Order Number 9015793

Non-traditional students' learning style preferences and course performance in undergraduate computer science courses

Piscopo, Phillip John, Ph.D.

Boston College, 1989

U·M·I
300 N. Zeeb Rd.
Ann Arbor, MI 48106

BOSTON COLLEGE
GRADUATE SCHOOL

The thesis of Phillip J. Piscopo

entitled Non-traditional Students' Learning Style Preferences and Course Performance in Undergraduate Computer Science Courses

submitted to the Department of Education

in partial fulfillment of the requirements for the degree of

Doctor of Philosophy in the Graduate School of

Boston College has been read and approved by the Committee:

[signature]

Mary T. Kennane

Mary H. Griffin

July 6 1989
Date

BOSTON COLLEGE

The Graduate School of Arts and Sciences
Department of Education

NON-TRADITIONAL STUDENTS' LEARNING STYLE PREFERENCES AND COURSE PERFORMANCE IN UNDERGRADUATE COMPUTER SCIENCE COURSES

A dissertation

by

Phillip J. Piscopo

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

May 1989

ABSTRACT

The purpose of this study was to determine the effect of learning style preference on course performance of non-traditional students enrolled in an undergraduate computer science program. Kolb's Learning-Style Inventory was used to assess students' learning style preferences in four learning style types: Converger, Diverger, Assimilator, and Accommodator. All computer science courses were classified according to content type: survey (concept generalizations), programming language (syntax and structure), advanced programming language (self-directed experimentation), and theory/analytical (abstract conceptualization). Instructor teaching style preference was determined using Lieberman's Teaching Style Self-Assessment.

The sample consisted of 16 different instructors, teaching a total of 25 sections of 13 different courses, and 213 enrollments. A three-way ANOVA was used to compare student course performance based on the four course groupings, the four learning style preferences, and the four teaching style orientations. The results indicated the difference in course grades was significant based on the course type, learning style preference, and teaching style preference for p-values of 0.110, 0.100, and 0.104, respectively. The course grade difference based on combined effects of the independent variables was significant for a p-value of 0.094. Although these levels of significance are problematic, the results support the need

for computer science curriculum designers to consider a variety of learning activities in specific types of courses.

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

Chapter 1

INTRODUCTION

Background and Significance

Rapidly changing technology has had a tremendous impact on society and education over the past two decades. There is every indication that this trend can be expected to continue. Part of the impact is the widespread use of computers in many activities of everyday life. College and university education has responded to society's need for data processing graduates with a plethora of undergraduate programs in computer science to meet the increasing industry demand for trained professionals.

At the same time, the number of non-traditional students (over 22 years of age) currently has increased. These new students bring with them different attitudes toward learning, different expectations of learning, and different career goals. Many older adult learners have selected a computer science major primarily because of the numerous career opportunities available in this field. To date, very little research has been done in the area of computer science instruction to address the specific learning needs of this new student population.

Most of the studies which have been done in undergraduate computer science programs have dealt with curriculum models as opposed to instructional or learning styles and have focused on the traditional student population. A few recent studies addressed instructional methodologies used with traditional students in specific courses.

Leifer and DeHaemer (1986) reported on the effective incorporation of six behavioral activities used to teach Computer Information Systems (CIS) courses. These activities were broken down into two sets of three exercises.

Set One: Interpersonal Experience.

1. Exercise: Myers-Briggs Type Indicator Questionnaire (short-form).
Objective: students are shown how they prefer to learn about and decide things in comparison to others.

2. Exercise: Active Listening.
Objective: students are motivated towards effective communication through experience in the major factors which facilitate or block person-to-person communication.

3. Exercise: Ranking Job Characteristics. Objective: students learn differences between their motivational needs and others involved in the information system such as programmers, managers, and users.

Set Two: Teamwork Experience.

4. Exercise: The Fishbowl Exercise.
Objective: students gain experience in observing a group doing problem solving and learn to distinguish between process and content issues in group decision making.

5. Exercise: Win as Much as You Can.
Objective: students experience the effects of destructive competition in a multigroup environment. The payoff for successful conflict resolution is demonstrated.

6. Exercise: Survival Exercise.
Objective: students learn by experience that the synergy of group solutions to complex problems are usually better than those made by individuals. Motivation to work effectively as a team in the process of problem solving is heightened. (pp. 74-75)

Wojtkowski, Brender, and Wojtkowski (1986) reported on the use of a Team Learning and Informative Testing (TL/IT) experiential learning methodology in introductory Computer Information Systems classes. This methodology incorporated three modes of learning --

individualistic, competitive, and cooperative. **Figure 1** presents the instructional activity sequence which is used in TL/IT.

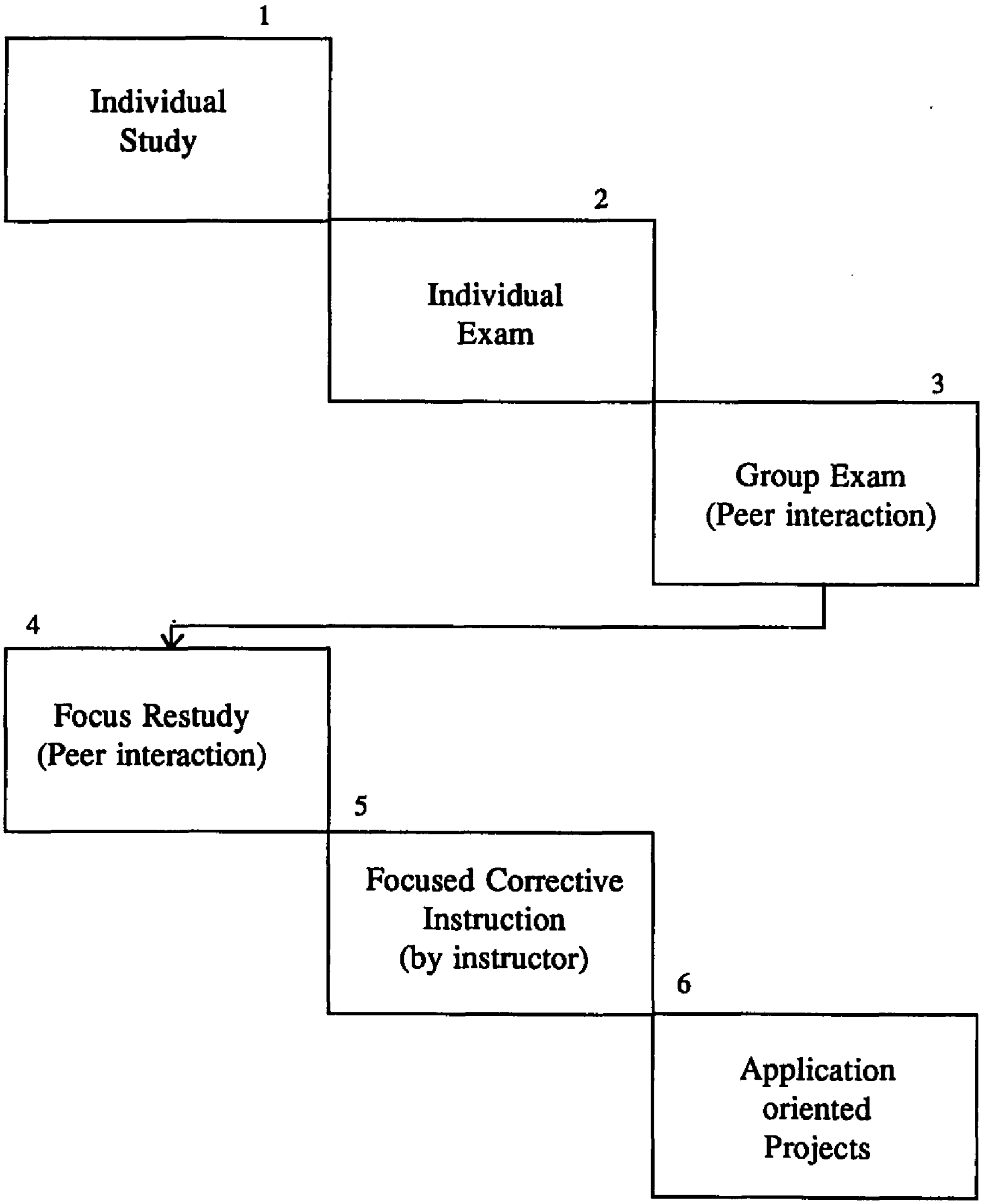


Figure 1.

Instructional activity sequence used in Cooperative Team Learning/ InformativeTesting teaching methodology. (Wojtkowski, Brender, and Wojtkowski, 1986, p. 82)

The above two studies focused on the needs of the computer marketplace, namely the development of computer scientists capable of working in project team environments. The direction was oriented towards team members rather than individual learning style preferences. Other recent studies, (Baker, 1986; Grun, 1986; Stone, 1986), addressed learning styles but did not isolate an undergraduate computer science curriculum.

There appears to be an absence of research addressing the learning style needs of non-traditional students in the area of computer science.

Learning Style

This study presents a discussion of learning style theory, an existential approach to learning which emphasizes the individual differences found in students. The instrument used in this study was the 1985 version of the Learning Style Inventory (LSI) developed by David A. Kolb. This Inventory was created to measure the individual learning styles derived from experiential learning theory.

The form of the test is a twelve-item self-description questionnaire. Each item asks the respondents to rank-order their four sentences in a way that best describes their learning style. One sentence in each category corresponds to one of the four learning modes--Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and Active Experimentation (AE).

Learning style types are determined by using two calculated scores AC - CE and AE - RO. These scores then are used to indicate the extent to which a student emphasizes abstractness over concreteness (AC - CE) and the extent to which an individual emphasizes action over reflection (AE - RO). Characteristics of Learning Style Types are shown in **Table 1** (Smith and Kolb, 1986).

Table 1

Characteristics of Learning Style Types

Accommodator	Diverger
* doing things	*imaginative ability
* solves problems intuitively by trial and error	* can organize relationships into a meaningful "Gestalt"
* action oriented	* can view concrete situations from a number of perspectives
* dominant learning abilities are **CE & AE**	* dominant learning abilities are **CE & RO**

Converger	Assimilator
* practical application	* creation of theoretical models
* deductive reasoning	* inductive reasoning
* likes to deal with things	* likes to deal with abstract concepts
* dominant learning abilities are **AC & AE**	* dominant learning abilities are **AC & RO**

Motivation and Learning

The increasing number of adults entering higher education requires educators to evaluate the motivations of these new students.

> If these adult learners are to be adequately served, institutions of higher education must assess their needs and motivations, understand the differences between adult learners and the traditional age college student, and make appropriate adjustments in administrative procedures, programming, and the teaching-learning process (Wolfgang and Dowling, 1981, p. 641).

This study will describe some of the current theories underlying motivation, especially as it applies to adult learning theory.

Teaching Style

Maintaining an atmosphere in which learning can flourish requires educators to be aware of both the physical and psychological needs of the students. In many cases, there is only a limited amount one can do with the physical needs of students. However, an understanding of students' learning style certainly will help the instructor recognize characteristics of diverse student types. It is just as important for the instructor to recognize his own teaching orientation.

The instrument used in this study to measure Instructor teaching style was Lieberman's 4MAT Teaching Style Self Assessment (TSSA). This instrument was developed to be used with Kolb's Learning Style Inventory. It identifies four statistically different teaching style orientations.

Respondents are asked to rate each of four "characteristics" in nine items. The characteristics are rated 1, 2, 3, or 4 and the same rating may not be given to two characteristics in the same item. All the characteristics are keyed to a particular teaching style. These teaching style characteristics then can be compared to the learning style characteristics of the students.

Statement of the Problem

The purpose of this research was to determine the learning style preferences and course performance of non- traditional undergraduate computer science students.

Hypotheses

In analyzing the relationship between student learning style preference and course performance, four specific hypotheses were tested. The null hypotheses tested were:

H_0 : There is no significant difference in the average course scores among students with different learning style preferences.

H_0 : There is no significant difference in the average course scores among students in different course categories.

H_0 : There is no significant difference in the average course scores among students taught by different teaching style orientations.

H_0 : There is no significant difference in the average course scores among students with different learning style preferences, in different course categories, taught by different teaching style orientations.

Organization of the Study

The first chapter provides a general introduction to the problem to be investigated. Chapter 2 presents a review of the related literature and an educational framework for conducting the study. It provides guidelines for undergraduate computer science curriculum and outlines the characteristics of non-traditional students. Various learnings styles and the relationship of learning to teaching are also discussed.

The third chapter describes the methodology used in the study and Chapter 4 presents the results. The final chapter, Chapter 5, provides an interpretation of the results and makes recommendations for further research. Additional comments are also included.

Definition of Terms

The following definitions are offered to provide a common understanding of terminology used in this research project:

Non-traditional Education refers primarily to an attitude that places the student in first priority and the institution in second. It views the purpose of education as providing students with skills and resources to develop fully their unique potentials. Furthermore, it encourages diversity of individual opportunity, while deemphasizing time and space requirements in deference to competence and/or performance requirements (Trotsky, 1978).

Computer Science Curriculum The curriculum as outlined by the "DPMA Education Foundation Model Curriculum for Undergraduate Computer Information Systems Education" presented at the National Computer Conference May, 1981 and "Curriculum '78, Recommendations for the Undergraduate Program in Computer Science", a report of the ACM Curriculum Committee on Computer Science March, 1979.

Non-traditional student A student who is over 22 years of age enrolled in a four year undergraduate computer science program.

Assumptions and Limitations

It was assumed in this study that the sample used is representative of non-traditional undergraduate computer science students. It also was assumed that the program's curriculum was representative of the DMPA suggested computer science curriculum. All subjects surveyed in this research attended one private university oriented to non-traditional students. All limitations of this study are derived from these limitations.

Chapter 2

REVIEW OF RELATED LITERATIURE

To more fully appreciate the issues involved in Computer Information Systems (CIS) undergraduate education, the review of related literature addresses five areas:

1. identification of content requirements for Computer Science undergraduate courses;

2. identification of the characteristics of non-traditional students;

3. description of the relationship between motivation and learning;

4. description of student learning styles; and

5. description of the relationship of learning to teaching.

