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AN EXPLORATION OF THE DETERMINANTS
OF ATTITUDE TOWARD COMPUTERS
IN MIDDLE SCHOOL STUDENTS

by

Earl Wayne Connell

A dissertation submitted in partial fulfillment
of the requirements for the degree of

DOCTOR OF EDUCATION

University of San Diego

1991

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ABSTRACT

The educational world is belatedly rushing into the world of technology with relatively limited factual information concerning students' attitude toward computers. While most students have a positive attitude, research has indicated that the male is more positive than the female for various reasons. The purpose of this study was to investigate a diverse set of possible determinants of attitude toward computers including sex, ethnic background, learning style, and computer literacy. The subjects were 284 coeducational students from four ethnic backgrounds that attended three middle schools in San Diego. A requirement that subjects have two years of experience with computer assisted instruction made the sample population relatively sophisticated concerning computers. The methodology primarily involved the analysis of data by ANOVA and related procedures.

Results of the quantitative analysis of data indicated that attitude toward computers was a complex phenomenon, with different aspects of cognitive skill as determinants. Furthermore, no simplistic generalization concerning attitude toward computers was truly applicable. Computer literacy had the strongest main effect. The analytic skill scale, the sequential processing skill scale, and the manipulative preference scale of the Learning Style Profile also had statistically significant main effects. Sex and

ethnic background were not found to be determinants.

The computer experience of the sample population was thought to have possibly been a factor in the outcome shifting the determinant of attitude from sex, found in earlier studies, to aspects of cognitive skill. The results of this research combined with earlier studies, indicated that attitude toward computers may be more site specific than generalizable. This characteristic increases the requirement for detailed local analysis prior to designing an effective computer assisted instruction program for a specific school.

DEDICATION

This dissertation is dedicated to my wife who has supported me with understanding through wars, businesses, and now a belated program of schooling. My children were also compassionate supporters of an effort they appeared to believe was worthwhile. Finally, this dissertation belongs to my father for the one he never wrote.

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AN EXPLORATION OF THE DETERMINANTS
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Chapter I

Statement of the Issue

Introduction

Educators are constantly involved in the struggle to find ways to improve both the teaching and the learning process. New teaching concepts are visualized and then implemented. New curriculum frameworks are written attempting to help education fulfill the dream of everyone in the community. The struggle is endless, not so much because it is often circular, but because society's problems appear to grow more complex with each new generation and educators feel bound to address these problems. Two different bodies of knowledge are being extensively investigated as part of this search to improve instruction and learning. One falls under the general term of technology with computers at the center. The other is generated by the understanding that different students learn in different ways and is referred to as learning style.

Computers have been utilized in education in two broad

ways, while at the same time becoming a very large and separate field of study themselves (Becker, 1987). One application of computers has been to assist in the school management process where they store and manipulate all types of data. The second broad category of computer use in education, and more important to this research, was their application as a tool to aid in the teaching process. In this second context, the use of computers has been limited only by human imagination and cost, with the number and type of applications increasing dramatically (Ediger, 1988). Within this diversity, many researchers (Bork, 1980; Bitter & Frederick, 1989; German, 1987) visualized computers as the major tool that would finally allow educators to make instruction appropriate to the individual.

However, German pointed out the obvious when noting that differences in the way students learn were not automatically overcome by the use of computers and students don't magically learn when working on a computer. According to Foreman (1988), students responded to various types of instruction on computers just as they responded differently to different techniques of conventional instruction. Even more basic than response to Computer Assisted Instruction (CAI), studies (Chen, 1985) strongly indicated that students had varying attitudes toward computers in general.

Understanding student attitudes toward computers became a vital step in developing and implementing good CAI

programs. With research concerning the interface between the student and the computer in the early stages, definitive information hasn't kept pace with the growth in computer technology or the increasing use of computers in education. Ediger (1988) indicated a sense of urgency was necessary if researchers were to provide useful information concerning the application of technology.

Research into attitudes toward computers has been particularly limited in breath. A study in conjunction with the California Assessment Program (CAP) administered in the Spring of 1983 and reported by Fetler (1985) indicated that both males and females had positive attitudes toward the computer, but that the male was more positive than the female. Additionally, the male used the computer in more diverse ways. Several researchers (Nickell, 1987; Krienberg, 1985) viewed this situation as a societal induced imbalance in favor of males and have created intervention programs to correct the situation. This research included sex as a possible determinant of attitude toward computers. But, the thought that sex alone was a sufficient basis for determining attitude, or that gender should be the dominant input for designing CAI programs, was considered a dangerously limited concept. These limitations became a motivating factor in investigating a broader range of human characteristics as possible determinants of students' attitude toward computers.

In a study of gender differences in computer use, Collis, Kieren, and Kass (1988) concluded that there were strong gender differences; but to fully comprehend the differences, a multidimensional model sensitive to contextual variables was necessary. There appeared to be a strong need for the investigation of a more diverse set of variables as the determinants of attitude.

Since attitude was a complex phenomenon, a variety of human characteristics needed to be considered as possible determinants. One characteristic, that provided insight into the student learning process and may therefore have a relationship with attitude toward computers, was learning style. It had become commonly accepted that students learned in different ways (Dunn & Dunn, 1978; Schmeck, 1983; Pask, 1976) and that student achievement was increased when teaching methods take particular learning styles into consideration (Holland, 1982; Gregorc, 1979; Dunn, 1988). However, Keefe (1987) indicated that broad classroom application of learning style information hadn't occurred. Mann and Sabatino (1985) reasoned that one cause of hesitancy in applying learning style information was the basic organization of many classrooms, where one teacher was isolated with a large number of students. Learning styles were potentially an important part of the individualization process, which in the future might depend on the computer as a primary method of implementation. Therefore, learning

style was not only a possible determinant of attitude toward computers, but was potentially important in the design of CAI programs.

Any discussion of learning styles presented several immediate difficulties. The main problem was the multiple meanings applied by researchers (Dunn, 1981) to learning style, combined with the often interchangeable use of the terms learning style and cognitive style. For the purposes of this research and based on arguments by Mann and Sabatino (1985), the distinction between learning style and cognitive style was considered arbitrary, with the primary difference being that learning style was focused on the learning process. The instrument used in this research to assess learning style covered characteristics that were encompassed in many of the different definitions of both learning style and cognitive style.

Another characteristic that research (Collis, 1987, Marcus, 1985) indicated might contribute to students' attitudes toward computers was the ethnic background of the student. Social scientists had been studying different cultures for many years resulting in better understanding between people. According to Agar (1980), one consistent difference between many of these different groups involved communications, which was the heart of the educational process and obviously involved in the interface between the human and the computer. Did different cultures have

different attitudes? The answer was yes (Agar). Therefore, ethnic background was an appropriate variable in this study as a possible determinant of attitude toward computers.

The last variable that was included in this study as a possible determinant of attitude toward computers was computer literacy. As with learning style, computer literacy was within itself a construct composed of many diverse and sometimes unknown factors. But while computer literacy is complex, it was also subject to definitive assessment. For the purposes of this research, three components of computer literacy were of particular interest: (a) computer literacy as, in part, a measure of academic achievement and therefore reflective of all of the variables involved in scholastic achievement; (b) computer literacy as, in part, based on knowledge of, or experience with, computers (Collis, 1985); and (c) the strong correlation that computer literacy had with socioeconomic status (Fetler, 1985).

Purpose

The general purpose of the study was to investigate several student characteristics that varied in composition from physical to mental to psychological constructs and to determine if a relationship existed between these characteristics and the attitude students had toward

computers. The student characteristics were sex, ethnic background, learning style, and computer literacy. Within the framework of this general purpose there were two specific components.

The first component assessed the main effects of the independent variables on the dependent variable, or more precisely, determined if different levels of the independent variables had different effects on the dependent variable. The second specific component investigated possible relationships between the independent variables as they related to the dependent variable, or in more specific terms, determined if there was interaction between the independent variables.

The information gained expanded the amount of information available concerning the interface between the student and the computer, and data was generated that provides insight into how different student characteristics might have related to their perception of computers. Research indicated that the interface between the student and the computer was complex and strongly argued against the perspective that students' attitude toward computers was primarily determined by such characteristics as gender. Additionally, it provided insight into how to approach the use of computers in education.

Finally, the research provided specific information concerning what student characteristics may be associated

with a more positive attitude toward computers and how these characteristics may be related to each other. The null hypotheses were as follows:

H₀₁: There is no statistically significant difference in attitude toward computers between subjects with different learning styles.

Due to the particular definition of learning style used in this research, learning style was broken down into specific independent scales which required the use of subhypotheses to address each independent scale of learning style.

H_{01a}: There is no statistically significant difference in attitude toward computers between subjects with different analytic skill.

H_{01b}: There is no statistically significant difference in attitude toward computers between subjects with different perceptual responses.

H_{01c}: There is no statistically significant difference in attitude toward computers

between subjects with different sequential processing skill.

H₀1d: There is no statistically significant difference in attitude toward computers between subjects with different manipulative preferences.

H₀1e: There is no statistically significant difference in attitude toward computers between subjects with different grouping preferences.

H₀1f: There is no statistically significant difference in the interaction between the different scales of learning style.

H₀2: There is no statistically significant difference in attitude toward computers between boys and girls.

H₀3: There is no statistically significant difference in attitude toward computers between subjects with Caucasian, Hispanic, Black, or Filipino ethnic backgrounds.

- H₀4: There is no statistically significant difference in attitude toward computers between subjects with different levels of computer literacy.
- H₀5: There is no statistically significant interaction between the learning style, sex, ethnic background, and computer literacy of the subjects in effect on attitude toward computers.
- H₀6: There is no statistically significant difference in attitude toward computers between subjects with different learning styles, ethnic background, sex, and computer literacy.

Definition of Terms

Three terms critical to this study were learning style, attitude toward computers, and computer literacy.

Definitions with explanatory remarks were included. Other terms requiring specific clarification were also defined.

Learning style

The definition of learning style was based on the multi-dimensional view of learning style with learning style as the umbrella term. The definition was drawn from the work associated with the National Association of Secondary School Principals (NASSP) effort to develop a comprehensive instrument for the assessment of learning style. The

results of the NASSP effort was a first level diagnostic instrument labeled Learning Style Profile (LSP).

Learning style was defined as the composite of characteristic cognitive, affective and physiological factors that served as relatively stable indicators of how a learner perceived, interacted with and responded to the learning environment. It was demonstrated in that pattern of behavior and performance by which an individual approached educational experiences. Its basis lay in the structure of neural organization and personality which both molds and is molded by human development and the learning experiences of home, school, and society.

Learning Style Scales. From this broad definition, there were four relatively independent scales and one category, taken from the overall LSP, that were used in this research. The scales were (a) analytic skill, (b) sequential processing skill, (c) manipulative preference, and (d) grouping preference. The category was perceptual response, which contained the three additional scales of visual, auditory, and emotive response.

Analytic skill. Analytic skill was defined as the ability to identify simple figures hidden in a complex field or, in broader terms, to use the critical element of a problem in a different way. This scale corresponded to the widely used field dependence versus field independence cognitive style.

