learning Preference Inventory[1]

Part 1 - Instructions:

Read all words listed in columns A through F, then rank all six words in each column according to your learning preferences: write "6" next to the word that promotes learning most for you and "1" next to the word that promotes learning least for you. Assign 2, 3, 4, and 5 to the remaining words in each column. (Please assign a different number to each word.)

Column A
___ a) factual
___ b) teacher-directed
___ c) teamwork
___ d) reading
___ e) self-evaluation
___ f) theoretical

Column B
___ a) self-instructional
___ b) myself
___ c) hypothetical
___ d) interpersonal
___ e) teacher-defined
___ f) practical

Column C
___ a) sharing
___ b) doing
___ c) guided
___ d) self-initiated
___ e) thinking
___ f) solitary

Column D
___ a) teacher-structured
___ b) concrete
___ c) writing
___ d) group
___ e) conceptual
___ f) self-directed

Column E
___ a) scientific
___ b) assigned
___ c) skill-oriented
___ d) personal
___ e) self-designated
___ f) team-oriented

Column F
___ a) individual
___ b) applied
___ c) supervised
___ d) autonomous
___ e) abstract
___ f) interactive

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[1] Adapted from Rezler's "Learning Preference Inventory" (Rezler, 1983, pp. 107-109), used with author's permission.

Part II - Instructions:

Read each item and then rank order all six responses. Write "6" for the statement that promotes learning most for you and "1" for the statement that promotes learning least for you. Assign 2, 3, 4, and 5 to the remaining statements in each item. (Please assign a different number to each statement.)

1. Rank the following statements in terms of how well they describe the teachers in whose class you enjoyed learning.
   ___ a) The teacher gave many practical and concrete examples.
   ___ b) The teacher let me set my own goals.
   ___ c) The teacher encouraged me to work by myself.
   ___ d) The teacher was friendly and outgoing.
   ___ e) The teacher made the relationships between different schools of thought clear.
   ___ f) The teacher made clear assignments and I knew what was expected of me.

2. Number the following kinds of work in the order in which they would interest you.
   ___ a) Work that would require cooperation among team members.
   ___ b) Work with specific and practical ways of handling things.
   ___ c) Work that would let me do things on my own.
   ___ d) Work that would permit me to deal with ideas rather than things.
   ___ e) Work that I would plan and organize myself.
   ___ f) Work that would be clearly defined and specified by my supervisor.

3. Rank the following in terms of their effect on how hard you work and how much you accomplish in a class.
   ___ a) I can set my own goals and proceed accordingly.
   ___ b) I can address myself to a concrete, practical task.
   ___ c) I have an opportunity to discuss or work on something with other students.
   ___ d) I can examine different schools of thought.
   ___ e) I understand what is expected, when work is due, and how it will be accomplished.
   ___ f) I can accomplish most tasks by myself.

4. The evaluation of student performance is a part of nearly all courses. Rank the following in terms of how you feel about such evaluations.
   ___ a) It should be assembled from questions provided by the students.
   ___ b) It should focus on individual performance.
   ___ c) It should consist of a written examination dealing with skills.
   ___ d) It should consist of a practical examination dealing with skills.
   ___ e) It should be consistent with clearly specified requirements.
   ___ f) It should not interfere with good relationships between the teacher and the student.

5. Rank the following in terms of their general value to you as you learn.
   ___ a) Study a textbook.
   ___ b) Engage in an internship or practicum.
   ___ c) Prepare a class project with other students.
   ___ d) Search for reasons to explain occurrences.
   ___ e) Follow a prepared outline by the teacher.
   ___ f) Prepare your own outline.

6. Rank the following in terms of how much they would attract you to an elective class.
   ___ a) Good personal relationships between teacher and students.
   ___ b) Clearly spelled out standards and requirements.
   ___ c) Emphasis on practicing skills.
   ___ d) Emphasis on independent study.
   ___ e) Opportunity to determine own activities.
   ___ f) Emphasis on theoretical concepts.