Computer Science Undergraduate Courses

In describing the characteristics of an undergraduate computer science curriculum, the content recommendations of two national professional organizations were used: the Association for Computing Machinery (ACM) **Table 2** and the Data Processing Management Association (DPMA) **Table 3.** There are no recommendations by either group with reference to instructional style.

Berztiss states that the ACM "Curriculum '68 was the first extensive attempt to define computer science as a rigorous independent discipline..." (Berztiss, 1987, p.356). The Curriculum Committee on Computer Sciences of the ACM updated its recommendations for an undergraduate program in computer science in a subsequent report "Curriculum '78". A further revision in 1983, identified eight courses in a core program with an additional four courses selected from elective offerings. The ACM Model stresses more co-ordination with mathematics and engineering departments than does the DPMA Model.

Lorents declares "the DPMA Model Curriculum is a professional program often leading to a business degree" (Lorents,1985, p. 33). This program seeks to clarify the roles of undergraduate computer education programs in order to improve education and training in the nation's colleges and universities. The goals of DPMA address business information processing and the training of applications programmers/analysts rather than scientific

Table 2
ACM Curriculum '78

Core courses

CS1. Computer Programming I
CS2. Computer Programming II
CS3. Introduction to Computer Systems
CS4. Introduction to Computer Organization
CS5. Introduction to File Processing
CS6. Operating Systems and Computer Architecture I
CS7. Data Structures and Algorithm Analysis
CS8. Organization of Programming Languages

Electives

CS9. Computers and Society
CS10. Operating Systems and Computer Architecture II
CS11. Database Management Systems Design
CS12. Artificial Intelligence
CS13. Algorithms
CS14. Software Design and Development
CS15. Theory of Programming Languages
CS16. Automata, Computability, and Formal Languages
CS17. Numerical Mathematics: Analysis
CS18. Numerical Mathematics: Linear Algebra

Table 3

The DPMA Model Curriculum

Core courses

CIS-1 INTRODUCTION TO COMPUTER-BASED SYSTEMS

CIS-2 APPLICATIONS PROGRAM DEVELOPMENT I

CIS-3 APPLICATIONS PROGRAM DEVELOPMENT II

CIS-4 SYSTEMS ANALYSIS METHODS

CIS-5 STRUCTURED SYSTEMS ANALYSIS AND DESIGN

CIS-6 DATABASE PROGRAM DEVELOPMENT

CIS-7 APPLIED SOFTWARE DEVELOPMENT PROJECT

Electives

CIS-8 SOFTWARE AND HARDWARE CONCEPTS

CIS-9 OFFICE AUTOMATION

CIS-10 DECISION SUPPORT SYSTEMS

CIS-11 ADVANCED DATABASE CONCEPTS

CIS-12 DISTRIBUTED DATA PROCESSING

CIS-13 EDP AUDIT AND CONTROLS

CIS-14 INFORMATION SYSTEMS PLANNING

CIS-15 INFORMATION RESOURCE MANAGEMENT

programmers. The DPMA Model recommends seven core courses plus three additional electives in computer science for a degree.

In a paper presented to the Fifth Annual Information Systems Educational Conference, Discenza and McFadden (1986, p. 46) cited surveys conducted by Pierson, et al. indicating both the DPMA and ACM curriculum guidelines being widely adopted by American Assembly of Collegiate Schools of Business (AACSB) accredited institutions. Survey forms were sent to 236 schools in January, 1984. Of those responding, eighteen percent indicated they used the DPMA model.

Thirteen percent indicated they used the ACM model. Additionally, another twelve percent responded that they used a modified DPMA and ACM combination. Another four percent of the schools indicated they used a modified DPMA model while 2.6 percent answered by indicating they used a modified ACM model.

In another survey cited by Discenza and McFadden, Souder found that 90% of 188 four-year academic institutions indicated that they either had implemented or planned to implement the DPMA model curriculum for their undergraduate computer information systems education (Discenza and McFadden, 1986, p. 46).

The differences between the ACM and DPMA curriculum recommendations are not very significant. In some cases, a required course in one is listed as an elective in the other. The time and intensity also differs. The DPMA model offers a greater selection of topics for electives. Both of these models were developed by professional organizations responding to their membership's needs.

Updated recommendations to their models by these two groups should not show marked dissimilarities.

According to Laurido-Santos (1985), the ACM Curriculum Committee's on-going mission is to develop recommendations to develop skills of their graduates:

> To face the current and future demands, the Committee considers the curriculum should address three basic goals: people needs, skill needs, and tool needs. Graduates of the program will be employed for major segments of their careers in positions involving organizational information .systems. To be effective on these functions, knowledge that includes human relations and nterpersonal skills for communications, in addition to the technical knowledge (p. 359).

It is interesting to note the emphasis on human relations and interpersonal skills, emphasis not traditionally noted for computer scientists. Characteristics such as the above can be identified with instruments such as Kolb's Learning Style Inventory, as well as others. In order to achieve these goals computer science programs will need to determine whether these goals are being incorporated into the curriculum.

Characteristics of Non-traditional Students

In describing the characteristics of non-traditional students, Richard E. Peterson and Associates (1979) identified six learning motivations: (a) Desire to achieve practical goals-to get a new job or advance in a current one or to improve income; (b) Desire to achieve personal satisfaction and other inner-directed personal goals such as personal development and family well-being; (c) Desire to gain new knowledge, including the desire to learn for its own sake; (d) Desire to achieve formal educational goals, including degrees or certification; (e) Desire to socialize with others or escape from their everyday routine; and (f) Desire to achieve societal goals.

Cross (1981) describes the new adult learner as being economically and educationally disadvantaged. This view is supported by Harrington (1977). Due to lack of social pressures and poverty, many non-traditional students did not pursue college immediately after high school; got married; and now find themselves in dead-end jobs. Harrington further describes typical adult learners as being in their thirties, favoring practical education and being self-supporting.

In support of these theories, there have been several studies conducted by the Educational Testing Service (ETS) attempting to analyze why adults were returning to the classroom (Carp, Peterson and Roelfs, 1974; Cross, 1978; Aslanian and Brickell, 1980). These studies determined that personal characteristics of adult learners were not the main reason for these students returning to the classroom. Instead, the findings indicated the primary reason was related to transitional periods occurring in their lives, such as career, family, leisure, or religion. Transition was directly related to the motivation for their return to the classroom. A summary of seven principal findings from this research on learning motivation follows:

1. Men learn more often than women because of career changes, while women learn more often than men because of family, leisure, or health transitions.

2. Adults under age 65 learn chiefly because of career transitions, while adults over 65 learn chiefly because of leisure and family transitions.

3. Adults who are single, married, or divorced learn mainly because of their careers, while widowed persons learn mainly because of their leisure and family activities.

4. Adults who have attended four-year colleges learn most often for their careers, while adults who have attended high schools or two-year colleges learn most often for other reasons--primarily reasons regarding family and leisure activities.

5. As income rises, adults learn more often for

career reasons.

6. Workers and students learn primarily to make career transitions, while homemakers and retired persons learn primarily to make leisure and family transitions.

7. As occupational level rises, adults learn more often for career reasons
(Aslanian and Brickell, 1980, p. 97).

The need for these studies was brought about by an enormous increase in adult learning, both formal and informal. Research indicated more than half of all full-time and part-time college students were adults 25 years of age and older and this situation is expected to continue well into the future. Findings in a national random sample indicated half of all Americans 25 years and older learned one of more topics during a one year period.

Table 4 shows the results of a study indicating that over 60 million adults were involved in some type of learning experience during a typical year (Aslanian and Brickell, 1980, p. 139).

Table 4

Learning Now or in Past 12 Months

Learning	Adults in Study Number	 Percent	Study Results Extrapolated to Nation
Yes	744	49	62 million
No	775	51	64 million
Total	1519	100	126 million

Older students, those who have severed connections with formal education for at least five years, according to Milton R. Stern (Milton and Associates, 1978) differ psychologically from traditional students. They do not regard the teacher as parent and have a sense of equality with the teacher. They may accept the clear authority of the professors in the limited subject area of their courses, but probably discount their opinions in other areas. These students are more likely to challenge faculty and ask questions traditional students would not. They are more inclined to disregard grades as a primary motivating factor. Their principle self-identity is not that of "student", but rather that of their current social role: worker, manager, homemaker,and mother. Stern classifies older students into two basic categories: (a) those motivated by job-related reasons, and (b) those motivated by personal factors.

Most studies tend to identify employment and restlessness as principle factors for adults returning to school. Although there are many characteristics of non-traditional or older students, advancement in their current job or training in a new vocation to escape a dead-end position are the most often noted characteristics. Lack of psychological fulfillment or rewards in their current situation and the realization that they can expect an increased lifespan also contribute. The identities of minorities, which were fostered in the 1960's and 1970's, encouraged older members of these groups to seek higher education.

The economic pressures and changing role models of women have likewise effected and prompted more women to enter college after having postponed their education for marriage and child bearing among other reasons. Their developed value system and life experiences, as well as their expectations require a new evaluation of what higher education can provide for these non-traditional students. A recent comprehensive study by Iovaccini, Hall, and Hengstler (1985) of a small comprehensive public urban university in the southeast supports the current theories of non-traditional students. Their study also provides us with some comparisons between degree-seeking and nondegree-seeking students. Nondegree-seeking students tended to be older (34 years) than traditional students and non-traditional degree-seeking students (32 years).

Older degree-seeking and nondegree-seeking students were more often employed as compared to their traditional counterparts. Over fifty-percent of the traditional students entered college immediately after high school as opposed to sixteen percent of the nondegree-seeking students. The traditional student placed greater importance on the cost of enrolling, the location of the school, and availability of the academic program.

> Nondegree-seeking students and older degree-seeking students tended to express a greater interest in computer science than their younger counterparts (Iovacchini, Hall, and Hengstler, 1985, p. 50).

Also indicated in this study were degree-seeking and adult students who appeared to have put more time into their studies. The researchers stated:

> more and more adults will need to update or refresh their current skills, while others will need to learn entirely new skills. This goal oriented emphasis will continue to tax many "popular" programs such as computer science, business, engineering, and the health professions (Iovacchini, Hall and Hengstler, 1985, p. 52).

The interest of older students, both degree-seeking and nondegree-seeking, for computer science supports the need for further research in this area. Studies such as these also point out the need for the development of certificate programs. Programs that allow nondegree-seeking students the opportunity to pursue concentration areas without matriculating as full time students. Many colleges at the present time only allow degree-seeking students into their computer science programs.

In an article by Scott, "Training Adult Learners - A New Face in End Users" (1988), the author emphasizes the need to evaluate the learning model used by teachers. Pedagogy was the only model used up to World War I. In this model, the teacher has full responsibility for all decision making. The teacher determines what will be learned, how it will be learned, when it will be learned. The teacher then determines whether it was learned or not. All teaching is teacher directed and places the learner in a submissive role.

Scott cites another model, andragogy, which she defines as "the art of helping adults learn" (Scott, 1988, p. 25). A definition also used by Knowles (1970, p. 38). This model makes use of several different assumptions but places the major emphasis on learner directed activities.

Both of these models can be broken down into six basic components outlined in **Table 5**.

Table 5

Pedagogy vs. Andragogy

	Pedagogy	Andragogy
The Need to Know	Learners do not need to know how what they learn will affect their lives	Adults need to know why they need to learn something before undertaking learning it
Self-Concepts	Dependent personality	Independent and self directing
The Role of Experience	The experience that counts is that of the teacher.	Adults, by virtue of having lived longer enter educational experience with a wealth of experience.

Table 5 Continued

Readiness to Learn	Learners become ready to learn what the teacher tells them to learn in order to pass a test	Adults become ready to learn those things they need to know in cope effectively real life situations
Orientation to Learning	Learners have subject centered orientation .	An adult's orientation is life centered or task centered.
Motivation	External motivators such as grades, a teacher's approval, parental pressure.	Internal motivators such as self-esteem, quality of life.

(Scott, 1988, p. 26)

Knowles' position is based on at least four, what he calls crucial, assumptions about the characteristics of adult learners in sharp contrast to the those of child learners.

> These assumptions are that, as a person matures, 1.) his self-concept moves from one of being a dependent personality toward one of being a self- directing human being; 2.) he accumulates a growing reservoir of experience that becomes an increasing resource for learning; 3.) his readiness to learn becomes oriented increasingly to the development tasks of his social roles; and 4.) his time perspective changes from one of postponed application of knowledge to immediacy of application, and accordingly his orientation toward learning shifts from one of subject-centeredness to one of problem-centeredness (Knowles, 1970, p. 39).

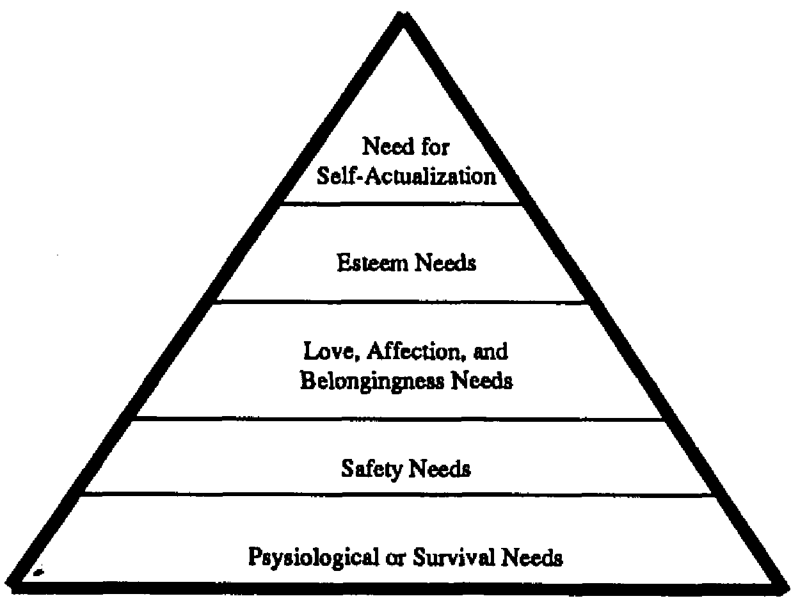
Much of the theories presented by Scott and Knowles can be traced to the work of Maslow and his emphasis of man's need for self-actualization and the Hierarchy of Human Needs, **Figure 2.**

Figure 2

MASLOW'S HIERARCHY OF HUMAN NEEDS

Maslow emphasizes that the need for self-actualization is a healthy man's prime motivation.