Sequential processing skill. Sequential (successive) processing skill represented one of the basic ways humans process information. Successive processing involved the representation of experience in which the elements were ordered serially or temporally. This kind of processing proceeded step by step in a more or less linear fashion. Verbal processing was sequential. The counterpart to sequential processing was simultaneous processing which related more to the integration of separate elements into the whole with the essential characteristic that the entire system was grasped at once. Successive and simultaneous processes referred to the ways individuals dealt with tasks mentally and not to the nature of the tasks themselves.

Perceptual response. Perceptual response was based on the Edmonds Learning Style Identification Exercise (ELSIE) developed by Harry Reinert and measured the tendency to react to a series of words in terms of visual, auditory, or kinesthetic modalities. Perceptual response characterized the functional level of one or more of the information-gathering modes.

Manipulative preference. Manipulative preference identified learner preference for hands-on learning activities. Manipulative learners liked to build, fix, make, or put things together, regardless of what their preferred perceptual response might be. No correlation existed between this scale and perceptual response.

Manipulative preference assessed task orientation while perceptual response measured initial orientation to stimuli.

Grouping preference. Grouping preference identified the learner's preference for whole class, small group, or dyadic learning arrangements. It had social characteristic and influence implications.

Attitude toward computers

Attitude toward computers was defined as the way an individual thinks and feels about computers and computers' impact on society, education, and the working environment. Attitude was measured by student response, on a Likert scale, to statements concerning different aspects or uses of computers (see Appendix A).

Computer literacy

Computer literacy was the degree of understanding of the capabilities, applications, and implications concerning computer technology, specifically including the design and operation of computer hardware and software with implications concerning computer systems in solving problems. The level of computer literacy could be demonstrated by the ability to correctly answer questions concerning the separate elements of computer systems, as well as their operation, appearance, application, and function.

Computer assisted instruction (CAI)

The use of the term CAI in this proposal was intended to include all terms describing the use of computers in the teaching and learning process.

Formal computer experience

Formal computer experience represented a criterion for the sample population meaning students had used computers as part of their school curriculum for at least 30 minutes a week for a minimum of two years. The experience necessarily included formal presentations concerning computers plus hands on operation in any of a variety of ways. Possible uses included word processing, the development of data bases, the programing of spread sheets, drill and practice programs in different academic subjects, the various possibilities with Logo, and simulations or games.

Middle school

Middle school was defined as grades 6 through 9.

Importance of the Issue

Knowledge of the relationship between the student and the computer had not grown commensurate with the rate of increase of the utilization of computers in education. Knowledge of this relationship was critical as education was looking for technology to assist in the improvement of the educational process demanded by society. As part of this larger problem, this study attempted to more clearly

understand the possible determinants of students' attitude toward computers, hopefully laying the groundwork for more definitive studies.

Additionally, the proposed research had the potential to contribute in unforeseen ways since the method of data analysis would identify possible interaction between the independent variables.

The second place that the issues under investigation had importance was in the mind of the researcher. In this case, Bitter and Frederick (1989) stated the motivating factor:

With the pervasiveness of technological change and its effect on society, we as educators must continually reflect on the phenomena and examine the needs of students for the future. We must also investigate how we can use this technology that is driving us into the future to enhance teaching, learning, and understanding in our society.(p. 36)

Limitations and Assumptions

The primary limitation of this research was that of generalizability. The first aspect of this limitation came from the criterion established for the sample population concerned with prior computer experience. This specific criterion created a group knowledgeable about computers that was not reflective of the total middle school population.

The second aspect of this limitation came from the socio-economic status of the sample population. Since the location of the schools was inner city, very few students from middle to upper income families were in attendance, and the fact that the schools were private, limited the very poor.

A primary assumption by the researcher concerned the hierarchy between attitude toward computers and computer literacy. In this research, attitude was the dependent variable with computer literacy the independent. The final argument for this arrangement came from the nature of attitude and literacy. Attitude was considered to be a combination of opinion and disposition formed as a product of external forces while literacy was thought to be a reflection of both external and internal forces as well as natural ability. Therefore, attitude was more to be formed by literacy than literacy was to be formed by attitude. However, in the final analysis, the concept that literacy formed attitude was assumed.

Other assumptions were that the students responded to the best of their ability on the attitude and computer literacy survey. While the learning style instrument contained a measure of student consistency, no such analysis was available for the other instruments.

Chapter II

Review of The Literature

Introduction

The review of literature focused on studies that involved the dependent variable of attitude toward computers with one or more of the independent variables of learning style, sex, ethnic background, or computer literacy. Pictorially, these possible relationships would be represented by a wheel with attitude toward computers at the center and learning style, sex, ethnic background, and computer literacy on the rim. The major emphasis was on the spokes or connecting links between the rim and the hub. Identified studies that were concerned with individual variables, as opposed to combinations, were utilized as background and theoretical information.

When considered independently the quantity of literature concerning each variable was often large, whereas when attempting to identify research concerning possible relationships between specific independent variables and dependent variable, the number of studies available was considerable diminished and fractured. For instance the amount of literature available concerning learning styles was extremely large, but the number of studies concerning

the possible relationship between learning style and attitude toward computers was relatively small. Additionally, those studies that were identified were often concerned with different concepts of learning style or other aspects of computers. Another example of the review of literature situation was exemplified in a report by the Ford Foundation (Lockheed, Thorpe, Broooks-Gunn, Casserly, McAloon, 1985) where a comprehensive review of literature concerning sex, ethnicity, and computers was conducted. The researchers were unable to identify any studies that were concerned with ethnic differences in computer performance or sex differences within ethnicity as related to computer performance. Although more applicable literature would have been beneficial to this research, the review of literature did identify a sufficient number of studies to provide both background, and in some cases, expectations for several of the possible relationships.

Organization of the Review

The report of the review of literature was divided into five main and three minor sections. Each possible relationship between one of the independent variables and the dependent variable was a area of major interest, with smaller general sections concerned with learning style, computers in education, and a summary. Both learning style and computers in education had been addressed by an extensive number of researchers over the past two decades

and were not included in this review in a comprehensive manner, but more to provide background and theoretical information. Although the review was organized into sections, the different parts were not mutually exclusive since many of the articles reviewed applied to more than one section with some qualifying for inclusion in every part.

Learning Style

According to Mann & Sabatino (1985) the study of cognition reached back to antiquity which was somewhat beyond the scope of this study. However, Dunn and Dunn (1978) indicated that learning styles had been undergoing a period of increased attention for the past 40 years in line with other societal changes focusing on education.

Different definitions of learning style by researchers had complicated the understanding of this construct. In the simplest sense, learning styles could be thought of as the way an individual learned. Although this definition provided little more information than the name implied, it retained the essence of this psychological phenomena. Bennett (1979) and Dunn and Dunn (1978) provided more elaborate definitions. According to Bennett, learning styles might be thought of as a student's preferred way of learning, representing a cluster of personality and mental characteristics that influenced how a pupil perceives, remembers, thinks and solves problems. According to Dunn

and Dunn, learning styles was a phenomenon that (a) varied among individuals, (b) was identifiable, and (c) required complimentary instructional methodology. Dunn (1981) wrote that style consisted of a combination of physical, psychological, emotional, and wide-spread elements that affected the ways individuals received, stored, and used knowledge or abilities. Another definition of learning styles presented by Schmeck (1983) was a predisposition on the part of some students to adopt a particular learning strategy regardless of the specific demands of the learning task.

According to Gregorc (1979), an individual's learning style consisted of distinctive and observable behaviors that provided clues about mediation abilities. Based on these clues and the suggestions they made, conclusions could be made about how an individual related to the world and how they learned. Gregorc suggested that these behaviors and preferences were what allowed the identification of learning styles by either observation, through interviews, or by paper and pencil instrumentation. Gregorc considered learning styles inborn where individuals had natural predispositions or proclivities toward a given style with minor proclivities, or better termed secondary learning styles, to cope with the varying demands of the environment.

Keefe (1987) and Dunn & Dunn (1978) approached learning style from the perspective that there were many separate

measurable elements that when considered together constituted more a profile than a single distinct characteristic. In the case of Keefe, learning style was separated into four categories and then further classified into 24 different relatively independent scales. The instrument associated with Keefe's work, known as the Learning Style Profile (LSP) provided a raw score for each scale which was converted to a standardized score. Several separate scales of this LSP were utilized in this study.

The Impact of Learning Style

The impact of learning style on the learning process was well documented by many researchers (Dunn & Griggs, 1988; Gregorc, 1979; Keefe, 1987) with a strong consensus that student academic performance was positively affected when students' learning style was taken into consideration in lesson preparation and delivery. Since computers in education were primarily utilized as a tool that had identifiable characteristics, there was sufficient basis to expect correlation between certain learning styles and attitude toward computers.

Computers in Education

Computers represented a technology that our society had embraced in a comprehensive manner reserved for only a few other concepts in our history. If the industrial age was symbolized by the automobile, then the information age was

symbolized by the computer. But while some elements of our society have rushed to incorporate computers, educational research (Ediger, 1988; Becker, 1987) indicated that the education community had been slow to respond. Some of this tardiness could be attributed to the state of the research.

German (1987) indicated that research concerning computers in education could be broken into two broad phases. The first period sought answers to the basic question of the effectiveness of CAI, and when positively concluded, the second phase sought to address the question of how to best utilize this tool. A study by Walker & Azumi (1985), that investigated the impact of CAI on mathematics learning gains, was typical of hundreds of identified works that addressed the first period question. In this case the researchers concluded that CAI maximized individualized instruction and had beneficial learning effects for all ability level students.

Research addressing the basic question of the effectiveness of CAI is still on going, albeit to a reduced degree, as shown by Gilman and Brantley (1988). While most studies have indicated positive results with CAI, Gilman and Brantley, in a comparison of two fourth grade classrooms, found no statistically significant difference in achievement between the one utilizing CAI and the other class with more conventional lesson presentation. Although in a minority, studies that indicated a lack of increased achievement when

CAI was utilized have motivated other researchers to find how and why to best utilize CAI.

The determination of best fit was inherently complex and further compounded by the continuing rapid development of the computer and the proliferation of different types of computer systems. Additionally, the school environment was also complex and dynamic. Becker (1987) in his analysis of the 1985 National Survey of Instructional Uses of School Computers provided impetus for the second phase of research when he stated that until computer activities took into account the complexities of instructing a heterogeneous mixture of young people in large group settings, the effectiveness of computers would be limited.

The second phase of research commenced approximately ten years ago and has pressed the state of the art in both computer science as well as in adaptation to education. Bull (1988), in a study that typified the change from the comparison of students with and without computers to a study that compared students with different types of CAI, investigated alternative models for the use of CAI to teach language skills as well as computer-based language activities that complemented learning and best practices. Recent studies, with considerable sophistication, included Stasz' work (1988) which investigated the effects of Intelligent Tutoring Systems (ITS). Such systems aimed to improve upon previous CAI by embedding much of the expert

knowledge that good human teachers possess. Another example of highly sophisticated second phase research was reported by Zock (1989), who described a program in development that would be interactive. It would not only assist in the learning of language would also provide analysis on how language was learned.