7. Consider the following in terms of their general effect on how well you do in class.
   ___ a) I can study on my own.
   ___ b) I can work with something tangible.
   ___ c) I can focus on ideas and concepts.
   ___ d) I can organize things my own way.
   ___ e) I can work with others.
   ___ f) I can work on clear-cut assignments.

8. Rank the following in order in which you think teachers should possess these characteristics or skills.
   ___ a) Getting students to set their own goals.
   ___ b) Getting students to demonstrate concrete skills.
   ___ c) Involving students in generating hypotheses.
   ___ d) Preparing self-instructional materials.
   ___ e) Relating well to students.
   ___ f) Planning all aspects of courses and learning activities.

9. Rank the following in terms of how much they generally help you learn and remember.
   ___ a) Studying alone instead of studying with fellow students.
   ___ b) Performing a specific task.
   ___ c) Having a knowledgeable teacher discuss theory upon which practice is built.
   ___ d) Determining your own approach and proceed accordingly.
   ___ e) Joining a student group to study together and share ideas.
   ___ f) Getting an outline of the course from the teacher and a clear understanding of what will occur in the course.

PLEASE FILL IN THE FOLLOWING:

GPA _____

Average number of hours of homework per week for the course on mechanical ventilation _____

Age _____

Gender _____

Race _____

APPENDIX C
ACHIEVEMENT TEST FOR RESPIRATORY THERAPY STUDENTS

Name _____

Achievement Test on Mechanical Ventilation

1. When mechanical ventilation is to be initiated for a patient and no settings are specified, which of the following would be the most appropriate for setting tidal volume?

   A. The patient's anatomical dead space multiplied by 3.
   B. 10 - 15 ml/kg of the patient's ideal body weight.
   C. 5% of the patient's TLC.
   D. 10% of the patient's TLC.
   E. 20% of the patient's TLC.

2. A patient is receiving patient-triggered or assisted mechanical ventilation, the manometer shows a negative deflection during the first half of inspiration and a positive deflection during the second half of inspiration. The respiratory therapist can correct this problem by:

   A. decreasing the nebulizer output.
   B. decreasing the pressure limit setting.
   C. increasing the inspiratory flow rate.
   D. draining water from the nebulizer.
   E. having the patient exhale forcefully.

3. Which of the following ventilators would be most appropriate to use for an adult patient whose lungs are stiff or noncompliant?

   A. Bird Mark 8
   B. Puritan-Bennett PR-2
   C. BEAR-2
   D. Bird Mark 7
   E. A and D

4. An alert, spontaneously breathing patient has a $PaCO_2$ of 35 mm Hg and a PaO_2 of 60 mm Hg while receiving and FIO_2 of 0.90. Which of the following is the best way to increase the patient's PaO_2?

   A. Intubate only.
   B. Increase the FIO_2 only.
   C. Intubate and increase the FIO_2.
   D. Apply CPAP with a face mask.
   E. Apply a rebreathing mask.

5. A 70 kg (154 lbs.) patient being ventilated in the IMV mode has the following arterial blood gas results:

pHa	7.32
$PaCO_2$	60 mm Hg
PaO_2	90 mm Hg
HCO_3	30 mEq/L

The ventilator settings are as follows:

FIO_2	0.40
IMV rate	2/min
Tidal Volume	500 ml
Spontaneous rate	25/min

The respiratory therapist should recommend increasing which two of the following?

I. IMV rate to 6/min.
II. tidal volume to 700 ml.
III. FIO_2 to 0.60
IV. inspiratory flow rate

A. I and II
B. I and III
C. I and IV
D. II and III
E. II and IV

6. A patient is being mechanically ventilated and a heat moisture exchanger ("artificial nose") is being used and the patient develops thick secretions which are difficult to suction. Which of the following should the respiratory therapist suggest?