Self-actualization means actualizing one's potential, becoming everything one is capable of becoming.



Most basic needs have to do with survival physically and psychologically.

On the whole an individual cannot satisfy any level unless needs below are satisfied
(Knowles, 1970, p. 24)

This hierarchy is read from bottom to top as man progresses from one stage to the next in achieving complete self- identity through the development of his full potential. Maslow (1971, p. 45) offers this definition of self- actualization:

> Self-actualization means experiencing fully, vividly, selflessly, with full concentration and total absorption. It means experiencing without the self-consciousness of the adolescent. At this moment of experiencing, the person is wholly and fully human.

The problem for educators over the debate between pedagogy and andragogy is when does the teacher change learning models? Is this model based on age or school level? There has been very little research on this topic to accept this model as the principal learning strategy in adult education. This model is further confusing when one tries to determine whether andragogy is a learning theory, philosophical theory, or a political theory (Cross, 1981). "Andragogy has been moderately successful in sparking debate; it has not been especially successful, however, in stimulating research to test the assumption" (Cross, 1981, pp. 227-228).

Knowles (1984), responding to this debate in a latter work, points out that andragogy is a model made up of several elements which can be adapted or modified in whole or in part. The great strength in the andragogical model is its flexibility. It is important for educational institutions to evaluate their commitment to the returning adult by providing support services. It is not necessary to adopt the whole andragogical model, but some adaption is required.

Another outcome of this debate has been to force educators to evaluate the relationship of the teaching - learning process. Therefore, even if the questions that have been raised are not fully answered by this model, it has had a positive influence on the teaching profession. By requiring educators to periodically evaluate the learning - teaching process can only bring a fresh enthusiasm into the classroom.

The education and training of adults will be influenced by many changes in the future, according to Seaman and Dutton (1981). Changes in politics, education, society, and technology which are occurring and which will continue to occur, will influence the training needs and opportunities of adults. This situation requires society training the educators to be prepared to handle this influx of adults seeking new knowledge and skills (Seaman and Dutton, 1981 p. 131).

This message is echoed by Hodgkinson, a long-time researcher and consultant who is also a senior fellow at the American Council on Education. Hodgkinson declares the baby boom has gone bust and that the American education system is loosing and will continue to loose its young people. One conclusion to all of this, Hodgkinson states:

> is that colleges and universities will have to attract, retain, and succeed in educating more and more older

students, or the institutions may not long survive (Jacobson, 1986, p. 1).

There has been many theories and sequential models on adult growth and development. It is beyond the scope of this study to cover all of the material written on this subject. However, a report written by Merrian (1984) provides us with a chart listing many of the principal authorities on this subject (**Table 6**). Similarities among the earlier and more recent theories can be found by glancing across a particular period. Those models that focus on one dimension of development (i.e. Loevinger, Perry, Kohlberg, and Fowler) also have much in common with one another.

Table 6 --- Sequential Models of Development

	Jung	Buhler	Erikson
1		0-15 Progressive	Trust vs.
2		Growth	Mistrust
3			
4			Autonomy vs.
5			Shame
6			
7			Initiative vs.
8			Guilt
9		15-25 Continued	Industry vs.
10		Growth	Inferiority
11		Expansion	
12			Identity vs.
13			Role
14			Confusion
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25	Youth	25-45 Stability of	Intimacy vs.
26	(puberty)	Growth	Isolation
27	to 35-40)	Culmination	
28		Period	
29		Self-deter-	
30		mination of	
31		Goals	
32			
33			
34			
35	Middle Age	45-65 Loss of Re-	Generativity vs.
36		productive	Stagnation
37		Ability	
38		Self-	
39		Assessment	
40			
41			
42			
43	Old Age	65 and over	Ego Integrity vs.
44		Regressive	Despair
45		Growth	
46		Biological	
47		Decline	
48		Experience	
49		Fulfillment/	
50		Failure	

Table 6 Continued

	Havighurst	Levinson	Gould
1	Infancy vs.		
2	Childhood (9 Tasks)		
3			
4			
5			
6			
7			
8			
9	Middle Childhood		
10	(9 Tasks)		
11			
12	Adolescence		
13	(10 Tasks)		
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25	Early Adulthood--	17-22 Leaving the	16-22 Leaving the
26	selecting a mate;	Family	Parents'World
27	living w/spouse;	22-28 Entering the	22-28 Getting into
28	starting a family;	Adult World	Adult World
29	rearing children;	28-33 Age-30	28-34 Questioning
30	home; starting an	Transition	& Reexamination
31	occupation; civic	33-40 Settling	35-45 Midlife
32	responsibility;	down	Decade
33	congenial social		
34	group		
35	Middle Age--		
36	civic and social	40-45 Midlife	43-50 Reconcilli-
37	respon.;standard	Transition	ation & Mellowing
38	of living;teen age	45-60 Middle Adult-	50 and over
39	children;leisure	hood,Restabilli-	Stability and
40	activities;spouse;	zation	Acceptance
41	physiological		
42	changes;parents		
43	Old Age--		
44	adjusting to death		
45	of spouse,retire-		
46	ment, decreased		
47	strength; social		
48	and civic obliga-		
49	tions; friendship;		
50	living arrangements		

Table 6 Continued

	Sheehy	Loevinger	Perry*
1		Impulsive,	
2		Presocial	
3			
4		Self-Protective	
5			
6			
7			
8			
9		Conformist	Basic Duality
10			Multiplicity
11			Pre-Legitimate
12		Concientious	Multiplicity
13		Conformist	Subordinate
14			Multiplicity
15			Correlate
16			Relativism
17			Commitment
18			Foreseen
19			Initial
20			Commitment
21			Implications of
22			Commitment
23			Developing
24			Commitment
25	18-22 Pulling up	Conscientious	
26	Roots		
27	22-28 Trying		
28	Twenties		
29	28-32 Catch 30	Individualistic	
30			
31	32-35 Rooting and	Autonomous	
32	Extending		
33			
34			
35			
36	35-45 Deadline	Integrated	
37	Decade		
38	45-50 Renewal or		
39	Resignation		
40			
41			
42			
43			
44			
45			
46			
47			
48			
49			
50			

*Perry's stages occur over 4 years of college.

Table 6 Continued

	Kohlberg	Fowler
1	Egocentric	Reflect
2		Faith of
3		Parents
4	Punishment	Takes on
5	& Obedience	Beliefs
6		of Others
7		
8		
9	Instrumental	Conform to
10	Relativist	Peers
11		
12	Good-boy,	
13	Nice-girl	
14	Approval	
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25	Authority	Critical
26	Rule Law	Reflection
27	& Order	and Doubting
28		
29	Social	Mature Faith
30	Contract,	Stage
31	Autonomous,	
32	Principled	
33		
34		
35		
36	Universal	Faith From
37	Ethical	Universal
38	Principle	Perspective
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		

(Merriam, 1984, pp. 15-16)

Motivation and Learning

Any study which attempts to determine success has to take into account motivation and its effects upon learning. Apps (1981) was able to record some factors in this area in his comparison between returning students (those twenty-five or older and out of school for some years) and traditional students (those eighteen to twenty-two who have gone to college directly after high school graduation) (Apps, 1981, p. 39).

High motivation to learn by returning students was a major factor for them to return to formal education. They were much more purposeful and tended to know what they wanted. By having concrete goals, these students are more willing to exert extra effort in their studies. Returning students, also, exhibited a clearer reason for their decision to return and, hence, were less likely to question their purpose for learning.

As previously reported, one of the most common reasons for non-traditional students returning to the educational community is job opportunity. It is also one of the major considerations for all students in the selection of a program concentration. A study done by Wilson (1985) found:

> the need for technically-trained people with a general business background is predicted to

> increase steadily through 1995 particularly in areas closely tied to management, or the end-user, such as systems analysis, business modeling and conceptual database modeling (Wilson, 1985 p. 371).

Many of these students lack the technical preparation necessary to master these subjects. However, with the proper motivation. Wilson continues:

> business students can master abstract or technical material if they are motivated to do so. And they can be motivated to learn such material if it is shown to be in their interest to do so. If a general technical training increases a business student's long-term marketability in the data processing industry or in information systems, then the student will be motivated to acquire the necessary training (Wilson, 1985, p. 371).

Wilson's article has two interesting points for computer science curriculum designers: (1) should emphasis be placed upon practical applications or theoretical problems, and (2) what kind of academic background can instructors expect of their students in computer science courses in the future?

Kelly (1986) in describing adult learners provides us with some additional insights on their motivation. Younger students, unlike adults, may be attending college because of peer or parental pressure. Adults, as previously stated, attend primarily for career enhancement. They give up family and leisure time in order to attend. If they are not involved with a company tuition refund or a government entitlement program, they generally have to cover all expenses themselves.

Kelly cites a study categorizing motivation of adult college students conducted by Morstain and Smart (1977). Adults were placed into five different groups, each with a different motivation profile using scores from Boshier's Educational Participation Scale (EPS). The five groups were: (a) non-directed learner, (b) social, (c) stimulation- seeking, (d) career-oriented learner, and (e) life-change learner (Kelly, 1986, pp. 9-12).

Results of this study indicated the non-directed learner had no specific purpose in attending college. Many traditional students fell into this category. The students who were placed into the social group were primarily attending college for social interaction and humanitarian or service projects and classes. The stimulation seeker was attempting to escape everyday boredom whether it was from a dull job or personal life. The career-oriented learner expected to find a direct application to their present job or to a future job interest.

The life-change learner was searching for a way to improve several different aspects of their lives. Aspects such as career enhancement, intellectual stimulation, breaking the monotony, or socialization were commonly given as reasons for attending college.

Some of the findings by Morstain and Smart indicated that female adult students were attending college for stimulation but were somewhat more non-directed than male adult students. Males tended to be more career oriented and were seeking life changes.

It is not easy to determine what motivates adult learners. In some cases, there may be more than one motivational factor, or what Maslow (1954) would call "multiple motivations of behavior." But, it is apparent that motivation plays an important part in answering the question of why adults return to college.

College students bring different frames of references and different functional considerations based upon what these students have been used to and what their purposes are in attending college. This determines the motivational force behind these students. Unfortunately, most college programs have only one orientation and it may differ from a majority of students' frames of reference. This can lead to a great many students dropping out or transferring to other colleges. The description of non-traditional students and the discussion of the motivation of adults gives us two characteristics which needs to be addressed. Namely, older students are more likely to be employed and are strongly motivated by job considerations. In the data processing market, as well as many others, tuition reimbursement is a common employee benefit. Most companies with such a program require their employee to obtain certain grade achievement in order to be reimbursed. This certainly could be considered a strong motivational factor for non-traditional students.

The discussion up to this point has shown us many characteristics of non-traditional students. It has, also, pointed out several factors which influence the motivation of these students. In the following section, this study will explore some of the currently held theories on learning styles.

Learning Styles

On-going research and the expansion and fragmentation of present thinking concerning traditional learning theory, according to Simpson, "would indicate that there is no comprehensive theory of learning that suffices for the divergent learning experienced by the adult throughout a lifetime" (Simpson, 1980, p. 57).

A position supported by Kolb, "specifically, we must avoid turning these ideas into stereotypes used to pigeon hole individuals" (Dunn, et al., 1981, p. 373). Much of this debate and confusion is due to the complex nature of the human being. In this Section there will be no attempt to select or reject any learning style theory. Rather, this Section is intended to provide a background for the selection of Kolb's Learning Style Inventory.

Butler, writing in Student Learning Styles and Brain Behavior (1982) identified four major learning styles: Concrete Sequential (CS); Abstract Random (AB); Abstract Sequential (AS); and Concrete Random (CR). The Concrete Sequential style reflects a need for order, precision and a structured environment. Lessons tend to be practical and are conducted under strict time limitations. Learning activities tend to apply the "hands-on" approach with constant reinforcement. This practical method is in sharp contrast to the Abstract Random learning style which tends to emphasize a preference for the emotional, sensitive, and psychologically pleasing environment. Rather than strict time limits, activities are flexible and personal relationships are encouraged. Class morale is regarded highly and humor can be found integrated within the class activities. Self-expression and group discussions are characteristic of this group.

In the Abstract Sequential style, intelligence and logic is preferred over individualism and pragmatism. This group tends to enjoy the lecture method where debate based upon evaluation and analysis is used. Reading assignments with documented evidence provides the basis for class discussion. The Concrete Random style encourages students to seek out new ideas. In this style students are capable of working independently. Class activities take the form of games, simulations, and experimentation where the physical world replaces the intellectualism of the Abstract Sequential.

There appears to be widespread agreement among researchers supporting the existence of individual differences. However, authorities on learning style provide different definitions which in many cases refer to the same things. Likewise, many instruments have been developed to measure these differences. A review of the definitions, instruments and applications provided by these researchers follows (Dunn, et al., 1981, pp. 372-375).

Canfield and Lafferty believe individual learning style is derived from: (a) academic conditions (relations with instructor and peers); (b) structural condition (organization and detail); (c) achievement conditions (goal setting, competition); (d) content (numbers, words, etc.); (e) mode of preferred learning (listening, reading, iconic, and direct experience); and (f) expectation of performance level (superior through satisfactory).

Their Learning Style Inventory is a self-report instrument based on a rank ordering of choices for each of 30 questions. For use with junior high through adult levels. Approximate administration time: 15 minutes

Major use is for developing instructional materials for whole class or individual students. LSI is viewed as a tool to aid in understanding students' difficulties in completing academic units and for counseling. Emphasis on attitudinal and affective dimensions in the Inventory strengthens such appplication.

Dunn, Dunn, and Price state Learners are affected by their: (a) environmental (sound, light, temperature, and the need for either a formal or informal design); (b) emotional (motivation, persistence, responsibility, and the need for either structure or options); (c) sociological (self, pair, peer, team, adult, or varied); and (d) physical (perceptual strengths, need for intake, time of day or night energy levels, and the need for mobility) preferences.