Obviously there were studies that contained elements of both phases. Lai (1984) conducted a study of the SCOPE computer program performing both quantitative and qualitative evaluation of the integration of computers into the math and science curriculum. The objectives were to determine overall effectiveness, first phase research, and to learn how to modify CAI to make improvements, second phase research. Results confirmed the efforts of first phase research where students demonstrated increased mathematical problem-solving abilities based on instruction utilizing CAI, while contributing to second phase research by providing useful information concerning computer program adaption.

Computers and Learning Style

The different definitions of learning style had produced diverse opinions on how to quantitatively measure this construct. Dunn (1981) indicated that often research done with computers and one learning style definition might not be fully understandable to a researcher using another

definition. Further complications arose from differences in classification of types of CAI. Research by Rowland and Stuessy (1988) was illustrative. For their research, they identified two modes of CAI: tutorial and simulation, to be correlated against two aspects of cognitive style as developed by Pask (1976). Pask had shown that learners attacked a learning task using a preferred strategy and that CAI could be prepared that facilitated learning by utilizing one of his two strategies. Rowland and Stuessy sought answers to the effect of the mode of CAI on achievement and understanding by matching holist to simulations and serialist to tutorials (the predicted optimum) and also mismatching the two possibilities. The holist and serialist cognitive style could be compared with simultaneous and sequential processing skill scales in the LSP. Simulation and serial CAI programs are sometimes referred to as games and drill and practice programs. From the perspective of this study, Rowland and Stuessy hypothesized that individuals with a more holistic cognitive style would perform better utilizing CAI that involved games than they would with the more step by step drill and practice programs. Additionally, the individual with sequential processing skills would prefer the opposite. They concluded that cognitive style interacted with the mode of CAI to influence student achievement but did not generalize their results. Abler & Sedlacek (1987) in a study of computer

orientation by Holland type found that females and students classified as artistic and enterprising demonstrated less positive computer attitudes than did males and other classifications. While both of these studies indicate the study of learning styles and computers could be fruitful, they offered only limited clues as to what any final outcome might be for research with the instrument utilized in this study.

According to Mann and Sabatino (1985), the most widely researched cognitive style was field independence versus field dependence. Research in this area had possible application to this investigation since the analytic skill scale of the LSP was derived from this definition of cognitive style.

Field independence and field dependence was assessed on the basis of perceptual accuracy where field independence represented the ability to resist inaccurate perception (Kogan, 1973). While there were efforts to soften the theoretical favoritism for field independence and to reduce the negative implications of field dependence, individuals classified as field independent were generally considered better performers in the academic environment (Mann & Sabitino). They consistently were rated brighter, more cognitively efficient, and better able to solve problems. Several researchers (Foreman, 1988; Post, 1985; Dahl, 1984; Baker, 1986) had studied the relationship between computers

and the cognitive style of field orientation.

In a study concerning the relationship between cognitive style and the acquisition of initial computer programing competence, Foreman found a strong correlation between field independence and most programming skills, while spatial ability was related to the specific functions of debugging and modification. Post found that field independent students learned more than field dependent students from the computer game Rocky's Boots. On the other hand, Dahl studied the influence of a field dependent or field independent cognitive style on learning outcomes of drill and practice and simulation CAI and found no main effects, and Baker's study of field orientation and learning on a drill-tutorial program also showed no relationship to performance.

A variety of other approaches to learning style had been employed in various studies. Wesley (1986) found that individuals with an external locus of control did better when using CAI than when using programmed text. Additionally, Baird and Koballa (1986) reported an interaction between the level of formal reasoning and the mode of CAI. Williams (1984) and Martini (1986) both studied the relationship between learning style and CAI, finding correlation between their definitions of learning style and some aspect of instruction with computers.

In a study of the effectiveness of CAI and its relationship to selected learning style elements, Williams (1984) found that CAI had a positive effect on achievement in mathematics, but that the achievement wasn't correlated to learning style. In his study, Williams used the learning style elements of grouping preference, visual perception, auditory perception, tactual perception, and kinesthetic perception as determined by an assessment instrument referred to as The Learning Style Inventory. Williams work also has direct application to this research since there was similarity between his elements of learning style and some scales of the LSP utilized in this study.

In a study of the relationship between learning styles and attitudes toward computer programming of middle school gifted students, Paskewitz (1985) utilized the Learning Style Inventory developed by Dunn, Dunn and Price with elements of formal or informal design, source of motivation, amount of persistence, level of responsibility, need for structure or flexibility, preference for learning situation, perceptual strengths or weaknesses, need for mobility, and right, left, or integrated brain hemisphere orientation. The only statistically significant findings were that boys had a more positive attitude toward programming than girls. Paskewitz also indicated that there was a future research requirement where other factors of learning style, including cognitive style should be investigated.

While the identified studies utilized various definitions of learning style with different categories of CAI and indicated a variety of results, they did support the idea that under some circumstances students with different learning styles reacted differently to computers and that the study of this difference was potentially worthwhile.

Attitude Toward Computers Based on Sex

The literature concerning students' attitude toward computers based on gender was an exception to the situation described where relationship literature was limited. There were a large number of studies that directly addressed attitude toward computers based on sex. These investigations were broadly categorized into studies concerned with different age groups, studies that were basically concerned with intervention techniques due to gender based inequality, and studies that established data bases.

Age of population studied

In Kagan's (1988) review of six investigations concerning the attitude toward computers of college age students he observed the consensus opinion that males had a more positive attitude toward computers than females. Nickel (1987) reported that, at the college level, more males enrolled in higher level computer science courses and that males used computers in a more diversified manner.

Studies (Stanley, 1987) of sample populations at these higher educational levels also indicated that attitudes were established prior to reaching that age group.

Miura (1986b) and Lockheed (1985) were representative of researchers that conducted studies at the high school and middle school level with the predominant conclusion that males had more positive attitudes toward computers than females. However, there was some reports (Chen, 1985; Webb, 1985)) of no difference in attitude.

Reporting on studies involving pre-adolescent age groups, Swadener & Hannafin (1987) observed that males had more positive attitudes at the sixth grade level while Jones (1987), Hoover & Austin (1986), and Elliot (1988) reported no differences in attitudes among the younger age groups.

The studies concerning attitude and gender represented international interest. In addition to the study from Canada (Collis & Willians, 1987), other studies (Hattie, J, & Fitzgerald, D., 1987; Culley, 1988) concerned with attitude and sex were done in England and Australia with results similar to those in this country.

Based on the review of literature, males clearly had more positive attitudes toward computers than females at the higher grade levels with reports at the lower grade levels mixed. Based on this trend, attitude toward computers was considered emergent during the adolescent years.

Intervention literature

Some researchers (Reece, 1987; Schubert, 1984; Linn, 1985; Gripshoever, 1984) viewed the difference in attitude toward computers based on sex and subsequent imbalance in higher level computer science class enrollment as discriminatory. Since careers involving computers were expected to be prestigious and financially rewarding, dominance by males would continue the existing social situation where males earned more than females. Therefore, the thrust of much of this literature was toward intervention techniques in the educational system to ensure equal opportunity for different sexes.

Data Bases

There were at least two studies relevant to student attitudes toward computers that created large data bases. In the Spring of 1983 the California Assessment Program (1984) administered an attitude and a computer literacy survey to sixth and twelfth graders that was intended to be a baseline measure for student attitude toward computers and their knowledge of computers in California. In this study, males were found to have a more positive attitude toward computers than females. Boys also had a higher computer literacy level than girls which was attributed to more experience with computers reported by boys. However, the difference in computer literacy based on sex was small in relation to the difference based on parent educational levels and a significant finding of the CAP study was the

positive correlation between socioeconomic status and computer literacy. Collis and Willians (1987) reported on an extensive survey conducted in the Victoria, British Columbia system with similar results.

Additionally, other studies (Wilder, Mackie & Cooper, 1985; Swadener & Hannafin, 1984) reported on smaller data bases where conclusions concerning attitude were mixed.

Ethnic Background and Attitude Toward Computers

In a comprehensive review of the literature concerning computer learning among girls (Lockheed et al, 1985), minority students, and inner-city students sponsored by the Ford Foundation, differences in participation in computers based on ethnic background was reported. Hispanic students used computers less frequently than either Black or White students, who used computers approximately equally, while Filipino and students classified as Other used computers more frequently. The subject of attitude toward computers was not addressed directly, but was considered to be a factor in participation. No study was identified that reported on performance with computers based on ethnic background.

Several researchers (Campbell, 1983; Urban, 1986) have identified access to computers as a factor in attitude toward computers and indicated it was also related to socioeconomic status (SES), ethnic background, and sex, with

wealthier White males more apt to have access to computers. Additionally, they reported that low SES students were more apt to use computers for remedial drill and practice with high SES students more likely to use computers in creative ways.

Wearden (1984) had some similar and some different results when he conducted two telephone surveys of adults to determine the effects of various demographic and psychological characteristics on attitudes toward microcomputers. Results indicated that computer experience, income, education, and having children all predicted a positive attitude toward computers. Findings also showed that conventional notions about the acceptance of computers only by White males may be an oversimplification. No difference in attitude based on sex was found and non-whites had a more positive attitude than did Whites.

Campbell & Connolly (1984) in a study of ethnic differences among the gifted found substantial cultural variations between Filipino and Caucasian students that impacted both attitude and academic performance with Filipino students higher in both categories.

Ethnic Background and Learning Style

Navarro (1978), using a cognitive style of field independence and field dependence, found no differences between the learning styles of Hispanics and White students which was reported as contradictory to earlier unspecified

research. Pheifer and Dudley (1984), in a study measuring achievement, found differences based on learning styles, sex, ethnic background, and socioeconomic status.

In a study of the educational styles of Afro-American children, Hale (1980) found that differences were more a factor of culture than of race or class. Hale indicated that Black culture has an orientation toward people rather than objects, proficiency in nonverbal communication, and utilization of a relational cognitive style as opposed to an analytic cognitive style. All of these characteristics differed from the typical behavior of Whites. Jones (1986) supported this cultural difference finding that various factors in the culture of Black Americans was seen as promoting cognitive style differences and greater field dependence. These included kinetic-tactile rather than visual information processing emphasis and a person oriented rather than object oriented cue selection style.

In a study into the relationships between cognitive preferences, achievement, and ethnicity of first year algebra students, O'Donnell and O'Donnell (1987) found that Asian students had higher graphic scores than Black students; Hispanic students had higher verbal scores than Asian students; and Black students had higher symbolic scores than Hispanic students.

Computer Literacy and Attitude Toward Computers

No literature was found that directly addressed computer literacy as a determinant of attitude toward computers, but there were studies concerning literacy and achievement. The most comprehensive study identified was the California Assessment Program (CAP) given in the Spring of 1983 reported by Fetler (1985). This study reported a small difference in computer literacy based on sex, but a much stronger difference based on socioeconomic status with the higher status having substantially higher computer literacy scores. Experience with computers was also associated with higher computer literacy. Web (1985) found no difference in the performance of males and females in learning Logo or programming in BASIC.

The study by Lockheed et al. (1985) did a comprehensive review of literature for sex and ethnic differences in middle school computer science covering grades four through eight. Among their findings was that minority girls tended to take fewer courses in mathematics, science, and technology, which further correlated with national performance assessments where this group performed less well.