A. Instill acetylcysteine (Mucomyst ™).
B. Decrease I.V. fluids.
C. Position the patient in a reverse Trendelenburg position.
D. Replace the exchanger with a heated humidifier.
E. Administer cromolyn sodium (Intal ™).

7. During controlled mechanical ventilation, the <u>most efficient</u> way to increase a patient's alveolar ventilation would be to increase the

A. ventilatory rate.
B. mechanical dead space.
C. expiratory time.
D. tidal volume.
E. FIO_2.

8. For a patient receiving mechanical ventilation the results of an arterial blood gas analysis are:

pHa	7.20
$PaCO_2$	37 mm Hg
PaO_2	110 mm Hg
HCO_3	13 mEq/L

These data indicate which of the following:

A. uncompensated metabolic acidosis
B. metabolic alkalosis
C. uncompensated hyperventilation
D. uncompensated hypoventilation
E. compensated hyperventilation

9. When applying CPAP only to an adult patient, which of the following alarms is the most appropriate to insure maintenance of therapy?

A. I:E ratio
B. high FIO_2
C. loss of airway pressure or low pressure
D. high respiratory rate
E. pulse monitor

10. The data below are recorded for a patient with respiratory failure receiving IMV.

FIO_2	0.80
Ventilator Tidal Volume	700 ml
IMV rate	8/min
Peak pressure	45 cm H_2O

The patient's arterial blood gas results are as follows:

pHa	7.40
$PaCO_2$	35 mm Hg
PaO_2	50 mm Hg
HCO_3	23 mEq/L

Which of the following would be indicated at this time?

A. Use SIMV at a rate of 10/minute.
B. Increase the tidal volume to 800 ml.
C. Increase the IMV rate to 15/minute.
D. Ventilate the patient on controlled mechanical ventilation at a rate of 10/minute.
E. Apply 5 to 10 cm H_2O PEEP/CPAP.

11. To achieve positive pressure ventilation without tracheal wall damage, the pressure in the cuff of the endotracheal tube should not exceed.

    A. 5 to 10 mm Hg.
    B. 15 mm Hg.
    C. 20 to 25 mm Hg.
    D. 50 mm Hg.
    E. 100 mm Hg.

12. The peak pressure on a volume cycled ventilator is 55 cm H_2O, the set tidal volume is 1000 ml, and the volume comprehension factor of the breathing circuit is 5 ml/cm H_2O. Under these conditions the delivered tidal volume to the patient is approximately

    A. 950 ml.
    B. 275 ml.
    C. 725 ml.
    D. 500 ml.
    E. 1000 ml.

13. A 45 year-old, 65 kg (143 lb) male patient is being ventilated on IMV after abdominal surgery with the following ventilator settings.

FIO_2	0.5
IMV rate	4/minute
Tidal volume	750 ml
Peak inspiratory flow rate	45 L/minute

The arterial blood gas results are as follows:

PHa	7.28
$PaCO_2$	52 mm Hg
PaO_2	154 mm Hg
HCO_3	24 mEq/L

The most appropriate recommendation would be to

A. increase the tidal volume to 1500 ml.
B. increase the IMV rate to 6 to 8/minute.
C. make no changes.
D. Apply 5 to 10 cm H_2O PEEP/CPAP.
E. Increase the peak inspiratory flow rate to 60 L/minute.

14. Monitoring of peak pressure during mechanical ventilation is useful because it reflects changes in

A. $PaCO_2$.
B. PaO_2.
C. Intracranial pressure.
D. lung-thorax compliance and airways resistance.
E. tissue perfusion.

15. The data below pertain to an adult patient who is being mechanically ventilated.

Peak pressure	40 cm H_2O
Plateau pressure	30 cm H_2O
Tidal volume	800 ml
PEEP/CPAP	5 cm H_2O
Inspiratory flow rate (constant)	60 L/minute (1 L/second)

On the basis of this information, the patient's static compliance is approximately which of the following?