Two instruments developed by Dunn, Dunn and Price are the Learning Style Inventory (LSI) and the Productiveity Environmental Preference Survey (PEPS). The LSI is a self-report instrument based on a rank ordering of choices for each of 104 items. It is intended for use with grades 3-12. Approximate administration time: 30 minutes.

The PEPS is an adult version of the LSI; it contains 100 items. Approximate administration time: 30 minutes.

The LSI and the PEPS are designed to diagnose individual learning characteristics. Accompanying manuals suggest prescriptions to complement selected styles to facilitate academic achievement.

Anthony F. Gregorc feels learning style consists of distinctive, observable behaviors that provide clues to the functioning of people's minds and how they relate to the world. Those "mind" qualities suggest that people learn in combinations of dualities: (a) concrete-sequential; (b) concrete-random; (c) abstract-sequential; and/or (d) abstract-random. Preferences for a particular set constitutes a learning style.

Gregorc's Transaction Ability Inventory is a self-report instrument based on a rank ordering of four words to each of 10 sets. Observation and interviews are suggested to aid in categorizing learning preference patterns or modes. It is intended for use with upper junior high-adult levels. Approximate administration time: 5 minutes.

Strong emphasis is placed on the matching of instructional materials and methods to meet the range of individual preferences. Gregorc also recommends that selected "nonpreferences" be utilized at times to encourage students to strengthen those areas.

Joseph E. Hill suggests Cognitive style is the unique way in which an individual searches for meaning. It is reflected in the way: (a) qualitative and theoretical symbols are handled; (b) cultural influences affect the meaning given to symbols; and (c) meaning is derived from symbols that are perceived.

Hill's Cognitive Style Interest Inventory is a self-report instrument based on a rank ordering which measures abstractions, visual, tactile, and auditory perceptions, motor coordination, and social interaction. It is for use with elementary-adult levels. Approximate administration time: 50 minutes.

Cognitive Style Mapping identifies student strengths and weaknesses through major, minor, and negligible categories. It serves as a basis for developing a Personalized Educational Program (PEP) which utilizes varied instructional modes to match students and the educational task.

David E. Hunt's learning style describes students in terms of those educational conditions under which they are most likely to learn and essentially describes the amount of structure individuals require.

Hunt has developed two instruments, the Teacher Assessment of student Learning Styles and the Paragraph Completion Method (PCM). The Teacher Assessment of Student Learning Styles makes use of observations based on student reactions to systematic teacher-introduced changes in structure.

The Paragraph Completion Method (PCM) is a semi-projective method which assesses conceptual level. Students write responses to a posed topic. For use with grade 6-adult levels. Approximate administration time: 20 minutes.

Hunt proposes matching educational approaches to student learning style facilitates academic achievement. Conceptual level, in terms of learning style, is a developmental phenomenon which ranges from the "unsocialized" to the "independent." Knowledge of learning style can influence and enhance the development of conceptual level.

David A. Kolb's research indicates Learning style is a result of hereditary equipment, past experience, and the demands of the present environment combining to produce individual orientations that give differential emphasis to the four basic learning modes postulated in experiential learning theory: Concrete Experience (CE); Reflective Observation (RO; Abstract Conceptualization (AC); and Active Experimentation (AE).

The Learning Style Inventory is a self-report instrument based on a rank ordering of 4 possible sentences in each of 12 different sets. Each completed sentence represents 1 of the 4 learning modes: feeling (CE); watching (RO); thinking (AC); doing (AE). For use with young adults. Approximate administration time: 5-10 minutes.

Emphasis is placed on individual awareness of personal learning style and available alternative modes. Knowledge of learning style differences should encourage the design of instructional experiences to enhance individual strengths and develop non-dominant orientation.

Ramirez and Castaneda determined Cognitive Style Differences (field independent/field sensitive) and cultural differences create individual learning styles. Because learning style is not permanently fixed, it is possible to intervene and affect it.

Their instrument is called the Child Rating Form It has a direct observation checklist format, yielding frequency of behaviour scales. It is completed by the teacher; it is suggested that older students can rate themselves. Approximate administration time: varies

Identification of cognitive style is used both to match and mismatch learning and teaching styles. The goal is to encourage personal "bicognitive ability" that reduces favoring one style over another continually.

Ronald R. Schmeck observes learning style is the product of the organization of a group of information processing activities that individuals prefer to engage in when confronted with a learning task. Those activities range from (a) deep and elaborative to (b) shallow, repetitive, and reiterative.

Schmeck's Inventory of Learning Processes is a 62-item. true-false, self- report inventory grouped via factor analysis into synthesis- analysis, study methods, fact retention, and elaborative processing. Approximate administration time: 20 minutes.

Students should be encouraged to develop a learning style which is thoughtful, deep, and elaborative. Through the use of specific instructional strategies, teachers should discourage shallow reiterative information processing.

The value of considering learning styles, according to Keefe, is:

> learning styles are cognitive, affective, and physiological traits that serve as relatively stable indicators of how learners perceive, interact with and respond to the learning environment (Keefe, 1982, p. 44).

Learning styles are just as important as intelligence groupings in placing students in appropriate courses. Joyce and Weil observed that learning styles are "relevant expressions of the uniqueness of the individual" (Joyce and Weil, 1986, p. 435).

Higher education is not only charged with the success of the high achievers, but it must also address the needs of the "marginal" learners--those who do not respond to the typical classroom activities. Educators must take into account the diverse learning styles these students bring into the classroom by designing activities that will stimulate active participation in the learning process.

There are many student learning styles. Therefore it is improbable to attempt to develop strategies for each and every case to meet the needs of all learners. However, it is feasible to identify broad categories and develop learning activities which will aid the majority of students in achieving their educational goals.

This position is supported by work conducted by Thelen (1968) and Chickering (1969). "*Under most conditions, obviously, a distinct program for study for each individual is not feasible. But some dimensions of difference are sufficiently widespread that program modification would affect large numbers of students* [italics in the original] (Chickering, 1969, p. 286).

Thelen suggests teachers develop subgroupings to deal with the individual development abilities of the students found in their classrooms. Comparing the classroom to the larger pluralistic society which includes various ways of life, each person discovers his own value system while developing the ability to accept the value system of others. Activities should be designed for each subgroup. Each subgroup should then participate in setting the goals for the entire class. By this discussion and interaction, each student can develop at a pace suited towards his personality while gaining an insight to the needs of others.

The above discussion on learning style theory provides us with a solid enough foundation to justify its value for curriculum design. Kolb's Learning Style Inventory (LSI) was selected from among the many instruments noted for measuring students' learning style preferences. Research has indicated that Kolb's Inventory could be effectively used to evaluate non-traditional students (Dorsey, 1984; Rush, 1983), was easily administered (Cavanaugh, 1981), and has a good correlation between student learning style and their field of study (McCarthy, 1981).

In a dissenting study, Hunsaker (1981, p. 151) found that "the LSI does not demonstrate sufficient reliability to grant it the predictive reliability that such a measurement instrument requires." Hunsaker, however, concedes that the underlying model "appears to receive enough support to merit further use and development." In a latter work, Merritt and Marshall (1984), reporting on the validity and reliability of the LSI found their "results provided support for the consistency between the learning style model proposed by Kolb and the LSI" (Merritt and Marshall, 1984, p. 469).

Many of the same theories found in learning styles can be found in teaching styles. The following Section will provide some techniques, faculty can use in order to improve their effectiveness in the classroom.

Relationship of Learning to Teaching

Silvernail (1979) observes that teaching is a complex art and suggests in order to be an effective teacher, one has to address a multitude of variables. His research established a correlational use of selected teaching styles and student achievement. He recommends further research in this area will be able to improve classroom teaching. Katz (1985) also views teaching as a progressive art in which teaching can be based upon observation and experimentation. These creative approaches can result in fresh classroom procedures that in turn can modify established concepts. Such research, he suggests, may be able to achieve a theory of cognitive style, cognitive development and college learning on the same scale that has been achieved in other academic areas.

Levin and Long's (1981) research concludes that students who are involved in their learning process have higher achievement than those who are less involved. The authors cite several studies which have shown particular instructional techniques can increase the active learning experiences of students. Student involvement is also dependent upon the unique characteristics students bring into the classroom. Levin and Long developed a model illustrating the relation of student characteristics and instructional processes to student involvement in learning and learning outcomes as shown in **Figure 3**.

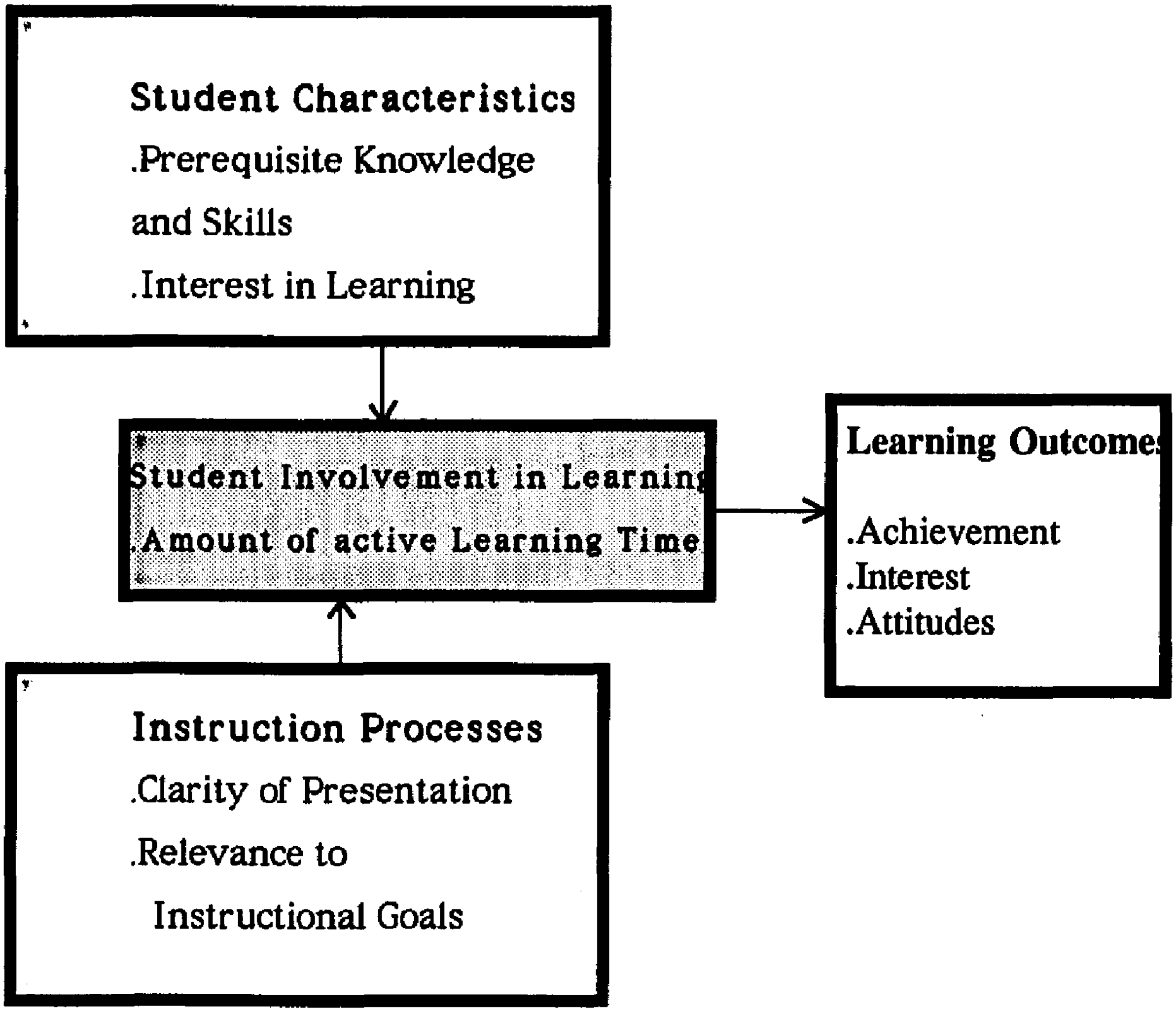


Figure 3. The Relationship of Student Characteristics and Instructional Processes to Students and Learning Outcomes

Students may vary greatly not only in their cognitive readiness for specific tasks, but also in their pace of learning, motivation to learn, anxiety, self-confidence, and self-concept as students. These factors effect how active students will be in the learning process. Teachers need to adapt to students' individual needs by using examples linked to actual or potential interests and by using practice exercises and explanations of differing complexity.

Snow and Peterson (1980) point out that teaching must be geared to meet the needs of each student taking into account their individual differences, i.e. preparedness, habits, learning styles, interests, and motivation in pursuing college work. This is significant even in "elite" institutions which select students based on only a few of the many personal attributes that contribute to success in learning at the college level. Thus, college instructors must accept the responsibility of teaching students who differ widely from one another. The challenge is one of fitting instructional methods to students' present aptitudes for learning, while simultaneously preparing students for further learning.

Dressel and Marcus (1982) have identified four basic teacher orientations: a) Discipline-centered, b) Instructor-centered, c) Student-centered cognitive, and d) Student-centered affective. The Discipline-centered teaching orientation is characterized by rigidly determined content and structure of class. The Instructor-centered approach casts the instructor as expert and the student as passive recipient with everything revolving around the instructor. In the Student-centered cognitive orientation, both content and teaching practices are selected and adjusted to accommodate the cognitive growth of students toward teacher- specified objectives. And finally, in the Student-centered affective approach, students' personal development and social development are the focus of the teaching-learning process. students are expected to develop idiosyncratically rather than to adapt to content or to the demands of the teacher.

Knowles (1978) in describing the facilitation of learning drawing upon the work of Rogers. In the facilitation of learning theory, the role of the teacher is a facilitator of learning. For this model to work, a personal relationship must be developed between the facilitator and the learner. The facilitator must possess three attitudinal qualities: (1) realness or genuineness, (2) nonpossessive caring, prizing, trust, and respect, and (3) empathic understanding and sensitive and accurate listening (Knowles, 1978, pp. 71).