Further findings of the Lockheed et al. (1985) study indicated that the studies they reviewed were frequently flawed in two important ways. One was that factors that were known to be correlated with gender or ethnicity were

not held constant before conclusions regarding differences were drawn. The second was that sex and ethnic differences in achievement were erroneously attributed to factors that, although associated with either gender or ethnicity, were actually uncorrelated with achievement.

Summary of the Review of Literature

In summary, the review of the literature was primarily focused on studies that identified relationships between the dependent and independent variables. While many studies reviewed provided only parallel information, sufficient information to develop expectation was available in most cases. The review clearly demonstrated that the proposed research was on fertile ground where much basic information was still required.

From the review of literature concerning computers in education and learning styles, computers had been found to be an effective tool in assisting learning. Additionally, it had been substantiated that classroom instruction incorporating learning styles had increased student achievement.

From the literature addressing computers and the field orientation definition of cognitive style, there was sufficient information to expect some possible correlation between the analytic skill scale of the LSP and attitude toward computers in the research reported on in this paper.

On the other hand, the literature indicated that no relationship was likely between the perceptual category of the LSP utilized in this research and attitude toward computers. From an overall perspective, the definition of learning style appeared critical in finding any possible relationship between computers and learning styles, with those learning styles emphasizing cognitive skills as being more probable. Additionally, the mode of CAI also seemed important, with decreased probability of a relationship between learning style and computers with routine drill and practice software.

The one relationship that was established by the review of literature was the correlation between attitude toward computers and gender. Males were predominantly reported as more positive than females for college age students with the situation moderating slightly for the adolescent years. Studies of preadolescent age students found a mixture between males being more positive and neither sex being more positive. Based on the review, a relationship between sex and attitude was expected with males being more positive.

The review of literature identified no specific study directly addressing ethnic background and attitude toward computers. However, several studies were found that addressed access to and frequency of use of computers and ethnicity or SES. In most cases, attitude was considered a factor in access or frequency of use. The review indicated

that SES was an indicator of both access and frequency with higher SES predominating. Higher SES students also used computers in more creative ways. Based on the review, expectations for this research included possible main effects between ethnic background and attitude toward computers.

The review of literature identified no specific study directly addressing the possible relationship between computer literacy and attitude toward computers. However, computer literacy was shown to have a strong relationship with SES and based on much the same logical sequence as used in the preceding section, computer literacy was expected to have main effects with attitude toward computers.

Chapter III
Research Design and Methodology
Introduction

The purpose of this research was to determine if a relationship existed between specific student characteristics and students' attitude toward computers. Student characteristics studied included sex, ethnic background, specific aspects of learning style, and computer literacy. The design of the research primarily involved the investigation of possible relationships between the dependent variable and the independent variables. Separate assessment instruments were used to determine students' attitude toward computers, learning style, and computer literacy with additional information concerning ethnic background, sex, grade level and age collected from questions in the instrument headers. There were no pre or post aspects to the design.

The concept behind this research was to both consolidate and to go beyond existing literature. Research (Bennett, 1979; Campbell, 1983; Culley, 1988) concerning attitudes toward computers had predominantly studied the effects of gender, indicating that males had a more positive attitude toward computers than females. Some subsequent literature

(Fetler, 1985; Gripshoeffer, 1984) had addressed the issue of educational intervention to remedy this condition. Still other studies had investigated the relationships between some aspects of computers and various other human characteristics, but none had addressed attitude toward computers as a complex phenomenon with a wide variety of possible determinants. This research proposed to add definition to existing knowledge concerning attitude toward computers by utilizing a broad based group of possible determinants. Student gender was included as a possible determinant in order to establish a basis from earlier studies. Student learning style was selected as a possible determinant due to the increasing importance of this psychological phenomenon in education. In this case, the profile concept of learning style was utilized in an effort to bridge the many definitions of learning style used in earlier studies. Ethnic background was considered most appropriate due to the increasing diversity of cultures that exist in many of our schools, particularly in Southern California. The various ethnic backgrounds involved in the sample population were Black, White, Hispanic, and Filipino. Computer literacy was included as a possible determinant of attitude due to its correlation with socio-economic status indicated in earlier studies and also as a measure of academic performance.

This enlarged perspective of possible determinants of attitude toward computers also offered the possibility of finding new relationships by studying interaction between all of the independent variables.

Sample Population

The criteria for the sample population had four factors, all important to the concept of the research. The sample was coeducational, with a diverse ethnic background, from the middle school age group, where all subjects had at least two years of academic experience utilizing CAI.

The effects of gender on attitude toward computers had been widely studied and was a necessary anchor in this research. Ethnic diversity was a logical extension of existing literature and relevant to the area where the research was conducted. Ethnic diversity also provided a potentially rich area of interaction with the other independent variables investigated. The selection of a middle school age group revolved around reports from earlier studies that indicated student attitude toward computers was emergent in this age group. And finally, the two year CAI requirement made the sample somewhat sophisticated concerning computers. Additionally, the computer experience requirement would provide additional insight into educational intervention programs suggested by earlier studies. For example, if the attitude of males and females

was similar in this sample population, then it would suggest that comprehensive computer programs adequately insured equal opportunity for females in the computer field. However, if the results of this research indicated that boys were more positive toward computers than girls, then intervention in the educational system would appear necessary.

Sample Population Selection

Due to access limitations, the sample population was constructed of naturally assembled groups. The only student scores eliminated from the analysis were those that didn't have at least two years of academic experience with CAI. Three school districts, two public and one private, were surveyed in order to find a population that would conform to the criteria established for the sample population. The final selection of a sample population from three schools in the private school district was based on several factors, some of which went beyond the criteria for the sample population that had been established.

First of all, due to the possible interruption of the education process and consideration for the protection of the privacy of students, this research was only possible with cooperation by school officials. This researcher found that private school officials had more authority over their school's educational program and could independently make or alter assessment plans. Additionally, the private schools

were smaller which increased their flexibility. In the final analysis, and based on the potential to obtain educationally beneficial information and student privacy considerations, the officials from schools involved in this study decided to incorporate the research instruments into their existing year end assessment process with testing expertise and manpower provided by the researcher. The data was given to the researcher after release by the parents or guardians.

When the three districts were compared solely on the basis of the sample population criteria, schools in the private district offered more racially diversity with qualifying CAI programs all within a reasonable number of locations. From a consideration of six schools, three private inner city schools were selected. The assessment process at these schools involved all students in appropriate grades. A random selection of the sample population was only achieved in the sense that a limited number of schools was utilized. Some impairment to the credibility of the research was accepted due to the sample population selection process, but the process was generally dictated by sample population criterion and practical accessibility.

During the survey, hidden criteria became apparent. In one school district, the academic achievement of the students was skewed toward the lower level and, if utilized,

would have changed the concept of the research. Another complication with middle schools from the public districts was that their students came from a number of feeder schools with CAI programs that varied from none to extensive. Additionally, there was a much more transit nature to the students in the public districts which would have further complicated compliance with the established criteria.

Each of the private schools selected had a comprehensive, although different, computer based educational program. Each school introduced computers at the first grade level but with variations in emphasis. One school primarily utilized the computer program of Logo with complexity increased as grade level increased. Students in this school had computer usage time in excess of an hour a week. Another one of the schools utilized CAI in math, spelling, and writing with some usage of data base programs for social science projects. The program in this school was dynamic and had recently been modified to include a specific computer literacy curriculum at the middle school level. Both of these schools primarily utilized Apple computers. The third school used IBM compatible hardware in support of writing, math, and spelling. Both of the last two schools mentioned had student computer usage in excess of the requirement.

The curriculum of each of the three schools included the Iowa Test for Basic Skills and scores indicated that the

majority of students ranked within one standard deviation of the national mean. No detailed analysis of norm referenced test scores was incorporated into the analysis. However, some analysis of data, based on the school a student attended, was conducted to check for homogeneity and the results included in the analysis section.

The three schools involved had all undergone a WASC evaluation and as part of their self study were required to make a statement as to the professional level of the families involved in their school. The basis for this self evaluation was subjective and varied between the schools from semi-skilled to skilled.

Participants. Two hundred and eighty four coeducational students in grades six through nine from three private schools participated in the study in the Spring of 1990. A numerical description of grade level, sex, and ethnic background of the sample population is shown in Table 1 and Table 2

Instrumentation

Attitude Toward Computers Instrument

The dependent variable of attitude toward computers was assessed with an instrument (see Appendix A) used by the California Assessment Program (CAP) in 1982-83 which in turn was extracted from questions that had been administered by the National Assessment of Educational Progress in the 1977-78 mathematics assessment. These questions were selected by

Table 1

Number of Participants by Grade Level and Sex

	Grade Level				Total
	6th	7th	8th	9th	
Male	38	46	38	13	135
Female	42	44	45	18	149
Total	80	90	83	31	284

a committee of specialists assembled from the public school system, universities, and industry. They were designed to encompass the diverse educational objectives and settings of many different district and school programs. Questions were reviewed for relevance and accuracy of content, sex or ethnic bias, and typographical correctness.

The CAP test was administered to a total of 293,717 sixth grade and 23,395 twelfth grade California students under standardized conditions. The primary goal of the computer segment of the CAP study was to examine the knowledge, attitude, and experiences of California's sixth and twelfth graders concerning computers. The aspects of attitude addressed by this instrument primarily involved

Table 2

Number of Participants by Grade, Sex, and Ethnic Background

	Grade Level				Total
	6th	7th	8th	9th	
Filipino	13	13	9	2	37
Male	9	9	3	1	22
Female	4	4	6	1	15
Black	8	13	13	2	36
Male	6	9	8	1	24
Female	2	4	5	1	12
Hispanic	20	28	25	16	89
Male	6	15	10	5	36
Female	14	13	15	11	53
White	37	29	30	7	103
Male	15	11	14	5	45
Female	22	18	16	2	58
Other	2	6	7	4	19
Male	2	2	3	1	8
Female	0	4	4	3	11

items that might have been formed or impacted by education. Attitude in this context was more informed opinion than emotional disposition. The results of the CAP testing provided a baseline measurement of the attitude toward computers for California's student population. This baseline aspect of the CAP results made the instrument desirable for research use in California.

A matrix format with a spiral distribution was used for the CAP for testing, meaning that different students took different test in an effectively random procedure. Results were reported for each individual question in detail with percentages for each Likert response provided on the basis of gender and four SES groupings. The detailed level of data analysis allowed for comparison on both an individual question basis as well as comprehensive perspective by any later study utilizing the same instrument.

The instrument was composed of thirteen questions answered with a five point Likert scale. The questions were unweighted with each individual question receiving a score of one to five with five being the most positive. The composite attitude score was the sum of the scores for each question. For each question, a neutral attitude toward computers was represented by a score of three, and a composite neutral score would have been 39.

Learning Style Instrument

The Learning Style Profile (LSP) was developed by a task force under the auspices of the National Association of Secondary School Principals. One of their purposes for this effort was to develop a comprehensive learning style instrument taking into consideration the diversity that existed in the field. The results were referred to as a Learning Style Profile containing 24 independent scales representing four higher order factors: cognitive skills, perceptual responses, study preferences, and instructional preferences. It was considered a first level diagnostic tool with many of the scale scores based on a limited number of questions. Questionable results for any scale for an individual student should be resolved by additional in depth testing. The LSP required 30 to 45 minutes to administer and contained 126 multiple choice or Likert type questions. Raw scores were normally converted to standard scores for analysis. Due to the size of the instrument, no copy was provided with this document.