A. 8 ml/cm H_2O
B. 20 ml/cm H_2O
C. 27 ml/cm H_2O
D. 32 ml/cm H_2O
E. 80 ml/cm H_2O

16. Based on the data in the previous question, the patient's airways resistance is approximately which of the following?

A. 40 ml/cm H_2O
B. 30 cm H_2O
C. 800 L/sec/cm H_2O
D. 2 cm HO/L/sec
E. 10 cm H_2O/L/sec

17. An adult patient is being mechanically ventilated. Which of the following should be recommended to improve oxygenation and to recruit collapsed alveoli?

A. Add PEEP/CPAP
B. Institute IMV
C. Increase the inspiratory flow rate
D. Increase the FIO_2
E. Decrease the inspiratory flow rate

18. A Bird Mark 7 ventilator set in the air-dilution position has a source gas of 100% oxygen. Which of the following is true about this situation?

    A. The FIO_2 will be 0.21
    B. The FIO_2 will be between 0.40 and 0.80
    C. The FIO_2 will be 1.0
    D. The pneumatic clutch will not operate
    E. The venturi will not operate

19. A patient ventilated with a volume cycled ventilator has a sudden decrease in lung compliance, as a result the

    A. peak pressure increases.
    B. peak pressure does not change.
    C. plateau pressure decreases.
    D. tidal volume automatically increases.
    E. peak inspiratory flow rate increases.

20. Lung compliance is measured in what units?

    A. L/cm H_2O
    B. cm H_2O
    C. L/sec
    D. cm H_2O/L/sec
    E. L/cm H_2O/sec

21. With a time cycled ventilator if the inspiratory time is held constant and the inspiratory flow rate is increased, what other functions change?

    A. Peak pressure
    B. PEEP/CPAP
    C. I:E ratio
    D. Ventilator rate
    E. Expiratory pressure level

22. A demand-flow valve CPAP system

    A. may only be used with a volume cycled ventilator.
    B. delivers a preset tidal volume.
    C. delivers inspiratory flow rate on demand and time cycles "OFF."
    D. may only be used with a time cycled ventilator.
    E. delivers inspiratory flow rate on demand during spontaneous breathing.

23. The Puritan-Bennett MA-1 and MA-2 ventilators are classified as

    A. time cycled.
    B. constant pressure generators.
    C. volume cycled.
    D. flow cycled.
    E. pressure limited and volume or time cycled.

24. The Baby-bird ventilator is classified as

    A. time cycled.
    B. pressure cycled.
    C. volume cycled.
    D. flow cycled.
    E. pressure limited and volume or time cycled.

25. The Emerson ventilator delivers as _____ inspiratory flow waveform during mechanical inhalation.

    A. square
    B. sinusoidal or "sine"
    C. accelerating
    D. decelerating
    E. linear

26. A ventilator that is classified as a constant flow generator delivers a square inspiratory flow waveform and a _____ airway pressure waveform.

    A. biphasic
    B. sigmoidal
    C. sinusoidal
    D. linear
    E. compliant

27. Which of the following measurements is the best index for determining the adequacy of ventilation?

    A. VE
    B. VA
    C. VT
    D. VD
    E. $PaCO_2$

28. For a patient being mechanically ventilated, which I:E ratio would adversely affect cardiac output the most?

A. 1:2
B. 1:4
C. 1:3
D. 2:1
E. 2:4

29. For a patient receiving patient-triggered or assisted mechanical ventilation, calculate the alveolar minute ventilation given the following data.

Exhaled tidal volume	700 ml
Physiologic dead space	200 ml
Peak pressure	40 cm H_2O
Ventilator rate	12/minute

A. 8.4 L/minute
B. 10.8 L/minute
C. 2.4 L/minute
D. 6.0 L/minute
E. 0.5 L/minute

30. Consider the operation of volume cycled and pressure cycled ventilators in terms of their respective responses to a sudden increase in airways resistance. Which statements are correct?