The following guidelines for the facilitation of learning are:

1. The facilitator has much to do with setting the initial mood or climate of the group or class experience.

2. The facilitator helps to elicit and clarify the purpose of the individuals in the class as well as the more general purposes of the group.

3. He relies upon the desire of each student to implement those purposes which have meaning for

him, as the motivational force behind significant learning.

4. He endeavors to organize and make easily available the widest possible range of resources for learning.

5. He regards himself as a flexible resource to be utilized by the group.

6. In responding to expressions in the classroom group, he accepts both the intellectual content and the emotionalized attitudes, endeavoring to give each aspect the approximate degree of emphasis which it has for the individual or the group.

7. As the acceptant classroom climate becomes established, the facilitator is able increasingly to become a participant learner, a member of the group, expressing his views as those of one individual only.

8. He takes the initiative in sharing himself with the group--his feelings as well as his thoughts--in ways which do not demand or impose but represent simply a personal sharing which students may take or leave.

9. Throughout the classroom experience, he remains alert to the expressions indicative of deep or strong feelings.

10. In his functioning as a facilitator of learning, the leader endeavors to recognize and accept his own limitations. (Knowles, 1978, pp. 71-71).

Adult students of age thirty and freshman of age seventeen are likely to bring different perceptual sets into the classroom. No single teaching orientation is likely to be successful with divergent groups. In fact, the first ten minutes of class frequently determine whether a student is going to be receptive to participation in the learning process once the course orientation is presented. Most researchers recommend that learning objectives, instructional materials, and teaching methods be adapted to meet students' individual differences in learning motivations and goals.

It is evident that more research needs to be done in this area of teacher-learner relationship to determine which specific activities have the greatest effect on student achievement. There is no doubt that teachers, as well as students, have different characteristics. Some characteristics cannot be easily changed; however, many can be modified.

In a work by Apps (1981), the author, using interviews with exemplary instructors, developed nine principles for teaching returning adults students:

1. Know the Students. Learn their names. Find out about their life experiences, the jobs they've had, the interests they have, and some of the reasons why they have returned to school.

2. Use Student Experience. Returning students often already know something of the content of the courses they are taking. Much of their information is practical information they have gained through their work and other activities. Starting with this experience base, the instructor can help returning students quickly see a tie between their experiences and the academic course they are now taking. Using students' experience in the classroom is also a motivational device, for returning students are usually interested in sharing their experiences.

3. Tie Theory to Practice. One of the reasons many students return to school is to improve themselves for the job they now hold or to prepare for another job. Returning students enjoy studying theory when they can see its relationship to the practical and often to

occupational application. Returning students expect the instructor not only to discuss theories but also to show the relationship of the theories to practice. They are put off by instructors who concentrate only on practice. They want to see a combination of the two.

4. Provide a Climate for Learning. The nature of the learning climate influences the quantity and quality of the learning that occurs, particularly when we consider returning students. Fundamental to a positive learning climate is an instructor's support for returning students.

5. Offer a Variety of Formats. For most returning students, particularly those who work full time and are in school part-time, the traditional three times a week for a fifty-minute class is not satisfactory. Returning students require more flexible formats: evening classes, weekend classes, late afternoon classes, classes that meet once a week for an hour and a half rather than three times a week for fifty minutes each, supervised independent study opportunities, internships, and network groups.

6. Offer a Variety of Techniques. There is no one way to teach classes for returning students that is automatically better then another. Some of the

exemplary professors lecture; some use group activities such as group discussion, panel discussion, and buzz groups. Not all agreed that audiovisual aids enhance learning all the time. Instructors should be careful to consider when to use audiovisual aids, realizing that, at times, an audiovisual aid may prevent learning.

7. Provide Feedback. Returning students want to know how they are doing. Returning students also want the opportunity to let the instructor know how he or she is doing. Thus feedback is a two-way process, involving examinations and grading, informal contacts, and the possibility of class steering committees.

8. Help Students Find Resources. Returning students often have difficulty using libraries to the extent traditional students are able to. Alternatives include providing multiple copies of written materials and placing more emphasis on purchasing textbooks. Many returning students are willing to pay a little extra to have written materials readily available. The community and fellow students are often overlooked as valuable resources for the returning student.

9. Keep Out-of-Class Contacts. For many returning students and for their instructors as well, the contacts

with students in out-of-class situations is often as valuable as what happens in formal learning situations. Providing ample office hours for student contact is an obvious way for professors to make themselves available to returning students (Apps, 1981, pp. 165-167).

Summary

We might summarize the instructional task before us as attempting to manage the learning needs of a heterogeneous student population, presenting a wide range of learning styles. These students bring with them diverse backgrounds and life styles. Many are seeking to enhance their job opportunities which will lead them to the "good life."

Needless to say, this challenge to meet these needs requires a considerable variety of teaching strategies and skill; however, teaching strategies alone will not insure student learning. Faculty must appreciate the relationship of teaching to learning.

Chapter 3

METHODOLOGY

Classification of Computer Science Courses

The Undergraduate Computer Science curriculum at a small private university in Western Washington consisted of over twenty different courses. Based on course focus, these were grouped into the following categories: a) survey, b) programming language--syntax/structure, c) programming language--advanced topics, and d) theory/analytical. Survey courses are those courses where many topics are covered and group discussions encouraged. Programming language-- syntax/structure courses are intended to familiarize the student with the rules of a programming language and exercises are designed for reinforcement and practice. Programming language--advanced topics deal with advanced features of a programming language and allow for individualization and experimentation. Theory/analytical seeks to apply logic to selected case studies/projects in a structured environment.

Population

The study population was comprised of Undergraduate Computer Science students. The university was founded in Seattle in 1973 as an independent, decentralized, private college. Influenced in its early organization by the recommendations of the Carnegie Commission Reports and the Seattle 2000 Commission, the university early embraced its primary purpose to provide educational opportunities to a segment of the population not being served through other, traditional processes, within its general service areas.

The university is incorporated in the State of Washington and is accredited by the Northwest Association of Schools and Colleges, of which it is a member. The average age of students enrolled as of December 31, 1985 was 32 years.

In order to make the university's programs "accessible, affordable, and useful", a small core of full- time administrators are employed at the Bellevue, WA Site. Most of the instructional staff are full-time working professionals contracted to teach individual courses on a part-time basis. Along with teaching many classes at the Bellevue Site, instructional locations are also located close to the working population. This extended campus model with centrally designed and controlled curriculum and the majority of students qualifying as non-traditional was the setting for this project.

It was estimated there were at least 800 enrollments in the undergraduate Computer Science program during an academic year.

A sample of 200 enrollments was used to insure representiveness of the four different categories of courses. A stratified proportionate random sampling schema was used. The stratifications were the four course categories.

Independent Variable

The independent variable in this study was Learning Style preference as measured by David A. Kolb's 1985 version of the Learning-Style Inventory (LSI) (see Appendix A). Kolb developed the LSI to identify four statistically different learning style types: (1) Converger, (2) Diverger, (3) Assimilator, and (4) Accommodator. The Accommodator is characterized by doing things, solving problems, and is action-oriented. The Diverger has imaginative ability and can organize relationships into meaningful "Gestalt". The Converger is more responsive to practical applications, deductive reasoning and likes to deal with things. The Assimilator can create theoretical models, has inductive reasoning and likes to deal with abstract concepts.

The Inventory is a 12 item, self-descriptive questionnaire which asks respondents to rank order each set of four terms of how they learn best. The LSI identifies the respondent's preference for four learning orientations: Concrete Experiences (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and Active

Experimentation (AE). Learning style types are determined by using two combinations scores AC-CE and AE-RO (see Appendix A).

Dependent Variable

The dependent variable in this study was student performance in Computer Science course measured by final course grade. The University's grading policy used a decimal grading scale, thereby providing interval scale of measurement data for the analysis of variance test.

Controlled Variables

Student demographic characteristics were assumed to have no significant impact, since a random sampling plan was used.

Moderator Variables

The differing course contents in the Computer Science curriculum may have exerted a confounding influence on the relationship between student performance and learning style. For this reason it was measured and treated as a moderator variable as described in the procedures.

It also was not possible to control the influence of instructors' teaching style on student performance. Therefore, this potentially uncontrolled variable was studied as a moderator variable. Instructors' teaching style was measured using Lieberman's (1987) 4MAT Teaching Style Self- Assessment (TSSA) (See Appendix B). This instrument was developed for use with Kolb's Learning-Style Inventory. It identifies four statistically different teaching style orientations. Validity and reliability measures were determined (in 1987) using 280 subjects. Item validity was determined to be "strong" using a "key person versus non-key person" response technique. Reliability was determined by discriminant analysis using a randomly selected half of 265 respondents to calibrate and the other half to categorize. Over 70 percent were correctly predicted.

The TSSA is a nine-item, self-descriptive questionnaire which asks respondents to rank order each set of four terms characterizing themselves and their classrooms. It identifies the respondent's preference for four teaching orientations which correspond to Kolb's learning orientations.

Uncontrolled Variable

The uncontrolled variable in this study was the influence of individual student motivation on student performance.

Procedures

Student population was treated as enrollments rather than individuals. Four strata were created to divide the population based on enrollments in the four categories of courses. Therefore, a student may have been included in the sample in more than one stratification. The total population of students enrolled in undergraduate Computer Science courses at the two main sites offering this major were administered the LSI. They were stratified according to course. A staggered schedule of administration of the instrument was used to allow the researcher to personally administer the Inventory to all identified students. A prepared script explaining procedures for completing the Inventory was used. This was expected to control for administrator bias and support internal validity of the data collected.

Instruments were scored according to procedures outlined by Kolb (1986). Four simple Learning Style Preferences and two interpreted scores to identify students' positions in a Learning Style

Grid were determined for each student (see Appendix A). If less than 200 students completed the LSI, a census would have been used.

All faculty who taught undergraduate Computer Science courses at City University during the time of this study completed the TSSA. Instruments were scored according to procedures outlined by Lieberman.

Data Analysis

A three-way ANOVA without and with interaction was performed comparing student course performance by four course groupings, four learning style preference, and four teaching style orientations.

The following chapter will examine the results of this study and analyze the data obtained. An examination of the four hypotheses tested will be discussed. Chapter 5 will provide some recommendations based upon these results and offer suggestions for further research.

Chapter 4

PRESENTATION OF RESULTS

The purpose of this study was to determine the effect of learning style preference on course performance of non- traditional students enrolled in an undergraduate computer science program. Kolb's Learning-Style Inventory was used to assess students' learning style preferences in four learning style types: Converger, Diverger, Assimilator, and Accommodator. All computer science courses were classified according to content type: survey (concept generalizations), programming language (syntax and structure), advanced programming language (self-directed experimentation), and theory/analytical (abstract conceptualization). Instructor teaching style preference was determined using Lieberman's Teaching Style Self-Assessment.

The results of this analysis are presented subsequently. The population studied will be described. the variables measured are discussed. An analysis of the data is given. And finally, an evaluation of the four hypotheses is presented.

Population

The population studied was comprised of all Undergraduate Computer Science students at the university during the academic year 1986-7, resulting in 213 valid cases. A total of 20 variables was identified for each of the 213 valid cases used in this study. Three variables were specifically related to the course taken by the student. Five variables were related to the instructor's teaching style and five were related to the student's learning style. Four demographic variables were identified for each student, while the remaining three variables were identifiers used for cross-referencing purposes. An identification of each of these variables and the different levels on which they were measured is presented in the Data Record Layout Chart found in Appendix D.

Controlled Variables

Student demographic characteristics were assumed to have no significant impact, since a census was used. Figures 4 thru 6 display the student demographic profile. The majority of the students, 71.8 percent, were between 25 and 40 years of age, with the mode being 29 years, while the median was 31 years and the mean was 31.5

years. The standard deviation for age was 7.1 years and the distribution was slightly positively skewed.

The students were distributed almost evenly by sex with 57.3 percent male and 42.7 percent female. Six students chose not to respond to the question on ethnic origin. Of those responding, .5 percent were Native American (Indian), 6.8 percent were Asian or Pacific Islander, 2.9 percent were Black non-Hispanic, 66.2 percent were White non-Hispanic, .5 percent were Hispanic or Spanish surname, and 23.2 percent were non-resident alien. This distribution was consistent with that of the university's undergraduate student population.

Figure 4. Student Demographic Characteristics:
Age of Student as of 12/15/87

```
COUNT  AGE  ONE SYMBOL IS APPROXIMATELY .60 OCCURRENCES
0      17
1      19   **
15     21   *************************
11     23   ******************
15     25   *************************
22     27   *************************************
26     29   *******************************************
24     31   ****************************************
22     33   *************************************
20     35   *********************************
14     37   ***********************
9      39   ***************
8      41   *************
8      43   *************
8      45   *************
1      47   **
2      49   ***
2      51   ***
0      53
0      55
1      57   **
            I----+----I----+----I----+----I----+----I----+----I
            0         6         12        18        24        30
                              FREQUENCY
```

Figure 5. Student Demographic Characteristics: Ethnic Origin

```
                              I
        Native     1          +
        American              I 1
                              +
                              I
        Asian          2      ----+
   Pacific Island             I   I 14
                              ----+
                              I
        Black      3          --+
     non-Hispanic             I I 6
                              --+
                              I
        White     4           --------------------------------+
    non-Hispanic              I                          137 I
                              --------------------------------+
                              I
                    5         +
        Hispanic              I 1
                              +
                              I
        Non-     9            -----------+
   resident Alien             I        48 I
                              -----------+
                              I.......I.......I.......I.......I.......I.......I.......I.......I
                              0       40      80      120     160
                                      FREQUENCY
```

Figure 6. Student Demographic Characteristics: Sex

```
                I
     1          -------------------------------+
   Male         I                         122 I
                -------------------------------+
                I
     2          ----------------------+
  Female        I                  91 I
                ----------------------+
                I..............I..............I..............I..............I..............I..............I
                0                        100                                  200
                            FREQUENCY
```

Independent Variable

The independent variable in this study was Learning Style preference as measured by David A. Kolb's 1985 version of the Learning-Style Inventory (LSI) (see Appendix A). The respondents' preferences for four learning orientations: Concrete Experiences (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and Active Experimentation (AE) were identified and used to determine the respondents' predominant learning style as: (a) Converger, (b) Diverger, (c) Assimilator, and (d) Accommodator. A summary of this inventory appears in Figure 7. The majority of the students, 70.4 percent, were Divergers, while 15 percent were Accommodators and 13.1 percent were Assimilators. Only three students, 1.4 percent, were Convergers.