Validity. Validation and norming of the LSP was conducted in 1986 with a nationally distributed population of 5,000. The average internal consistency reliability for the scales was 0.61. Reliability study tables were available in the examiner's and technical manuals.

Concurrent validity of the LSP was determined in studies comparing specific scales with the Group Embedded Figures Test (GEFT) as developed by Witkin, the Edmonds

Learning Style Identification Exercise (ELSIE), and the Learning Style Inventory (LSI) as developed by Dunn and Dunn, and Price. Correlation of the Analytical Scale of the LSP with the GEFT was 0.39. Correlations between ELSIE scales of Picture, Sound, and Feeling were statistically significant with LSP scales of Visual, Auditory, and Emotive. Additionally, strong correlations were found between the LSP scales and the related LSI scales.

Reliability studies for each scale were performed separately with no Alpha calculation reported that was less than 0.54. The inclusion of each separate scale in the LSP was based on extensive review of the literature and existing instruments, and confirmed by factor analysis during preliminary and national field test.

Sections of LSP used. Although the complete LSP was administered, the results of only seven independent scales were used in the analysis. The analytic skill scale was used due to its connection to the cognitive style of field orientation. The sequential processing skill scale was used since it was one of two logical processing methods on the learning style instrument. The other processing type was simultaneous. The visual, auditory, and emotive scales, from the perceptual response category, were used due to their relatively common application in schools. The manipulative scale, from the study preference category, and grouping scales, from the instructional preference category,

were used due to their possible implications concerning the mechanics of actually working with computers.

Scoring. The results from the LSP were machine scored, developing raw scores that were converted to standard scores with a mean of 50 and a standard deviation of ten. Scores were further converted to three levels for use with the ANOVA analysis procedure. Level one included all scores more than one standard deviation below the mean. Level two was all scores within one standard deviation of the mean and level three was all scores at least one standard deviation above the mean. Additionally, the scoring procedure included a consistency calculation for each subject which provided a score reflecting the students uniformity in answering the questions. Results indicated the students were responsible in completing the instrument.

Table 3 is a summary table of the separate LSP scale scores across their three levels. The purpose of this table was to show a particular perspective of the distribution. Cell count was provided in parenthesis.

Computer Literacy Instrument

The survey of computer literacy was developed by a committee of specialists in computer technology assembled from the public school sector, universities, and industry under the auspices of the California Department of Education. The instrument was used by the California Assessment Program in 1983 to establish a baseline

Table 3

Mean Standard Scores by Level for the Different Scales of
The LSP Used in This Research with Cell Count in
Parenthesis.

LSP Scales	Level 1	Level 2	Level 3
Analytic Skill	33 (93)	50 (131)	67 (60)
Sequential Processing	29 (52)	54 (232)	none
Visual Perception	31 (52)	49 (200)	68 (33)
Auditory Perception	35 (60)	50 (183)	63 (41)
Emotive Perception	33 (48)	51 (198)	68 (38)
Manipulative Preference	33 (53)	49 (163)	64 (68)
Group Preference	31 (204)	46 (78)	63 (2)

measurement of what California's students knew about computer technology.

Cognitive test questions were written to conform to a set of objectives developed and used with the Department of Defense Dependents Schools curriculum. Test questions were checked for relevance and accuracy of content, sex or ethnic bias, and typographical correctness. Computer literacy questions were five part multiple choice with one answer being "I do not know the answer" (see Appendix B).

Scoring was based on the number of correct responses. The mean and standard deviation were developed from the raw scores and then the raw scores were converted to levels for use with the ANOVA procedure utilizing the same process as for LSP scores. Table 4 contains the mean attitude scores with cell count for the different levels of computer literacy.

The instrument used to evaluate computer literacy was given to sixth and twelfth graders in April 1983 as part of the California Assessment Program. On the state wide assessment, the mean correct answers for sixth graders was 28 percent and 46 percent for twelfth graders. For the sample population in this research project, the mean sixth grade computer literacy score was 38 percent increasing to over 50 percent at the eight grade level. The large difference in scores between the two testing time periods and populations is readily explained by the increase in educational use of computers and the requirement for the sample population to have experienced two years of CAI.

Collection of Other Information

Information concerning sex, ethnic background, age, and grade level were collected by questions in the headers of the various instruments. Table 5 shows the mean attitude scores for different sex and ethnic backgrounds.

Administration

The tests were administered during the normal sequence

Table 4

Mean Computer Literacy Scores with Cell Count for the Three Levels.

	Level 1	Level 2	Level 3
Computer literacy	6	11	16
Cell count	51	186	47

of the school day with no prior student preparation concerning the content of the instruments. Test were given in the afternoon class periods during mid-week. Students were grouped in adjoining classrooms and test supervision was performed by the primary researcher with assistance from classroom teachers. Instructions for each instrument were written and presented by the primary researcher and one hired assistant just prior to the administration of the test. All of the instruments were administered during one session of approximately one and one half hours with a snack break in the middle. All students present in the designated grade levels completed the instruments. The completed tests were given to the primary researcher for evaluation after parental permission was received. The rights of each individual were protected in accordance with the directives of the University of San Diego Human Subjects Committee.

Table 5

Mean Attitude Scores of Different Groups of Participants
with Cell Count.

	Mean Attitude Score	Cell Count
Males	48.40	135
Females	47.98	149
Filipino	48.35	37
Black	47.06	36
Hispanic	47.73	89
White	48.84	103

Methods of Analysis

Analysis of Main Effects

The basic research question was to determine what effect, if any, the independent variables had on the dependent variable. In more direct and simple terms and using the example of gender, the research wanted to know if males and females had statistically significant different attitudes toward computers. Quantitative methods were used to analyze the data. The main statistical procedure was Analysis of Variance (ANOVA) which tested the hypothesis that the group means for the dependent variable were equal. More specifically, a fixed factor ANOVA was employed. In

this process, the dependent variable was interval level and one or more categorical variables defined the groups.

SPSS/PC+ and SPSSx computer software were employed to perform the statistical calculations following directions as set forth in their manuals.

The SPSS/PC+ ANOVA summary table produced both the F ratio and the F significance value. The F significance value was a direct indication of the probability of committing a Type I error and removed the requirement of finding an F critical value. For this research, an alpha level of 0.05 was established for testing hypotheses.

Analysis for interaction

Interaction is present in a multiple ANOVA when the effect of levels of the first independent variable is not the same across the levels of the second independent variable. The analysis of data for interaction primarily involved the multiple ANOVA procedure with graphic analysis as a confirmation process. The SPSS/PC+ multiple ANOVA summary table produced F ratios and F significance values for interaction. However, the SPSS/PC+ software limited the number of independent variables for any one computer run to five and since more than five independent variables were investigated, several multiple ANOVA procedures were required to insure all possible interaction combinations were considered. Analysis was limited to possible two-way interactions.

Graphic analysis was used to confirm interaction calculations and also used to independently investigate interaction on a practical but not necessarily statistical significant level. While graphic analysis can't ascertain statistical significance, it can provide clear indication of relationships between independent variables as they concern the dependent variable.

Chapter IV

Analysis of the Data

Introduction

This study was designed to investigate the possible effects of learning style, sex, ethnic background, and computer literacy on students' attitude toward computers. The purpose was to determine if the different student traits used as independent variables were associated with variations in attitude toward computers. The secondary purpose of the study was to investigate the possible relationships between the independent variables as they related to attitude toward computers.

Preliminary Analysis of Data

The dependent variable in this research was attitude toward computers and the analysis was primarily concerned with differences in attitude across the levels of the independent variables. It was specifically noted that the great majority of students had a very positive attitude toward computers. The mean of the raw attitude score for the sample population was 48.18 where a neutral score would have been 39. Only 12 of 284 individual attitude scores were 39 or below.

The distribution of the attitude scores was plotted showing a mean of 48.18, standard deviation of 4.70, Kurtosis of $-.19$, and Skewness of $-.06$.

Past research concerning attitude and literacy had been criticized for not controlling for age. The data produced by this research was analyzed for grade level concerning both attitude toward computers and computer literacy. Attitude scores were stable over the four grades of the sample population while computer literacy scores advanced with increasing grade levels. These patterns held true for all ethnic groups and both sexes. The data was also analyzed for differences in schools with no statistically significant results.

Attitude scores exhibited both expected and unexpected differences from the baseline established by the 1983 CAP results. The overall scores for the sample population were more positive than the earlier CAP scores with the difference in females scores greater than with the males. The emphasis of the attitude instrument and the level of computer knowledge of the sample population explain at least part of these differences. Additionally, the scores were more closely bunched than those on the CAP. The limited variation in the SES of the sample population may partially explain this second variation from the baseline established by the CAP.

ANOVA assumptions

The ANOVA assumptions were met in that the scores on the dependent variable were normally distributed in the population and the population variances in all cells of the factorial design were within limits. However, total random selection of the sample population was not possible and normally formed groups were used. As discussed earlier, some randomness was achieved in the group selection process.

One area of concern during the analysis was the individual cell count. ANOVA procedures are robust concerning assumptions as long as cell counts are equal or proportional. In those cases where the size and variation in cell count was marginal, hierarchical ANOVA processing and Kruskal Wallis non-parametric procedures were used.

Order of detailed analysis

The analysis of individual hypothesis concerning main effects was discussed first followed by the discussion of the hypothesis concerning interaction. Since the first hypothesis was broken down into six sub-hypotheses dealing with both main effects and interaction, the detailed analysis of hypotheses was out of numerical order. The order of analysis by number was #1a, #1b, #1c, #1d, #1e, #2, #3, and #4 which concerned main effects and then #1f and #5. Hypothesis #6 dealing with an overall perspective was discussed last.

Analysis

Results of Hypothesis #1

H₀1 There is no statistically significant difference in attitude toward computers between subjects with different learning styles.

Hypothesis #1 was investigated using subhypotheses.

Results of Subhypothesis #1a

H₀1a There is no statistically significant difference in attitude toward computers between subjects with different analytic skill.

The scores for the analytic skill scale of the LSP were reduced to low, medium, and high levels and then run as an independent variable in multiple and one way ANOVA procedures. Table 6 was a summary table of the oneway ANOVA procedure with attitude toward computers as the dependent variable and the analytic skill scale of the LSP the independent variable. The F ratio of 3.3985 and F significance value of $p = 0.0348$ indicated statistically significant main effects. The F significance value in the ANOVA summary table was a direct calculation of the probability of a type one error and therefore there was no requirement to compare the F ratio to some critical value.

Table 7 shows calculations concerning the homogeneity

Table 6

Oneway Analysis of Variance Summary Table for the Dependent Variable of Attitude toward Computers by the Analytic Skill Scale of the LSP

Source of Variation	DC	MS	<u>F</u> Ratio	<u>F</u> Significance
Between Groups	2	74.1088	3.3985	0.0348*
Within Groups	281	21.8065		
Total	283			

* $p < 0.05$

of variance assumptions. Results of homogeneity calculations were interpreted in the same manner as the F ratio and the F significance value. A low probability would have indicated that the homogeneity calculation were statistically significant and homogeneity assumptions hadn't been met. In Table 3, $p = 0.602$ for Cochran C calculation and $p = 0.705$ for the Bartlett-Box calculation indicating homogeneity of variance assumptions were valid.