I. Volume cycled ventilators cycle "OFF" after a preselected volume has been delivered.
II. Pressure cycled ventilators will deliver a greater tidal volume.
III. Pressure cycled ventilators will compensate by increasing inspiratory time.
IV. Pressure cycled ventilators deliver a decreased tidal volume.
V. Volume cycled ventilators will indicate an increase in peak pressure.

A. II and V
B. I and II
C. I and III
D. III and V
E. I, IV, and V

31. Which condition might cause an increase in the peak pressure reading?

    A. Increasing the tidal volume
    B. Increasing the expiratory time
    C. Decreasing the peak inspiratory flow rate
    D. Decreasing the ventilatory rate
    E. Increasing the patient's compliance

32. For a patient connected to a mechanical ventilator, what data are needed to calculate airways resistance?

    A. Peak pressure and tidal volume
    B. Peak pressure and positive and expiratory pressure
    C. Peak pressure, plateau pressure, and inspiratory flow rate
    D. Peak pressure, tidal volume, and inspiratory flow rate
    E. Plateau pressure and inspiratory flow rate

33. Which of the following classifications could pertain to the Siemens 900 C ventilator?

    A. Pneumatically and electrically powered
    B. Volume cycled
    C. Time cycled
    D. Pressure cycled
    E. A and C only

34. A pressure cycled ventilator cycles from the inspiratory to the expiratory phase after a

    A. preselected inspiratory time elapses.
    B. preselected expiratory time elapses.
    C. preselected airway pressure is reached.
    D. preselected tidal volume has been delivered to the patient.
    E. specific inspiratory flow rate has been reached.

35. A volume cycled ventilator cycles from the inspiratory to the expiratory phase after a

    A. preselected inspiratory time elapses.
    B. preselected expiratory time elapses.
    C. preselected airway pressure is reached.
    D. preselected tidal volume has been delivered to the patient.
    E. specific inspiratory flow rate has been reached.

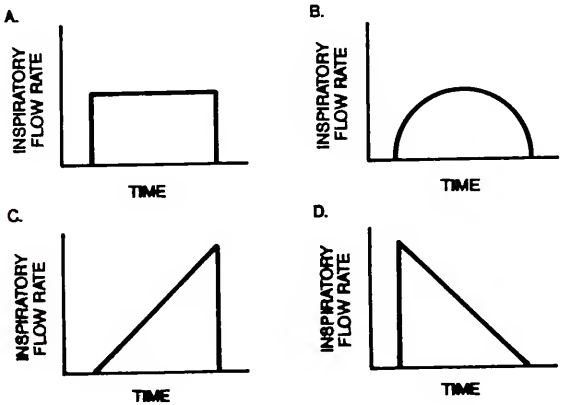
36. A time cycled ventilator cycles from the inspiratory to the expiratory phase after a

    A. preselected inspiratory time elapses.
    B. preselected expiratory time elapses.
    C. preselected airway pressure is reached.
    D. preselected tidal volume has been delivered to the patient.
    E. specific inspiratory flow rate has been reached.

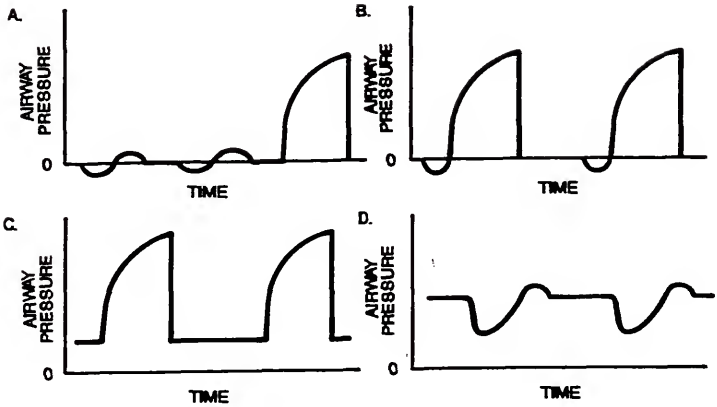
37. A flow cycled ventilator cycles from the inspiratory to the expiratory phase after a

    A. preselected inspiratory time elapses.
    B. preselected expiratory time elapses.
    C. preselected airway pressure is reached.
    D. preselected tidal volume has been delivered to the patient.
    E. specific inspiratory flow rate has been reached.