Figure 7. Student Predominant Learning Style

```
                 I
           1     -+
   Converger     II  3
                 -+
                 I
           2     ------------------------------------+
    Diverger     I                              150 I
                 ------------------------------------+
                 I
           3     -------+
 Assimilator     I    28 I
                 -------+
                 I
           4     --------+
Accommodator     I    32 I
                 --------+
                 I.........I.........I.........I.........I
                 0        40        80       120       160
                           FREQUENCY
```

Dependent Variable

The dependent variable in this study was student performance in Computer Science courses measured by final course grade using a four-point decimal grading scale. **Table 7** presents a descriptive summary of student performance.

Table 7. Student Performance by Course Grade Summary Statistics

MEAN	3.389	STD DEV	.858
MODE	4.000	VARIANCE	.737
MEDIAN	3.700	SKEWNESS	-2.351

The majority of the students, 84 percent, received grades of 3.0 or better. The modal course grade was 4.0, while the median grade was 3.7 and the mean was 3.389. The standard deviation for course grade was .858 and the distribution was negatively skewed with a coefficient of -2.351.

Moderator Variables

Two variables were treated as moderator variables since they could not be controlled and their influence might have confounded the relationship of interest. They were: (a) instructors' teaching style and (b) differing course contents. Four distinct teaching styles were identified: (a) Converger, (b) Diverger, (c) Assimilator, and (d) Accommodator. A total of 17 different instructors taught 25 classes containing the 213 students in this study. A breakdown of total students taught by the four different teaching styles appears in **Table 8**. The majority of the students, 77.5 percent, were taught by Assimilators. No instructors had a preference for the Accomodator style, while 17.4 percent of the students were taught by Divergers and 5.2 percent were taught by Convergers.

Table 8. Predominant Teaching Style

VALUE LABEL	FREQUENCY	PERCENT
Converger	11	5.2
Diverger	37	17.4
Assimilator	165	77.5
TOTAL	213	100.0

The Computer Science courses were categorized by the predominant learning activities and presentation techniques traditionally used. Four distinct groupings were identified: (a) survey, (b) programming language-syntax structure, (c) programming language-advanced topics, and (d) theory/analytical. Of the 23 courses in the major, six courses were categorized as survey, five were programming language-syntax structure, five were programming language- advanced topics, and seven were theory/analytical. The breakdown of students in each category of courses was 14.6 percent in survey, 31 percent in programming language- syntax structure, 10.3 percent in programming language-advanced topics, and 44.1 percent in theory/analytical.

Data Analysis

A three-way ANOVA without and with interaction was performed comparing student course performance by the four course groupings, four learning style preferences, and four teaching style orientations. A tabular breakdown of course grade by the independent variable and the two moderator variables appears in **Table 9.**

Table 9. Breakdown of Course Grade by Predominant Teaching Style, Predominant Learning Style, and Course Type

DESCRIPTION OF SUBPOPULATIONS

CRITERION VARIABLE		**GRADE**	**Course Grade**
BROKEN DOWN	**BY**	**TSPREDOM**	**Predominant Teaching Style**
	BY	**LSPREDOM**	**Predominant Learning Style**
	BY	**CTYPE**	**Course Type**

VARIABLE	LABEL	MEAN	STD DEV.	CASES
ENTIRE POPULATION		**3.3892**	**.8583**	**213**
TSPREDOM	Converger	3.6091	.3833	11
LSPREDOM	Converger	3.5000	.4243	2
CTYPE	Programming Language	3.5000	.4243	2
LSPREDOM	Diverger	3.5571	.4198	7
CTYPE	Programming Language	3.5571	.4198	7
LSPREDOM	Assimilator	3.8000	.0000	1
CTYPE	Programming Language	3.8000	.0000	1
LSPREDOM	Accommodator	4.0000	.0000	1
CTYPE	Programming Language	4.0000	.0000	1

Table 9. Continued

TSPREDOM	Diverger	3.3892	.7936	37
LSPREDOM	Diverger	3.3174	.9049	23
CTYPE	Survey	3.6500	.7000	4
CTYPE	Theory/Analytical	3.2538	1.0501	13
CTYPE	Programming Language	3.2333	.7448	6
LSPREDOM	Assimilator	3.5250	.7089	4
CTYPE	Survey	3.6000	.0000	1
CTYPE	Theory/Analytical	4.0000	.0000	1
CTYPE	Programming Language	3.2500	1.0607	2
LSPREDOM	Accommodator	3.5000	.5617	10
CTYPE	Survey	3.1500	1.2021	2
CTYPE	Theory/Analytical	3.5429	.4036	7
CTYPE	Programming Language	3.9000	.0000	1
TSPREDOM	Assimilator	3.3745	.8953	165
LSPREDOM	Converger	3.3000	.0000	1
CTYPE	Theory/Analytical	3.3000	.0000	1
LSPREDOM	Diverger	3.4808	.8397	120
CTYPE	Programming Language	2.4833	1.8723	6
CTYPE	Survey	3.7824	.2651	17
CTYPE	Theory/Analytical	3.5538	.6789	52
CTYPE	Programming Language	3.4156	.8759	45

Table 9. Continued

LSPREDOM	Assimilator	2.8739	1.1588	23
CTYPE	Programming Language	2.9500	.4950	2
CTYPE	Survey	1.7500	2.4749	2
CTYPE	Theory/Analytical	3.0250	.8976	12
CTYPE	Programming Language	2.9143	1.3837	7
LSPREDOM	Accommodator	3.3190	.7353	21
CTYPE	Programming Language	3.3333	1.1547	3
CTYPE	Survey	3.5400	.3050	5
CTYPE	Theory/Analytical	3.1500	.5831	8
CTYPE	Programming Language	3.3600	1.1082	5

The results of the tests of the four null hypotheses tested at the 0.05 level of significance appear in **Table 10.** An interpretation of these results follows:

Table 10. ANOVA Table of Course Grade by Predominant Teaching Style, Predominant Learning Style, and Course Type

*** ANALYSIS OF VARIANCE ***

	GRADE	Course Grade
BY	CTYPE	Course Type
	LSPREDOM	Predominant Learning Style
	TSPREDOM	Predominant Teaching Style

SOURCE OF VARIATION	F	SIGNIF OF F
MAIN EFFECTS	1.727	0.094
CTYPE	2.039	0.110
LSPREDOM	2.111	0.100
TSPREDOM	2.293	0.104

Hypothesis One

H_0 : There is no significant difference in the average course grades among students with different learning style preferences.

The F-value is 2.111 with a reported p-value of .100, therefore the null hypothesis is rejected. There is no evidence to support that the difference in average course grades based on preferred learning style is significant for the .05 level.

Hypothesis Two

H_0 : There is no significant difference in the average course scores among students in different course categories.

The F-value is 2.039 with a reported p-value of .110, therefore the null hypothesis is rejected. There is no evidence to support that the difference in average course grades based on different course type is significant for the .05 level.

Hypothesis Three

H_0 : There is no significant difference in the average course scores among students taught by different teaching style orientations.

The F-value is 2.293 with a reported p-value of .104, therefore the null hypothesis is rejected. There is no evidence to support that the difference in average course grades based on preferred teaching style is significant for the .05 level.

Hypothesis Four

H_0 : There is no significant difference in the average course scores among students with different learning style preferences, in different course categories, taught by different teaching style orientations.

The F-value is 1.727 with a reported p-value of .094, therefore the null hypothesis is rejected. There is no evidence to support that the difference in average course grades based on the combined effects of a preferred learning style, course type, and preferred teaching style is significant for the .05 level.

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

Findings of this Study

This study found that learning style preference had no significant effect on course performance for an alpha of .05. However, it must be noted that of the 213 total respondents, 150 indicated a preference for the diverger learning style. This large subgroup may have distorted the test results. Had alpha been set at .10, the ANOVA would have shown significance for the main effects and Learning Style Preferences. This suggests that more subjects should be evaluated before any final conclusion can be drawn.

Research in this area should assist curriculum developers in designing course strategies for undergraduate computer science programs. Implications of this study are not limited to computer science programs, but also can be used for any content area. By identifying the predominant learning styles, the instructor and curriculum designer can develop activities taking into account the cultural differences of the students.

Problem solving is a difficult topic to address using the lecture method. However, by knowing the learning style preference, activities can be developed which demonstrate the ideas to be conveyed. The Accommodator's problem solving strength lies in the ability to initiate problem finding based on some goal or model of how things should be, and to execute solutions. The Diverger's strength lies in the ability to identify the multitude of possible problems and opportunities that exist in reality. The Assimilator excels in abstract model building which is necessary to choose a high-priority problem and alternative solutions. The Converger's strength lies in evaluation of solution consequences and final solution selection.

This study's secondary objective was to measure the interaction of the instructor's role and type of class structure. Four distinct course groupings were identified:

1. survey courses

2. beginning programming language courses

3. advanced programming language courses

4. theory/analytical courses.

A breakdown of Computer Science Courses by course type is shown in **Table 11.**

Table 11

Breakdown of Computer Science Courses by Course Type

Programming Language Advanced

CS210 File Management
CS222 COBOL II
CS232 FORTRAN II
CS425 Advanced COBOL/CICS
CS427 Distributed Data Processing
CS460 C Programming with UNIX

Survey

CS204 Office Automation
CS212 Operating Systems
CS241 Principles of Information Processing
CS419 Data Communication Systems
CS423 Programming Language Survey

Theory/Analytical

CS252 Systems Analysis
CS411 Data Structures

Table 11. Continued

CS416 Data Base Management

CS454 Systems Design

CS475 Artificial Intelligence

Programming Language

CS202 Structured BASIC

CS221 COBOL I

CS231 FORTRAN I

CS234 PASCAL Programming

CS249 Assembly Language

In the survey courses, learning was principally a function of perception. Lectures were the principal mode of instruction and the instructor's role was that of guide.

In the beginning programming language courses, learning emphasis was on active participation. Students spent many hours on the computer entering programming code, obtaining feedback, correcting their code, and resubmitting their programs. The instructor took the position of role model.

The advanced programming language courses let students utilize their past experiences in basic programming courses. They are encouraged to experiment in solving new problems using previously learned programming tools and structured methodology. The instructor's role was that of coach or helper.

For the theory/analytical courses, learning involved critical thinking. The instructor's role was presenter of information and stimulator of critical thinking.

Limitations of this Study

Other studies by Smith and Kolb (1986) indicate that the Converger and Assimilator learning styles were the ones most favored by data processing professionals and computer scientists. These two styles tend to favor abstract conceptualization in which the student perceives or takes in new information abstractly and transforms it reflectively into integrated and rational explanations. These learners prefer dealing with technical tasks and problems rather than social and interpersonal issues. Persons with these characteristics are most likely to enter into careers involving technology and information processing.

Unlike the findings of Smith and Kolb (1986) who also worked with computer science students, the predominant learning style favored by the students in this study was the Diverger (70.4%). This phenomenon may be explained by several characteristics of the population surveyed:

1. no entrance requirements for admission into any program in the University

2. non-traditional nature of the student population

3. no formal policy for dealing with non-traditional students

4. the majority of students were employed in computer-related activities

Most colleges and universities require prerequisites for college admissions. Candidates are required to have completed college preparatory courses in high school. Some colleges require that the student graduate in a certain percentile of class rank. Most schools require students to take the College Entrance Exam, and almost all schools require the completion of a high school diploma. Specific departments within colleges and universities may make additional requirements for entrance into their programs. Computer science programs traditionally have been associated with either the mathematics or engineering departments. Mathematicians tend to favor the Assimilator Learning Style and engineers the Converger Learning Style consistent with the observed characteristics of computer scientists (Smith and Kolb, 1986). The fact that no pre-admissions were required by the university in this study may have attracted students who would not have been admitted to traditional institutions.

The literature indicates that many non-traditional students are more mature and more highly motivated. They are more goal oriented and tend to focus on practical aspects rather than theoretical ones. They bring a wealth of practical experience with them into the classroom. In many respects these students differ little from the instructors. The students in this study had a mean age of 31.5 years. Most of the instructors who participated in this survey were adjunct faculty. They held full-time day positions and taught either during the evening or on week-ends. As shown earlier, this profile is also typical for most of the students in this study.

It is possible that instructor identification with students may have resulted in grade inflation, thereby impacting the outcome of this study. The mean course grade of all courses surveyed was 3.389. This appears to be high.

Some research on grading and grade inflation has been conducted, but the findings are inconclusive. In a paper presented at the Annual Meeting of the American Educational Research Association, Prather and others (1978) found that although much concern has been expressed about the decline in standards, few studies have empirically analyzed grading trends to see the extent, if any, of changes in grades. The paper goes on to imply that their findings of a rise in grades indicated faculty were responding to the educational needs of college students rather than an increase in academic achievement.

According to Milton, Pallio and Eison (1986), there has been a paucity of research about the influences of grades on students. They believe it has been assumed that grades provide universal incentives. Their findings indicated this is a false assumption. Furthermore, some of the studies they surveyed suggested that grades can produce some damaging personal effects on talented students. They identify a need to study the influences of tests and grades on the learning of content. Grades also can be influenced by the educational institution and its attitudes and values regarding grades.

Another factor which could have influenced the awarding of high course grades in this study was that many of the students were pursuing their degree on a part-time basis. Therefore they may have been able to devote more time and effort by taking one or two courses at a time. Most of the students were from the Greater Seattle area which is a a high-tech region. The Boeing Corporation dominates the employment market and is a testing site for IBM products. Microsoft, the leading software development company in the world is located in this area. Most companies in this region are computerized. Since the majority of student in the computer science program are employed full-time, most are already working in computer-related jobs. Students with this experiential background can be expected to do well in computer science courses. They also tend to be highly motivated since they already know where job advancement opportunities are either within their own company or in the local marketplace.