The non-parametric Kruskal Wallis procedure was utilized to confirm the statistical significance of the analytic skill scale of the LSP because of some variation in

Table 7

Tests for Homogeneity of Variances for the Analytic Skill
Scale of the LSP

Cochrans $C = \text{Max. Variance} / \text{Sum}(\text{Variances}) = .3664, p = .602$

Bartlett-Box $F = .349, p = .705$

Maximum Variance / Minimum Variance = 1.167

cell count. Table 8 summarizes the confidence validation derived from the Kruskal Wallis procedure.

Figure 1 graphs the mean attitude scores across the levels of the analytic skill variable and clearly shows the substantial increase in attitude scores as the analytic skill scores increased. The X axis scale was the three levels of the analytic skill variable and the Y axis scale was mean attitude score. The mean attitude score was lowest for analytic skill level 1 and increased as the level increased.

Conclusion. Based on the analysis, the hypothesis that there is no statistically significant difference in attitude toward computers between subjects with different analytic skill was rejected. A Scheffé multiple comparison was performed which indicated the statistically significant difference to be between levels one and three.

Table 8

Kruskal Wallis Non-parametric Summary Table for Attitude
toward Computers by the Analytic Skill Scale of the LSP

Mean Rank	Cases		
115.79	83	ANA =	1
138.85	124	ANA =	2
145.11	<u>58</u>	ANA =	3
	Total	265	
Corrected for Ties			
Cases	Chi-Square	Significance	Chi-Square Significance
265	6.3575	.0416*	6.3869 .041*
* p < .05			

Figure 1. The Mean Attitude Scores for the Three Levels of the Analytic Skill Scale.

Results Subhypothesis #1b

H01b There is no statistically significant difference in attitude toward computers between subjects with different perceptual responses.

The perceptual response category of the LSP was composed of the three scales of visual, auditory, and emotive which were each analyzed independently. The scores for each scale under the perceptual response category were

Table 9

Results of Oneway ANOVAs for The Dependent Variable of Attitude Toward Computers by the Three Scales of the Perceptual Category of the LSP

Perceptual Scale	<u>F</u> Ratio	<u>F</u> Significance
Visual	.2011	0.8179
Auditory	.1995	0.8192
Emotive	.2436	0.7840

independently processed in the same manner as other raw scores obtained by the LSP. Table 9 shows the results of oneway ANOVA procedures for all three scales indicating non-significant results. Based on these results no further analysis was conducted concerning the perceptual category.

Conclusion. The hypothesis that there is no statistically significant difference in attitude toward computers between subjects with different perceptual responses was retained.

Results Subhypothesis #1c

Holc There is no statistically significant difference in attitude toward computers between subjects with different sequential processing skill.

As with other scales of the LSP, raw scores on the sequential processing skill were transformed to standard scores and then further classified according to their deviation from the mean. For the sequential processing skills scores, normative data did not allow the possibility of scoring more than one standard deviation above the mean so in effect the sequential scale of the LSP had only two levels.

Table 10 is a oneway ANOVA summary table for the dependent variable attitude toward computers by the independent variable sequential processing skill. The table shows that the sequential processing skill variable to be statistically significant to the $p = 0.042$ level. Since there were only two variable levels, no multiple comparisons procedures were utilized. ANOVA assumptions concerning homogeneity of variance were confirmed by homogeneity of variance calculations. Variation in cell count indicated a need for a Kruskal Wallis non-parametric procedure which produced a Chi-Square significance value of $p = 0.056$. Although the Chi-Square significance value was slightly outside the 0.05 limit, the calculation was interpreted as a confirmation of the statistically significant ANOVA calculation.

Conclusion. Based on the analysis, the hypothesis that there is no statistically significant difference in attitude toward computers between subjects with different sequential

Table 10

Oneway Analysis of Variance Summary Table for the Dependent Variable of Attitude toward Computers by the Sequential Processing Skill Scale of the LSP

Source of Variation	<u>DC</u>	<u>MS</u>	<u>F</u> Ratio	<u>F</u> Significance
Between Groups	1	91.48	4.1715	0.042*
Within Groups	282	21.93		
Total	283			
* $p < .05$				

processing skill was rejected.

Results of Subhypothesis #1d

Hold There is no statistically significant difference in attitude toward computers between subjects with different manipulative preferences.

The raw scores for the manipulative preferences scale of the LSP were processed in the same manner as other scales and the mean attitude scores for the three levels of the variable are shown in Table 11. The mean attitude scores increased as the manipulative preference level increased, especially from level two to level three.

Table 11

Mean Attitude Scores for the Three Levels of the
Manipulative Scale of the LSP with Cell Count

	Manipulative Scale Levels		
	1	2	3
Mean attitude scores	47.55	47.92	49.92
Cell count	53	163	68

The oneway ANOVA procedure indicated a significance probability of $p = .0717$, just outside the statistical significance level of 0.05. However, the Kruskal Wallis non-parametric procedure produced a Chi-square ration of 7.837 and a Chi-square significance value of $p = 0.019$ (see Table 12). Based on the unequal cell count shown in Table 11, the Kruskal Wallis procedure was considered more appropriate than the ANOVA and indicated the manipulative preference scale of the LSP had statistically significant main effects.

Conclusion. Based on the analysis, the hypothesis that there is no statistically significant difference in attitude toward computers between subjects with different manipulative preferences was rejected.

Results of Subhypothesis #1e

Hole There is no statistically significant difference in

Table 12

Non-parametric Kruskal Wallis Summary Table for the
Dependent Variable of Attitude Toward Computers by the
Manipulative Preference Scale of the LSP

Mean Rank		Cases	
127.20		53	ANA = 1
137.77		163	ANA = 2
165.76		<u>68</u>	ANA = 3
		Total	284

Corrected for Ties				
Cases	Chi-Square	Significance	Chi-Square	Significance
284	7.8371	.0199*	7.8755	.0195*

* $p < .05$

attitude toward computers between subjects with different group preferences.

Table 13 shows the mean attitude scores with cell counts in parenthesis over the three levels of the group preference scale of the LSP and indicates that the majority of the subjects desired a small group environment. The unusual distribution made analysis unproductive.

Table 13

Mean Attitude Scores for the Three Levels of the Group Scale of the LSP with Cell Count

	Group Scale Levels		
	1	2	3
Mean attitude scores	48.32	47.77	50.00
Cell count	204	78	2

Conclusion. The null hypothesis that there is no statistically significant difference in attitude toward computers between subjects with different grouping preferences was retained.

Results of Hypothesis #2

Ho2 There is no statistically significant difference in attitudes toward computers between boys and girls.

A basic look at the two level variable of sex showed that the mean attitude scores were almost the same with 48.40 as the mean for males and 47.98 the mean for females. Cell counts for males and females was also almost equal. All analysis procedures confirmed the non-significant status of the variation in the scores. However there were results with practical application which will be discussed under hypothesis concerning interaction.

Conclusion. The null hypothesis that there is no statistically significant difference in attitude toward computers between boys and girls was retained.

Results of Hypothesis #3

Ho3 There is no statistically significant difference in attitudes toward computers between subjects with Caucasian, Hispanic, Black, or Filipino ethnic backgrounds.

Figure 2 graphed the mean attitude scores for the levels of the Ethnic background variable. The X axis scale was ethnic background and the Y axis scale was the mean attitude score. Unlike most of the other independent variables, the assignment of different level numbers to different ethnic backgrounds was arbitrary. Therefore, in this graph only the difference between levels was noteworthy where in some others, the shape was also of interest. As shown in Figure 2 and Table 14, Blacks had the least positive attitude toward computers, Hispanics and Filipino were similar, and Whites were the most positive.

Table 14 shows the mean attitude scores for the different ethnic backgrounds with cell count.

Although there was obvious variance in the mean attitude between the different ethnic backgrounds, the ANOVA calculations indicated an F ratio of 1.653 with an F significance value of $p = 0.1775$. There was considerable cell count difference as shown in Table 14 and a Kruskal

Table 14

Mean Attitude Scores for the Different Ethnic Background
Groups with Cell Count

	Ethnic Backgrounds			
	Filipino	Black	Hispanic	White
Attitude Scores	48.35	47.06	47.73	48.84
Cell counts	37	36	89	103

Figure 2. The Mean Attitude Scores for the Four Levels of the Ethnic Background Variable.

Wallis non-parametric procedure was utilized to verify the ANOVA results. Results of the Kruskal Wallis indicated a Chi-square ratio of 5.6262 with a Chi-square significance value of $p = 0.1313$, which was similar to results from the ANOVA procedure and not statistically significant.

Conclusion. The hypothesis that there is no statistically significant difference in attitude between subjects with Filipino, Black, Hispanic, or White ethnic backgrounds was retained.

Results of Hypothesis #4

Ho4 There is no statistically significant difference in attitude toward computers between subjects with different levels of computer literacy.

Table 15 showed the mean attitude scores over the three levels of the independent variable of computer literacy with cell count. The mean attitude scores dramatically increased as computer literacy increased.

Figures 3 and 4 graphed the ethnic background variable and sex variable across the three levels of computer literacy. All ethnic backgrounds and both sexes exhibited the same pattern where attitudes increased as the levels of computer literacy increased.

The oneway ANOVA procedure for the dependent variable of attitude toward computers by the independent variable of computer literacy produced an F ratio of 12.1211 with the F significance value of $p = 0.000$ indicating that computer literacy had a strong main effect on attitude toward

Table 15

Mean Attitude Scores for the Three Levels of the Computer Literacy Variable with Cell Count

	Variable Levels		
	Level 1	Level 2	Level 3
Attitude scores	46.43	47.98	50.85
Cell count	51	186	47

Figure 3. The Mean Attitude Scores of the Ethnic Background Variable Across the Three Levels of Computer Literacy.

Figure 4. The Mean Attitude Scores for Males and Females Across the Three Levels of Computer Literacy.

computers. Homogeneity of variance calculations and cell counts indicated that the ANOVA assumptions were met. Calculations for eta value produced a figure of 0.2818.

Conclusion. Based on the analysis, the null hypothesis that there is no difference in attitude between subjects with different computer literacy was rejected. A Scheffé multiple comparison (see Table 16) indicated the statistically significant differences to be between level three and level one, and also between level three and level

Table 16

Results of Scheffe' Multiple Comparison for Computer Literacy

Mean	Group	Level		
		One	Two	Three
46.43	1			
47.98	2			
50.81	3	*	*	

two. Table 16 has an asterisk at the intersection of the column and row where the statistically significant main effects occur.

Results of subhypothesis #1f

H01f There is no statistically significant difference in the interaction between the different scale of learning style.

The scales of the LSP were analytic skill, sequential processing skill, visual perceptual response, auditory perceptual response, emotive perceptual response, manipulative preferences, and group preferences. Table 17 is a matrix of the F significance values for two way interaction between the different scales of the LSP. To

determine a specific F significance value for the interaction between two scales of the LSP, find one scale at the top of the columns and the other desired scale at the side of the rows, and then read the figure at the junction of the row-column. These figures were interpreted in the same manner as the F significance value for main effect. If the statistic was less than .05, then interaction became statistically significant.