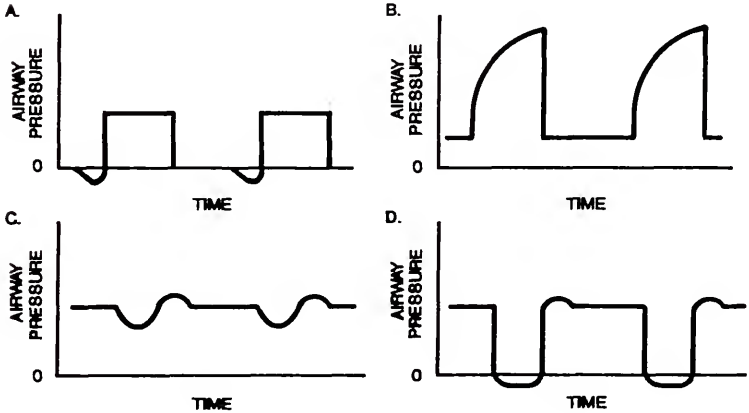
38. Which may be classified as a sinusoidal or "sine" inspiratory flow wave form?



39. Which airway pressure wave form typifies a patient breathing on IMV?



40. Which airway pressure wave form typifies a patient breathing on CPAP?



APPENDIX D
SAMPLE LETTER TO DIRECTORS OF RESPIRATORY THERAPY PROGRAMS PARTICIPATING IN THE STUDY

Dr./Mr./Ms. J. Doe
Director, Respiratory Therapy Program
College
Address

Dear Dr./Mr./Ms. Doe:

Thank you for agreeing to participate in a nationally conducted study designed to explore the problem of the low pass rate on the Certified Respiratory Therapy Technician (CRTT) examination. As you know, this is a national problem that has confronted our profession for several years and, as yet, no clear explanation has been advanced. Your program, along with other respiratory therapy programs in the northern, southern, easter, and western regions of the United States, have agreed to participate in this study. All names and inferences to any individuals participating in the study <u>will</u> <u>not</u> be mentioned in the final report. All materials will be treated in a confidential manner.

As per our conversation, this study will examine the learning/cognitive preferences of second or final year respiratory therapy students and their instructor for a major course in the program. In order to obtain this information, a <u>learning styles inventory</u> (LSI) and a <u>learning preferences inventory</u> (LPI) will be used. In addition, all students participating in the study will be asked to complete an <u>achievement test</u> designed for a specific course, i.e., theory and use of mechanical ventilators. Please distribute the enclosed materials as follows:

1. Give the LSI, LPI, and achievement test to each <u>second</u> or <u>final</u> year student enrolled in the course on mechanical ventilators.
2. Give the LSI and LPI to the instructor who taught the course on mechanical ventilators.

The LSI and LPI require approximately five minutes each to complete. Directions for answering the LSI and LPI instruments are at the top of each form. Approximately 30 minutes are required to complete the

achievement test. Please return all materials to me (in the enclosed stamped, addressed envelope) as soon as they have been completed.

Your assistance in this project will be invaluable and I am grateful for your help. Please extend my appreciation to your faculty and students as well. If you have any questions, please feel free to call (904-392-3153).