Suggestions for Further Research

The changing characteristics of the higher education student population require educators to design programs which will meet the needs of these new students. Increasing numbers of older adults can be expected to return to the classroom in the future. The educational opportunities afforded in the United States also have placed great pressures on the educational system by bringing students with different cultures and languages into the classroom. Additionally, the needs of the marketplace will impact significantly the subject areas these students will pursue.

Results of this study indicate a need for further research. The sample size should be increased to determine whether differences can be isolated at the alpha .05 level, the traditional standard for social science research. Further research should attempt to measure a more heterogeneous group of subjects, both traditional and non-traditional. Several institutions should be sampled to account for differences in programs. A standardized objective instrument measuring course performance should be developed to validate the grading system.

The relationship between motivation and learning has been well documented. However, the relationship between tuition and reimbursement and motivation has not adequately been researched. It is possible that this study was influenced by the high number of working adults participating. There is a need to examine this factor in future research.

Studies such as this have value for individual instructors by making them more aware and sensitive to the individual needs of their students. Learning style is a general term used to describe the way students process knowledge. Since the transmission of knowledge is a vital aspect of the educational process, anyone concerned with education can profit from the findings of this study.

According to Katz (1958), there has been a renewed interest in faculty development brought about by a growing diversity of students and a need to serve populations who are variegated ethnically, socially, and in aptitude from those of the past. He also identifies an alienation of students from academic learning due in part to increased emphasis on faculty specialization and the kinds of research they learned in graduate school. It is evident that more work needs to be done to assist current and new faculty members to understand learning style differences and how the learning process takes place. Additional research needs to be done in the area of measuring educational objectives. Gronlund (1985) states that published tests are seldom closely related to the instructional objectives of a particular course. Furthermore, they only measure a portion of the desired learning outcomes emphasized in instruction.

Remarks

In our complex society, education has become a life-long learning process. Research on learning styles is growing at a rapid rate. As educators we need to differentiate the learning needs of the individuals we are responsible to educate by answering the following questions about this group. What are their characteristics, their desires, their aspirations? What are the learning opportunities they seek and for what purposes? What should be the content of these learning opportunities and what are the best methods and strategies to facilitate learning? What support should we provide for learners and what support for the faculty? In addition to these questions we need to evaluate the institution's value system regarding the learning process. It is critical to have a supportive administration, one which will provide the leadership, direction, and resources necessary to meet the needs of all students.

> The integrity of American higher education is grounded firmly in its responsiveness to new and diverse

> populations. Each major sociological expansion in society has resulted in new students entering the college populations and influence the curriculum and goals of higher education. At no previous time, however, have we been faced with such overwhelming heterogeneity in our student body. (Knefelkamp, 1980, p. 15)

The methodology used in this study could be adapted to any environment in which learning takes place. Since a knowledge of learning styles is based upon individual differences, this research can be applied to any subject group as it attempts to identify the environment in which the learner functions best. Most educational systems tend to search for a single comprehensive method of instruction to serve the needs of all of the students. This may benefit the majority of the students, but it often is ineffective for other select groups.

There is a need for traditional education in our society to insure an orderly transmittal of knowledge from one generation to the next. There is also a need to provide non- traditional programs for that segment of the population which has different learning needs. Regardless of the type of program, traditional or non-traditional, once an institution admits a student it has an obligation to provide meaningful opportunities for that student to succeed. Students need to be evaluated upon entrance and monitored throughout their college experience. Institutions need to determine whether they are achieving their stated objectives.

References Cited

AACM Curricula Recommendations for Computer Science, Vol. 1. New York: Association for Computing Machinery, 1983.

Apps, Jerold W. The Adult Learner on Campus: A Guide for Instructors and Administrators. Chicago: Follett Pub.. 1981.

Aslanian, Carol B., and Henry M. Brickell. Americans in Tranisition: Life Changes as Reasons for Adult Learning. New York: College Entrance Examination Board, 1980.

Baker, Jesse Wheelock. Cognitive Style, Learning Style and Aptitude: Predictors of Achievement in Computer-Related Courses. Unpublished doctoral dissertation, The University of Maine, 1986.

Berztiss, Alfs. "A Mathematically Focused Curriculum for Computer Science." Communications of the ACM. May 1987, pp. 356-365.

Butler, Kathleen A. "Learning Style Across Content Areas" In Student Learning Styles and Brain Behavior. Reston, Va.: National Association of Secondary School Principals, 1982.

Carp, Abraham, Richard Peterson, and Pamela Roelfs. "Adult Learning Interests and Experiences", in Planning Non-Traditional Programs: an Analysis of the Issues for Postsecondary Education. San Francisco: Jossey-Bass, 1974.

Cavanaugh, David P. "Student Learning Styles: A

Diagnostic/Prescriptive Approach to Instruction", Phi Delta Kappan, Nov. 1981, 63(3), pp. 202-203.

Chickering, Arthur W. Education and Identity. San Francisco: Jossey-Bass, 1969.

Computer Information Systems Curriculum. Park Ridge, Il.: DPMA Education Foundation, 1981.

Cross, K. Patricia Adults as Learners: Increasing Participation and Facilitating Learning. San Francisco: Jossey-Bass, 1981.

Cross, K. Patricia. The Missing Link: Connecting Adult Learners to Learning Resources. New York: College Entrance Examination Board, 1978.

Discenza, Richard and Fred R. McFadden. "The DPMA's Curriculum '86 versus the ACM's Information Systems Curriculum Recommendations for the 80's: How do they Compare?", in ISECON '86, Park Ridge, IL: Data Processing Management Association, 1986.

Dorsey, Oscar L. and Michael J. Pierson. "A Descriptive Study of Adult Learning Styles in a Nontraditional Education Program", Journal of Lifelong Learning, May 1984, pp. 8-11.

Dressel, Paul L. and Dora Marcus On Teaching and Learning in College: Reemphasizing the Roles of Learners and the Disciplines. San Francisco: Jossey-Bass, 1982.

Dunn, Rita, et al. "Learning Style Researchers Define Differences Differently", Educational Leadership, Feb. 1981, 38(5), pp. 372-375.

Garger, Stephen J. Learning Styles: A State of the Art and A Curriculum Design for Application, Unpublished doctoral dissertation, Seattle University, 1982.

Gronlund, Norman E. Measurement and Evaluation in Teaching. 5th Edition. New York: Macmillan, 1985.

Grun, Alton Francis. An Analysis of Learning Styles and Academic Achievement Based on Experiential Learning Theory, Conceptual Level Theory, and Right-Left Brain Hemisphere Theory. Unpublished doctoral dissertation, The University of Minnesota, 1986.

Harrington, Fred H. The Future of Adult Education: New Responsibilities of College and Universities. San Francisco: Jossey-Bass, 1977.

Hunsaker, Johanna Steggert. "The Experiential Learning Model and the Learning Style Inventory: An Assessment of Current Findings", Journal of Experiential Learning and Simulation, 1981, (2), pp. 145-152.

Iovacchini, Eric V., Linda M. Hall, and Dennis D. Hengstler. "Going Back to College: Some Differences Between Adult Students and Traditional Students", College and University, Fall 1985, 6(1), pp. 43-54.

Jacobson, Robert L. "Consultant's Delight: Making Educators and Politicians Confront Bad News", The Chronicle of Higher Education 19 March 1986, p. 1.

Joyce, Bruce and Marsha Weil. Models of Teaching. Englewood Cliffs, N.J.: Prentice-Hall, 1986.

Katz, Joseph, Ed. Teaching as Though Students Mattered. San Francisco: Jossey-Bass, 1985.

Keefe, James W. "Assessing Student Learning Styles: An Overview".

In Student Learning Styles and Brain Behavior. Reston, Va.: National Association of Secondary School Principals, 1982.

Kelly, Diana, "Adult Learners: Implications for Faculty", (11 Dec. 1986) (ERIC No. ED 277 442).

Knefelkamp, L. Lee. "Integrating Adult Development Theory With Higher Education Practice", in 1980 Current Issues in Higher Education. Washington, D.C.: American Association for Higher Education, 1980.

Knowles, Malcolm S., and Associates. Andragogy in Action. San Francisco: Jossey-Bass, 1984.

Knowles, Malcolm S. The Adult Learner: A Neglected Species, 2nd. Ed. Houston: Gulf Pub., 1978.

Knowles, Malcolm S. The Modern Practice of Adult Education: Andragogy Versus Pedagogy. New York: Association Press, 1970.

Laurido-Santos, Osvaldo. "An Updated Information Systems Curriculum", SIGCSE Bulletin (March 1985), pp. 358-366.

Leifer, Richard and Capt. Michael J. DeHaemer. "Behaviorally Based Teaching Methodologies for CIS Courses" in ISECON `86, Park Ridge, IL: Data Processing Management Association, 1986.

Levin, Tamor with Ruth Long. Effective Instruction. Alexandria, Va.: The Association for Supervision and Curriculum Development, 1981.

Lorents, Alden. "The DPMA Model Curriculum and AACSB Accreditation." Proceedings of the 4th Annual Information Systems Education Conference, DPMA. Houston, TX, Oct. 26-7, 1985.

Maslow, Abraham H. Motivation and Personality. New York: Harper &

Brothers, 1954.

Maslow, Abraham H. The Farther Reaches of Human Nature. New York:
The Viking Press, 1971.

McCarthy, Bernice. The 4MAT System: Teaching to Learning Styles with Right/Left Mode Techniques. Oak Brook, Il: Excel Inc., 1981.

Merriam, Sharan B. "Adult Development: Implications for Adult Education", (1984). (ERIC No. ED 246 309).

Merritt, Sharon L. and Jon Clark Marshall. "Reliability and Construct Validity of Ipsative and Normative Forms of the Learning Style Inventory", Educational and Psychological Measurement, 1984, (44), pp. 463-472.

Milton, Ohmer and Associates On College Teaching: A Guide to Contemporary Practices, San Francisco: Jossey-Bass, 1978.

Milton, Ohmer, Howard R. Pollio, and James A. Eison. Making Sense of College Grades. San Francisco: Jossey-Bass, 1986.

Morstain, B. R. and J. C. Smart. "A Motivational Typology of Adult Learners", Journal of Higher Education, Nov./Dec. 1977 pp. 665-679.

Peterson, Richard E. and Associates. Lifelong Learning in America: An Overview of Current Practices, Available Resources, and Future Prospects. San Francisco: Jossey-Bass, 1979.

Prather, James E. and Others. "The Relationship of Undergraduate Course Grades with Student Ability Levels Programs of Study and Longitudinal Trends: A Multivariate Analysis". (1978) (ERIC No. ED 16065)

Rogers, Carl R. Freedom to Learn. Columbus, O.: Merrill, 1969.

Rush, Isabel E. "Comparative Study of Learning Styles and Related Factors between Traditional and Nontraditional Students at the University of Akron". (1983) (ERIC No. ED 240 408).

Scott, Julie A. "Training Adult Learners - A New Face In End Users", SIGUCCS Newsletter, Spring 1988, 18(1), pp. 25-29.

Seaman, Donald F. and Donnie Dutton. "The Future of Human Resources Development", in Preparing Educators of Adults. San Francisco: Jossey-Bass, 1981.

Silvernail, David L. Teaching Styles as Related to Student Achievement. Washington, D.C.: National Education Association, 1979.

Simpson, Edwin L. "Adult Learning Theory: A State of the Art", in Adult Development and Approaches to Learning. Washington: National Institute of Education, 1980.

Smith, Donna M. and David A. Kolb. USER'S GUIDE FOR THE LEARNING STYLE INVENTORY: A Manual for Teachers and Trainers. Boston: McBer and Company, 1986.

Snow, Richard E. and Penelope L. Peterson. "Recognizing Differences in Student Aptitudes" In New Directions for Teaching and Learning. San Francisco: Jossey-Bass, 1980.

Stone, Margaret Ehrich. Learning style preference: A study of graduate and undergraduate students. Unpublished doctoral dissertation, University of Missouri-Columbia, 1986.

Thelen, Herbert A. Classroom Grouping for Teachability. New York: John Wiley & Sons, 1968.

Wilson, Judith W. "What Should be the Mission of Four Year

Undergraduate Programs in Information Systems?", SIGCSE Bulletin (March 1985), pp. 367-372.

Wojtkowski, Wita, Susan Brender, and W. Gregory Wojtkowski. Methodology for Teaching CIS Courses", in ISECON `86, Park Ridge, IL: Data Processing Management Association, 1986.

Wolfgang, Mary E. and William D. Dowling. "Differences in Motivation of Adult and Younger Undergraduate", Journal of Higher Education, Nov./Dec. 1981, 52(6), pp. 640-646.

Appendix A

Learning-Style Inventory

Appendix B

Teaching Style Self-Assessment

Appendix C

DPMA Endorsement Letter

ISECON '87
INFORMATION SYSTEMS
EDUCATION CONFERENCE

Data Processing Management Association
Education Foundation
505 Busse Highway, Park Ridge, IL 60068-3191
(312) 825-8124

June 9, 1987

Mr. Phillip J. Piscopo
Computer Science
City University
16661 Northup Way
Bellevue, WA 98008

Dear Phil:

Please find enclosed our complimentary copies of the 1985 and 1986 ISECON Proceedings. I feel that the papers in these Proceedings will address the issues that you brought up in our recent telephone discussion.

DPMA is extremely interested in your work and I would appreciate your efforts to keep us apprised of your progress. Your findings will be very valuable in our future curricula efforts.

For this reason, please keep me informed and, above all, do consider my office a resource.

Sincerely yours,

John D. Cargill
Director of Education

JDC:hr
Enclosures (2)

Appendix D

Data Record Layout Chart

IS This variable references the data input summary sheet for each course surveyed

COURSE This variable represents the three digit course number designation. All computer science courses are prefaced by "CS". Refer to Appendix G for catalog descriptions of the following courses.