The lowest F significance value in Table 9 was the two way interaction between the auditory scale and the manipulative scale. Figure 5 graphed the three levels of the manipulative variable across the three levels of the auditory variable. The X axis scale was the three levels of the auditory variable. The Y axis scale was the mean attitude score. The three plots across the graph were the three levels of the manipulative variable. Interaction was present when the effects of the levels of the manipulative variable were not the same across the levels of the auditory variable. For example, manipulative level one decreased from auditory level one to auditory level two while manipulative level three increased from auditory level one to auditory level two. The total pattern was clearly disordinal and the interaction was presented pictorially. This interaction was statistically significant to the $p = .016$ degree.

The results shown in Figure 5 were unique among all of the other variables involved in this research, which in turn

Table 17

Matrix of the Two Way Interaction F Significance Values for
the Different Scales of the LSP

	LSP Scales				
	Sequential	Visual	Auditory	Emotive	Manipulative
Analytic	.741	.433	.338	.978	.420
Sequential		.550	.922	.282	.283
Visual			.496	.515	.179
Auditory				.644	.016*
Emotive					.471
* $p < 0.05$					

was what indicated the interaction. Based on earlier analysis these results were not expected since indications were that as manipulative preference increased, attitude increased. Therefore, subjects in level one of the manipulative preference would have been expected to have low attitude scores. However, in the case shown in Figure 5, the combination of low auditory perceptual response and low manipulative preference produce relatively high mean attitude scores. High auditory perceptual response and high manipulative preference also produced high attitude scores.

Figure 5. The Mean Attitude Scores for the Three Levels of the Manipulative Variable Across the Three Levels of the Auditory Variable.

Almost every other combination produced a lower attitude score. The fact that all three lines intersect at one point was a graphic phenomenon and not significant in the analysis. No other interaction between different scales of the LSP was statistically significant.

Conclusion. The subhypothesis that there is no statistically significant difference between the different scales of the Learning Style Profile was rejected.

Results of Hypothesis #5

Ho5 There is no statistically significant interaction between the learning style, sex, ethnic background, and computer literacy of the subjects in effect on attitude toward computers.

Table 18 is a matrix of the F significance values for two-way interaction between the independent variables that aren't covered in Table 17. No value in the table was less than 0.05 indicating no statistically significant interaction. The lowest F significance value was between the emotive scale of the LSP and computer literacy.

A discussion of interactions that were not statistically significant but had practical interest was presented under Other Findings.

Conclusion. The hypothesis that there is no statistically significant interaction between the learning style, sex, ethnic background, and computer literacy of the subjects in effect on attitude toward computers was retained.

Other Interactions

Ethnic Background and Sex. Some interactions have practical application although the interaction may not be statistically significant. One interaction that fell in the practical application area was between ethnic background and sex. Figure 6 graphically shows the differences between the

Table 18

Matrix of the F Significance Values for Two Way Interaction
between Sex, Ethnic Background, Computer Literacy, and
Scales of the LSP

LSP Scales	Sex	Ethnic Background	Computer Literacy
Analytic	.643	.649	.922
Visual	.393	.399	.251
Auditory	.540	.675	.755
Emotive	.827	.371	.190
Sequential	.521	.423	.317
Sex		.384	.206
Ethnic			.800

mean attitude scores of males and females for each ethnic background.

The males maintained consistent scores across the levels of ethnic background while the females differed substantially. One caution was necessary before drawing firm conclusions. The cell count for Black females was small (12) and the average mean attitude score for that group was lowered one point by one score. While the interaction described wasn't statistically significant, the practical effects indicated that main effects by sex and

Figure 6. Graph of the Sex Variable across the Four Levels of the Ethnic Background Variable.

ethnic background on attitude toward computers should be tested at the local level.

Computer Literacy and Sex. Computer literacy and sex had a somewhat similar pattern in that the males were consistent across the first two levels and then increased rapidly, while the females started with much lower attitude scores when computer literacy was low and their attitude scores rose higher when their computer literacy level was high (see Figure 3).

Conclusions. There was interaction that had practical application between gender and ethnic background as well as

with computer literacy and sex. The practical aspects of the interaction indicated that gender or ethnic background considerations alone were insufficient when dealing with attitude toward computers and although there were no main effects, they can't be ignored. Both variables must be taken into consideration. Furthermore, gender based educational intervention programs concerning computers may not be adequately grounded.

Concerning computer literacy and sex, females had a much greater variation in attitude based on their level of computer literacy. Females with high computer literacy levels had very high attitude scores while females with low computer literacy levels had relatively low attitude scores. Males varied, but in a different pattern and not to the same extent.

One additional conclusion was that some, but not necessarily all, minority females appeared to be relatively low in attitude scores even after considerable exposure to computers. Results produced by this research were not sufficient to declare that all Black females had relatively poor attitudes toward computers, but they were sufficient to state that a sensitivity to minority females should be maintained in designing CAI and in establishing educational programs.

Results of Hypothesis #6

Ho6 There is no statistically significant difference in attitude toward computers between subjects with

different learning styles, ethnic background, sex, and computer literacy.

The intent of Hypothesis #6 was to take an overall perspective toward the investigation and both assist and confirm the analysis of other hypothesis. The approach involved the development of a correlation matrix with all variables utilizing both raw and levelized scores. Findings of statistically significant correlation were then compared with the results of investigations concerning other hypothesis. Table 19 is a condensed version of the correlation matrix developed from levelized scores. Most non-significant columns and rows have been omitted to make the presentation easier to interpret.

There was agreement to some degree between relationships indicated in the correlation procedure and those indicated by the analysis for main effects. Computer literacy had the statistically greatest main effect on attitude (see Table 20) and also had the highest correlation (see Table 19). Analytic skill with statistically significant main effects was also correlated with attitude to a statistically significant degree. Sequential processing skill and manipulative preference were positively correlated with attitude at a lessor level.

Possible relationships between correlation and interaction were also investigated, but since there was almost no statistically significant interaction, no

Table 19

Condensed Correlation Matrix of Independent and Dependent Variables

Variables			
Variables	Attitude	Visual	Emotive
Attitude Toward Computers	1.00	.0378	-.0137
Computer Literacy	.2739***	.1193*	-.0670
Visual Perception	.0379	1.0000	-.3636***
Auditory Perception	-.0480	-.2773***	-.0072
Manipulative Preference	.1258*	-.0205	.0939
Analytic Skills	.1477**	.1791**	-.0280
Sequential Processing	.1207*	.1130	-.0138
1-tailed Signif: * $p < .05$ ** $p < .01$ *** $p < .001$			

relationship could be established. Other relationships not directly associated with the purpose of this research were also indicated in the correlation matrix. The most obvious was the negative correlation between the visual variable and both the auditory and emotive variables.

Based on this investigation, Hypothesis #6 was rejected. The results from other hypotheses were confirmed and students with different characteristics have different

attitudes toward computers.

Conclusion. Based on the analysis, the hypothesis that there is no statistically significant difference of attitude toward computers between subjects with different learning styles, ethnic background, sex, and computer literacy was rejected.

Impact of Attitude Instrument on Findings

The content of the attitude instrument was discussed earlier with the notation that the particular questions used addressed attitude from a more informed opinion perspective than emotional disposition. Additionally, the sample population had a computer experience requirement. When these two characteristics were combined, they appeared to have some immeasurable impact on the results of this research. One possible effect was the amplification of main effects that reflected cognitive skills and the reduction of main effects related to physical characteristics. Another possible effect was to limit the overall distribution of the attitude toward computer scores which in turn reduced the ability to discern differences. While the total impact of these conditions are not clearly distinguishable, they clearly point out the need for additional research.

Summary

The results of this research concerning main effects were summarized in Table 20, which listed the F significance and Chi-Square significance value for the appropriate

hypothesis. Four independent variables had an F significance value of $p < 0.05$ and were considered to have had statistically significant main effects.

The importance of the main effects of both analytic skill, sequential processing, and manipulative preference was the determination that specific aspects of learning style had a relationship with attitude toward computers. In combination with the lack of main effects by sex or ethnic background, mental characteristics became more important than physical characteristics relative to attitude. Additionally, the mental characteristics could be identified with first level diagnostic instruments.

The manipulative preference variable was a unique aspect of learning style. Individuals who preferred doing things with their hands had a more positive attitude toward computers. Such a conclusion gave credence to intuitive reasoning which would indicate that individuals who liked hands on activities, would have a more positive attitude toward computers.

The investigation of interaction produced dichotomous results. Based on ANOVA calculations there was only one statistically significant two-way interaction. The auditory scale of the LSP and the manipulative preference scale combined to make a unique pattern. High manipulative preference combined with high auditory perception forming a group with a very positive attitude toward computers. At the same time, low manipulative preference and low auditory

Table 20

Summary Table of all F Significance and Chi-Square
Significance Values Produced by this Study

Hypothesis Number	Independent Variable	ANOVA F Significance Value	Kruskal Wallis Chi-Square Significance
1a	Analytic Skill	.0348*	.0150*
1b	Perceptual Responses		
	Emotive	.5040	.5586
	Visual	.8179	.5563
	Auditory	.8192	.6578
1c	Sequential Processing	.0420*	.0560
1d	Manipulative Preference	.0717	.0195*
1e	Group Preference	Not computed	
2	Sex	.4537	.4125
3	Ethnic Background	.1775	.1313
4	Computer Literacy	.0000*	.0000*

* $p < 0.05$

perception also had a very positive attitude. All other combinations of manipulative preference and auditory perception had a less positive attitude.

Little practical meaning was attributed to the interaction between manipulative preference and auditory perception. It did open questions to be answered by additional research in that low manipulative and low auditory may constitute a group that needs definition. If this group can be more clearly defined, further study and possibly intervention might be appropriate.

Additionally, graphic analysis indicated that the sex variable interacted with both the ethnic background and computer literacy variable in a way that had practical importance. In both cases, this interaction was characterized by relatively consistent male attitude scores across the ethnic background and computer literacy variable while the females had dramatic variation. In both cases the mean attitude scores of the females were highest of the high and the lowest of the low. In a practical sense this meant that there should be relatively little concern about the attitude toward computers or computer literacy of males based on their ethnic background. Females presented a difference situation, but not one where blanket statements were readily applicable. Some intervention may be required in the educational system to insure that variations involving females are taken into account when designing and implementing CAI programs. Increased computer time for females may have been the answer for some minority groups, but not for all.

Chapter V

Summary, Conclusions, and Recommendations

Introduction

The research objective of this study was to investigate four variables as possible determinants of attitude toward computers. These variables included sex, ethnic background, learning style, and computer literacy. The sample population, involving 284 subjects, was composed of coeducational middle school students that had experienced at least two years of CAI in their academic program. The subjects attended three inner city parochial schools in a Southern California city that had been selected from a group of both public and private school districts based on ethnicity of the student body and the schools computer curriculum. The ethnic backgrounds of the students included Black, White, Hispanic, and Filipino.