Sincerely,

Michael J. Banner
University of Florida
College of Medicine
Department of Anesthesiology
Box J-254
Gainesville, FL 32610-0254

APPENDIX E
MEAN, STANDARD DEVIATION, AND CORRELATIONAL ANALYSIS OF ALL VARIABLES

Table E-1

Means and Standard Deviations of All Variables

Variable	Mean	Standard Deviation
Achievement Score (ACH)	74.6	18.6
Grade Point Average (GPA)	2.96	0.49
No. Hours Homework per week (HW)	5.27	2.72
Concrete Experience Discrepancy Score (CE)	8.35	6.14
Abstract Conceptualization Discrepancy Score (AC)	12.42	10.2
Reflective Observation Discrepancy Score (RO)	11.39	9.5
Active Experimentation Discrepancy Score (AE)	8.76	6.97
Interpersonal Discrepancy Score (INTP)	17.04	11.3
Individual Discrepancy Score (INDV)	13.9	8.15
Abstract Discrepancy Score (ABS)	16.21	10.13
Concrete Discrepancy Score (TSTR)	17.73	12.32
Student Structured Discrepancy Score (SSTR)	16.58	10.75

Table E-2

Correlational Analysis of All Variables (correlation coefficient/p value)

	ACH	GPA	HW	CE	AC	RO	AE	INTP	INDV	ABS	CONC	TSTR	SSTR
ACH	1												
GPA	.67/.01	1											
HW	.33/.01	.32/.01	1										
CE	-.28/.01	-.21/.01	-.24/.01	1									
AC	-.78/.01	-.55/.01	-.32/.01	.29/.01	1								
RO	-.48/.01	-.25/.01	-.08/.34	.15/.07	.52/.01	1							
AE	- .7/.01	-.54/.01	-.33/.01	.39/.01	.63/.01	.38/.01	1						
INTP	-.05/.5	-.15/.08	-.23/.01	.07/.36	.06/.42	.07/.36	.09/.24	1					
INDV	-.15/.07	- 2/.02	- .2/.02	.13/.11	.16/.06	.12/.2	.13/.10	.36/.01	1				
ABS	-.15/.06	-.21/.01	-.32/.01	.2/.01	.1/.3	-.02/.8	.22/.01	.33/.01	.29/.01	1			
CONC	-.66/.01	- .5/.01	- .3/.01	.17/.04	.65/.01	.33/.01	.6/.01	.09/.01	.3/.01	.27/.01	1		
TSTR	-.28/.01	- .3/.01	-.25/.01	.07/.38	.3/.01	.04/.65	.24/.01	.12/.15	.27/.01	.16/.04	.32/.01	1	
SSTR	-.36/.01	-.35/.01	-.2/.01	.14/.10	.36/.01	.24/.01	.24/.01	.18/.02	.32/.01	.07/.35	.33/.01	.45/.01	1

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BIOGRAPHICAL SKETCH

Michael Joseph Banner was born in Detroit, Michigan. While living in Michigan, he attended elementary school and later graduated from high school in 1967. In 1971, he graduated with honors from Macomb Community College earning an associate in science degree in respiratory therapy. Following graduation, he passed the registered respiratory therapists (RRT) board examination and then moved to Miami, Florida, where he was employed as a staff respiratory therapist at the University of Miami/Jackson Memorial Medical Center. In 1976, he graduated from Florida International University with a Bachelor of Science degree in biological health sciences. In that same year he was appointed as a clinical instructor in the respiratory therapy program at Miami-Dade Community College. From 1977 to 1979, he was the director of the Respiratory Care Service at the University of Miami/Jackson Memorial Medical Center. While at that same university, he was also appointed to the position of Research Associate in Anesthesiology from 1979 through 1980. In 1981, he was appointed Assistant in

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Mr. Banner has authored articles in scientific journals and chapters in medical textbooks on the subject of respiratory therapy. He has served on the editorial boards of several national medical and scientific journals and as a consultant for other journals. He has also presented lectures and scientific papers at state and national medical and respiratory therapy conferences.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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