CS202 Structured BASIC

CS203 Computer Math

CS204 Office Automation

CS210 File Management

CS212 Operating Systems

CS221 COBOL I

CS222 COBOL II

CS231 FORTRAN I

CS232 FORTRAN II

CS234 PASCAL Programming

CS241 Principles of Information Processing

CS249 Assembly Language

CS252 Systems Analysis

CS411 Data Structures

CS416 Data Base Management

CS419 Data Communication Systems

CS423 Programming Language Survey

CS425 Advanced COBOL/CICS

CS427 Distributed Data Processing

CS454 Systems Design

CS460 C Programming with UNIX

CS475 Artificial Intelligence

CTYPE This variable identifies the categorization of the courses based on the traditional learning activities required of students measured as

1 Programming Language Advanced involves individualization and experimentation in the solution of advanced programming problems.

2 Survey involves an overview of many topics and group discussions.

3 Theory/Analytical involves the use of logic and analytical ability.

4 Programming Language involves reinforcement and practice in the syntax and structure of programming languages.

INST This variable is an identifying code number for course instructors.

TS1 This variable reports the instructor's Teaching Style Concrete Experience Score.

TS2 This variable reports the instructor's Teaching Style Reflective Observation Score.

TS3 This variable reports the instructor's Teaching Style Abstract Conceptualization Score.

TS4 This variable reports the instructor's Teaching Style Active Experimentation Score.

TSPREDOM This variable is the instructor's predominant teaching style measured as:

1. Converger's style is more responsive to practical applications, deductive reasoning and likes to deal with things.
2 Diverger's style emphasizes imaginative ability and organizes relationships into meaningful Gestalts
3 Assimilator's style creates theoretical models, uses inductive reasoning and prefers to deal with abstract concepts.
4 Accomdator's style is characterized by doing things, solving problems, and is action-oriented.

ID This variable is a student identification code number

SEX This variable identifies the student's sex

ETHNIC This variable identifies the student's ethnic origin, measured as:

1 Native American (Indian)
2 Asian or Pacific Islander
3 Black non-Hispanic
4 White non-Hispanic
5 Hispanic or Spanish surname
9 Non-resident Alien

AGE This variable reported the student's age as of 12/15/87

GPA This variable reported the student's overall grade point average as of 12/15/87

LS1 This variable is the student's Learning Style Concrete Experience Score.

LS2 This variable is the student's Learning Style Reflective Observation Score.

LS3 This variable is the student's Learning Style Abstract Conceptualization Score.

LS4 This variable is the student's Learning Style Active Experimentation Score.

LSPREDOM This variable is the student's predominant learning style measured as:

1 Converger's style is more responsive to practical applications, deductive reasoning and likes to deal with things.

2 Diverger's style emphasizes imaginative ability and organizes relationships into meaningful Gestalts

3 Assimilator's style creates theoretical models, uses inductive reasoning and prefers to deal with abstract concepts.

4 Accomdator's style is characterized by doing things, solving problems, and is action-oriented.

GRADE This variable reported the student's grade for the specific computer science course

Appendix E

Table of Three-way ANOVA Interaction Effects on Student Course Grades

	GRADE	Course Grade
BY	CTYPE	Course Type
	LSPREDOM	Predominant Learning Style
	TSPREDOM	Predominant Teaching Style

TOTAL POPULATION

3.39 = Average

(213) = Number of Students

CTYPE

1	2	3	4
3.20	3.55	3.41	3.34
(22)	(31)	(94)	(66)

LSPREDOM

1	2	3	4
3.43	3.46	3.00	3.40
(3)	(150)	(28)	(32)

TSPREDOM

1	2	3	4
3.61	3.39	3.37	0
(11)	(37)	(165)	(0)

	LSPREDOM			
	1	2	3	4
CTYPE				
1	3.50	3.06	3.23	3.50
	(2)	(13)	(3)	(4)
2	0.	3.76	2.37	3.43

	(0)	(21)	(3)	(7)
3	3.30	3.49	3.10	3.33
	(1)	(65)	(13)	(15)
4	0.	3.39	2.99	3.45
	(0)	(51)	(9)	(6)

	TSPREDOM			
	1	2	3	4
CTYPE				
1	3.61	0.	2.80	0.
	(11)	(0)	(11)	(0)
2	0.	3.50	3.56	0.
	(0)	(7)	(24)	(0)
3	0.	3.39	3.42	0.
	(0)	(21)	(73)	(0)
4	0.	3.31	3.35	0.
	(0)	(9)	(57)	(0)

	TSPREDOM			
	1	2	3	4
LSPREDOM				
1	3.50	0.	3.30	0.
	(2)	(0)	(1)	(0)
2	3.56	3.32	3.48	0.
	(7)	(23)	(120)	(0)
3	3.80	3.53	2.87	0.
	(1)	(4)	(23)	(0)
4	4.00	3.50	3.32	0.
	(1)	(10)	(21)	(0)

TSPREDOM = 1

CTYPE	LSPREDOM 1	2	3	4
1	3.50	3.56	3.80	4.00
	(2)	(7)	(1)	(1)
2	0.	0.	0.	0.
	(0)	(0)	(0)	(0)
3	0.	0.	0.	0.
	(0)	(0)	(0)	(0)
4	0.	0.	0.	0.
	(0)	(0)	(0)	(0)

TSPREDOM = 2

CTYPE	LSPREDOM 1	2	3	4
1	0.	0.	0.	0.
	(0)	(0)	(0)	(0)
2	0.	3.65	3.60	3.15
	(0)	(4)	(1)	(2)
3	0.	3.25	4.00	3.54
	(0)	(13)	(1)	(7)
4	0.	3.23	3.25	3.90
	(0)	(6)	(2)	(1)

TSPREDOM = 3

CTYPE	LSPREDOM 1	2	3	4
1	0.	2.48	2.95	3.33
	(0)	(6)	(2)	(3)
2	0.	3.78	1.75	3.54
	(0)	(17)	(2)	(5)
3	3.30	3.55	3.02	3.15
	(1)	(52)	(12)	(8)
4	0.	3.42	2.91	3.36
	(0)	(45)	(7)	(5)

TSPREDOM = 4

CTYPE	LSPREDOM 1	2	3	4
1	0.	0.	0.	0.
	(0)	(0)	(0)	(0)
2	0.	0.	0.	0.
	(0)	(0)	(0)	(0)
3	0.	0.	0.	0.
	(0)	(0)	(0)	(0)
4	0.	0.	0.	0.
	(0)	(0)	(0)	(0)

Appendix F

Catalog Descriptions of Computer Science Courses

CS090 Computer Laboratory (non-credit)
Individualized guided practice with computer language programming; hours and emphases are arranged with the instructor. Co-requisite: Another designated "CS" course.

CS202 Structured BASIC (5)
Fundamental programming concepts and techniques, including input, output, branching, and data transformation, through the study of the BASIC computer programming language. Students will demonstrate mastery of the fundamentals of BASIC language programming. Co-requisite: CS090.

CS203 Computer Math (5)
Mathematical concepts, principles and skills necessary to computer programming; the binary, octal and hexadecimal systems of numeration; Boolean algebra and logic; applied mathematical solutions to programming problems.

CS204 Office Automation (5)
Comprehensive survey of the information technologies underlying office automation; the productivity challenge and the organizational and behavioral implications of office automation; foundation studies for further exploration for useful information management and design. Strongly recommended: CS252.

CS210 File Management (5)

An exploration of the interaction between programs and data files, data access methods, file organizations, and features of the BASIC language relative to file management. Prerequisite: CS241. Strongly recommended: CS202. Co-requisite: CS090.

CS212 Operating Systems (5)

As operating systems are an integral part of any computing environment, emphasis is placed on resource management as a main feature of all control programs, focusing more on principles than on specific procedures for implementation. Process, storage, processor and device management will be covered. Prerequisite: CS241.

CS221 COBOL I (5)

Introduction to the language specifications of COBOL; the coding, compilation and testing of typical management problems. Familiarity with this programming language is achieved through practical application. Prerequisite: CS241. Co-requisite: CS090.

CS222 COBOL II (5)

Advanced features and capacities of COBOL; merging, sorting and random and sequential access; symbolic debugging; file processing, table handling, segmentation, report writing and library facilities. Programs will be written, coded, compiled and debugged by the student. Prerequisite: CS221. Co-requisite: CS090.

CS231 FORTRAN I (5)

Introduction to the language specifications of FORTRAN for scientific data processing applications; writing and testing programs. Prerequisite: CS241. Co-requisite: CS090.

CS232 FORTRAN II - Applications (5)

Advanced features of the FORTRAN programming language. Programs will be written involving linear equations and numerical integration. Prerequisite: CS231. Co-requisite: CS090.

CS234 PASCAL Programming (5)

An introduction to the powerful and popular computer language that is closely related to the new U.S> Defense Department ADA language; the syntax, command repertoire, data-structuring facilities, and systematic and modular approach to program design enforced by PASCAL. Students will write and debug PASCAL programs. Co-requisite: CS090. Strongly recommended: CS202 or CS221.

CS241 Principles of Information Processing (5)

An introduction to the field, and professional dimensions of information processing; elaboration of the logic which underlies computer programming. Structured programming techniques, data types, algorithms; the professional role of the programmer. This is a founmdation course for all computer science courses.

CS249 Assembly Language (5)

Fundamental concepts in the organization and operation of a computer; introduction to machine language, and addressing; assembly language programming. Prerequisite: CS241. Co-requisite: CS090.

CS252 Systems Analysis (5)

The application of systems concepts, tools and techniques for the improvement of management activities; organization, flow charting, work measurement, office layouts, forms design and control, procedures and manuals, records management, administration work flow analysis, feasibility studies and management presentations. Prerequisite: CS241. Strongly recommended: knowledge of a programming language.

CS399 Special Topics in Computer Science (1-5)

Contemporary themes and problems of computer science. Each course offering has its own title, course description and prerequisites.

CS411 Data Structures (5)

Survey of basic data structures such as lists, stacks, queues, trees, and their application to the analysis of problems associated with searching and sorting; study of the complexity and storage requirements of algorithms. Prerequisite: * Co-requisite: CS090. Strongly recommended CS234.

CS416 Data Base Management (5)

Identifying and eliminating organizational and technical obstacles to the optimal use of data resources; the organizational environment for data bases; data redundancy; integrity; the uses of the data dictionary, and data base management technologies; administrative tasks, including security and recovery procedures and standards documentation. Prerequisite: *

CS419 Data Communication Systems (5)

A comprehensive study of hardware and software components used in data communications; use of basic components in a communication system. Exposure to, and illustration with, a relevant currently available data communication system. Prerequisite: *

CS423 Programming Language Survey (5)

A comparative study of several major programming languages; formal language concepts such as syntax and grammatical structure; the effect of the run time environment on various language features. Prerequisite: * Co-requisite: CS090.

CS425 Advanced COBOL/CICS (5)

Introduction to IBM's Customer Information Control System (CICS); basic components of CICS; mapping support, application controls, file controls, and other features will be covered. COBOL will be the interface language. Prerequisite: * Co-requisite: CS090.

CS427 Distributed Data Processing (5)

Distributed systems and the influence on the business enterprise; technological implications of computer hardware, software and communications elements applied to the design, development and implementation of distributed data processing systems. Prerequisite: *

CS435 Directed Research Project (5)

Guided, individualized research into an assigned practical problem in systems design, systems analysis or other applied areas within information systems. May be satisfied by either an internship, computerized application or research paper. Prerequisite: Permission of the Computer Science Department Chair.

CS454 Systems Design (5)

Analysis and design of computer systems applications in organizations; input/output requirements of the various managerial functions; problem definition as a preliminary to system design; data organization and actual data structuring;

selection of software and hardware. Prerequisite: *

CS460 C Programming with UNIX (5)

Introduction to the C programming language under the UNIX environment. Students will write typical applications using the C programming language. Many features of the UNIX system will be covered. Prerequisite: * Co-requisite: CS090.

CS475 Artificial Intelligence (5)

Introduction to real-world applications of Artificial Intelligence and Expert Systems with emphasis on concepts and techniques of organizing knowledge, exploiting contraints, searching through alternartives and analyzing patterns. May substitute for another upper division CS course required in administrative core of Computer Information Systems baccalaureate program, with the permission of the Computer Science Chair.

CS499 Independent Study (1-15)

Students contract to undertake a special investigative or research project in computer science. Permission of the Computer Science Department Chair is required.

* **Prerequisite**: Students will need to satisfy Data Processing Proficiencies (30 credits).

CS221 COBOL I

CS222 COBOL II

CS241 Principles of Information Processing

CS252 Systems Analysis

AND Any two 'CS'-designated programming language courses

Appendix G

Presentation to Students Requesting

Participation in Study

Prior to start of Quarter

1) At Faculty meeting, explain research to faculty member in Computer Science Department and request their assistance.

2) Arrange convienient time with Instructor for administrating the Learning Style Inventory.

In Class

1) Put on board - Course Name and Number
2) Quarter
3) Academic Year
4) Days & Time
5) Make sure you have copy of Class List with Student IDs

To Students

Thank you Prof.________________ for allowing me to take up some of your valuable class time.

Good Day/Evening, my name is Phil Piscopo and I am the Chair of the Computer Science Department. As part of my Doctoral Studies at Boston College, I am conducting research on the Learning Style Preferences of non-traditional students. I will be comparing these preferences to the grades awarded in this class. I will attempt to survey all of the undergraduate computer science classes.

By evaluating the results, I hope to better understand the needs of our students and use this information to develop meaningful activities in our classes while accomplishing our educational objectives.

The instrument we will use is the Kolb's Learning Style Inventory. It contains 12 Questions. Each Question has 4 Responses. It is requested that you answer each Response with either a 4, 3, 2, or 1. 4 being the best and 1 being the least liked response. You can only use each number once!

(ANY QUESTIONS?)

All responses will be kept strictly **confidential.** Student's name and ID will not appear on any report. This information will only be used by myself for my research. However, I do request that you provide your Student ID on the front of the Questionnaire in order that I may be able to compare your responses to the final course grade. You may if you wish provide your name. I have a class list with your student ID if you can not remember it.

Thank you again for your time and participation.

To Instructor

Give the Instructor a copy of the Teaching Style Inventory to complete.

Collect all materials

Keep all responses together with cover sheet indicating class information and date of survey.