The thrust behind the research stemmed from the current observed efforts of the educational system to incorporate sometimes large and expensive computer systems into the curriculum without a clear concept of their impact on student learning. This problem is particularly amplified with the increasing diversity of the student population in such areas as Southern California. The knowledge exist that

technology can be an effective educational resource, but the expertise to correctly apply such tools as computers is limited and subject to personal taste. Past studies, that appear based on personal agendas, would indicate that complex student characteristics such as attitude toward computers can be simplistically determined by sex, further complicating program implementation. Several large educational programs currently sponsored by the California State Department of Education have required technology components with no guidance as to how or why it should be used. Even in this period of limited funds, we may have more money than concise, usable information.

The design of the study primarily involved the attempt to determine, and to what degree, a relationship existed between the dependent variable of attitude toward computers and the independent variables of sex, ethnic background, select elements of learning style, and computer literacy. Data was collected by the administration of assessment instruments for attitude toward computers, computer literacy, and learning style with additional information concerning ethnic background, age, grade level, and sex taken from instrument headers. There was no pre or post test aspect to the design.

The data consisted of attitude toward computer scores, computer literacy scores, scores of selected scales from the Learning Style Profile, sex, ethnic background, grade level,

and age. The analysis of data primarily involved oneway and multiple fixed factor analysis of variance and Kruskal Wallis calculations utilizing SPSS/PC+ and SPSSx computer software. The ANOVA and the Kruskal Wallis were critical procedures for determining the statistical significance of possible main effects. If main effects were present, then the Scheffé' multiple comparison procedure was employed to determine exactly what variable levels were statistically significant. ANOVA assumptions concerning homogeneity of variance were tested for with Cochran C and Bartlett Box calculations. The ANOVA procedure was also employed to check for interaction between independent variables with support from graphic analysis. Additionally, a correlational matrix was constructed to provide a broad confirmation of other analysis.

Findings

Hypothesis Testing

Hypothesis #1. In Hypothesis 1 different scales of the Learning Style Profile were tested against the dependent variable of attitude toward computers. In order to test each specific scale separately, Hypothesis 1 was divided into six subhypotheses. Each subhypothesis tested a specific independent category or scale of the LSP for main effects against the dependent variable of attitude (see Table 21).

Table 21

Listing of Subhypothesis Variables under Hypothesis #1.

Hypothesis Number	Variable
Hypothesis #1	Learning Style
Subhypothesis #1a	Analytic Skill Scale of LSP
Subhypothesis #1b	Perceptual Category of LSP
	Visual Response Scale of LSP
	Auditory Response Scale of LSP
	Emotive Response Scale of LSP
Subhypothesis #1c	Sequential Processing Scale of LSP
Subhypothesis #1d	Manipulative Preference Scale of LSP
Subhypothesis #1e	Group Preference Scale of LSP
Subhypothesis #1f	Test for Interaction between Scales

Hypothesis 1 stated that there was no statistically significant difference in attitude toward computers between students with different learning styles. Subhypothesis 1a, 1b, 1c, 1d, and 1e each tested a specific independent category or scale of the LSP for main effects against the dependent variable of attitude (see Table 21).

Subhypothesis 1f tested for interaction between the different scales of the profile.

Subhypothesis 1a. Subhypothesis 1a stated that there were no statistically significant differences between students attitude toward computers based on analytic skill. Subhypothesis 1a was rejected. The mean score for attitude toward computers for subjects evaluated as analytic skill level three was higher, to the statistically significant level of $p < .05$, than the score for those subjects evaluated as analytic skill level one.

Subhypothesis 1b. Subhypothesis 1b was retained. Subhypothesis 1b stated that there was no statistically significant difference in attitude toward computers between subjects with different perceptual response levels. The perceptual response category of the LSP was further broken down into the three scales of visual, auditory, and emotive response. Each of these scales was analyzed separately. Analysis of the data indicated that there was no statistically significant difference in attitude toward computers between the different levels of any of the three scales.

Subhypothesis 1c. Subhypothesis 1c stated that there was no statistically significant difference in attitude toward computers between subjects with different sequential processing skill. Subhypothesis 1c was rejected. The mean score for attitude toward computers for subjects evaluated as sequential processing skill level two was higher than those subjects evaluated as level one. This difference was

statistically significant at the $p < .05$ level. The LSP scale of simultaneous processing skill wasn't fully ready for inclusion in testing, but could have added considerable definition to the results.

Subhypothesis 1d. Subhypothesis 1d stated that there was no statistically significant difference in attitude toward computers of students with different manipulative preferences. Subhypothesis 1d was rejected. The mean attitude scores for the manipulative preference group evaluated as level three was higher to a statistically significant degree than level one. The main effect of the manipulative preference had practical as well as statistical significance. Manipulative preference was a simple and reliable test to administer and may prove useful as an attitude indicator at the local level.

Subhypothesis 1e. Subhypothesis 1e stated that there was no statistically significant difference in attitude toward computers with students with different grouping preference. Subhypothesis 1e was retained. There was a large difference in mean attitude scores between level three and levels one and two. However, the cell count was distorted with the majority of the sample population showing a preference for small groups (level 1). Due to the distribution, meaningful analysis was not possible.

Subhypothesis 1f. Subhypothesis 1f was rejected. Subhypothesis 1f stated that there was no statistically

significant interaction between the different scales of learning style. The different scales were analytic skill, sequential processing, visual response, auditory response, emotive response, manipulative preference and group preference. Analysis indicated that every scale of learning style had some interaction with every other scale, albeit very small in most cases. Only in one case was there statistically significant two way interaction. The auditory response scale and the manipulative preference scale interacted to the $p = .016$ level. This interaction was created by the condition where mean attitude scores were high when auditory responses and manipulative preference scores were both low as well as when they were both high (see Figure 5). Mean attitude scores were lower for almost all other situations.

Hypothesis 2 and 3. Hypothesis 2 and 3 compared attitude toward computers of subjects based on sex and ethnic background. Ethnic background involved Filipino, Black, Hispanic, and White. Hypothesis 2 stated there was no statistically significant difference in attitude toward computers between male and female, and Hypothesis 3 stated that there was no statistically significant difference in attitude between different ethnic groups.

Both hypothesis 2 and 3 were retained. Prior research strongly indicated that boys had a more positive attitude toward computers than girls. When the total sample

population was considered, this research found no such relationship. While in the total sample population boys had a slightly, but not statistically significant, more positive attitude than girls, this pattern did not hold true for all ethnic groups, grade levels, and schools, White girls were more positive than boys and the situation reversed for all other ethnic backgrounds.

The boys were relatively consistent across ethnic groups while the girls showed considerable variation (see Figure 6). Variations were also observed in grade levels with girls in the seventh grade more positive than boys while boys were more positive in grades six, eight, and nine. When different schools were compared, the girls in school one were more positive than boys while it was reversed in school two and three. While these hypotheses were not rejected, the practical implications obtained during the analysis of interaction should be given consideration.

The results of the investigation of main effects in this study which indicated that attitude was not a gender based issue can obviate the real situation the same as earlier research that indicated attitude was determined by gender alone. Attitude is a complex characteristic that can't be adequately addressed with one variable.

The same condition existed for ethnic background that was described for gender. When the total sample population was considered, statistically significant differences based

on ethnic background weren't found. However, graphic analysis of interaction (see Figure 6) provided additional interpretive information discussed under Other Findings which indicated the attitude of different ethnic backgrounds needs to be addressed at the local level.

Hypothesis 4. Hypothesis 4 was rejected. Hypothesis 4 stated that there was no statistically significant difference in attitude toward computers of students with different levels of computer literacy. Computer literacy was found to have a clear association with attitude and to be statistically significant to the $p < 0.0001$ level. The level one computer literacy group had the lowest mean attitude scores of any group of any variable. The mean attitude score for computer literacy level two was close to the grand mean while the level three group had the highest mean attitude score of any group of any variable. These results generally held across both gender and ethnic background.

A simply interpretation of these results would say that individuals that knew more about computers should have a more positive attitude about computers. Such a concept doesn't take into consideration the complexities of academic performance. High computer literacy scores should be considered as the product of several complex variables, just as performance in any discipline. This research did not address the complexities of the determinants of computer

literacy, but did specifically point out that the relationship between computer literacy and attitude was more complex than just saying that people that know more about computers have a more positive attitude toward computers.

Earlier research (Fetler, 1985) had established a relationship between SES and computer literacy. Other research (Hoover & Austin, 1986) had indicated a relationship between attitude toward computers and SES. In this research the sample population was composed of students from private schools designated as inner city with a relatively limited variation in SES. For this study, there is solid indication that there are statistically significant causes of variation in attitude other than SES.

Hypothesis 5. Hypothesis 5 stated that there was no statistically significant interaction between the learning style, sex, ethnic background, and computer literacy of the subjects in effect on attitude toward computers. Hypothesis 5 was retained. hypothesis 5 was similar to hypothesis 5 was similar to hypothesis 1f in that it was concerned with interaction but on a more comprehensive scale. The ANOVA procedure for two way interaction produced no results indicating a statistically significant relationship between any possible combination of variables.

Included in the analysis for interaction was the analysis of a large number of graphs. Since the definition of interaction (Hinkle, Wiersma, & Jurs, 1988) was that the

levels of one variable had different effects across the levels of another variable, graphs were constructed to pictorially illustrate possible interaction. Since graphs provided no calculation of F ratios and F significant values, they were limited to either pictorially supporting other calculations or presenting evidence of a more practical nature.

Graphic analysis of the gender variable across the ethnic variable indicated that there was possible practical interaction between ethnic background and gender as they related to attitude toward computers. The variation in female attitude scores was much greater than male attitude scores. While the interaction wasn't statistically significant, the nature of the variations indicated that sex and ethnic background must be considered in designing and planning CAI programs.

Graphic analysis produced similar results between computer literacy and sex. The variation in female scores was greater than the male although not statistically significant. From a practical perspective, the relationship between gender and computer literacy needs to be considered when designing and implementing CAI programs.

Hypothesis 6. Hypothesis 6 was rejected. Hypothesis 6 stated that there was no statistically significant difference in attitude toward computers between subjects with different learning styles, ethnic background, sex, or

computer literacy. Hypothesis 6 was a comprehensive statement placing all independent variables in one null hypothesis and was an attempt to provide an overall perspective to the investigation. The procedure utilized for analysis was the construction of a correlation matrix which was then compared with results from other hypotheses.

In the correlation matrix (see Table 19), computer literacy correlated at a statistically significant level with attitude toward computers confirming the relationship demonstrated by analysis for main effects (see Table 20). Analytic skill also correlated with attitude at a statistically significant level and confirmed the main effect calculations. Sequential processing skill and manipulative preference were positively correlated with attitude to a lesser level and further confirmed the results of other analysis. Since there were very few statistically significant interactions, the comparison of the results in the correlation matrix and the results of interaction analysis were inconclusive. Therefore, the results of hypothesis 6 confirmed, to some degree, other results.

Discussion of Other Findings

The transferability of the results is primarily effected by the sample population criterion for all subjects to have had at least two years of experience with computer assisted instruction. However, the naturally assembled population with randomness only in school selection must be

keep in mind as well. Additionally, the sample population came from school where the leadership characteristic of the principals was noticeable. The impact in this study of positive and cooperative school officials on the performance of students, even on such things as assessment instruments can't be quantified, but also can't be totally discounted.

Another factor that emerged during the study was the unexpected results with the attitude toward computers instrument. The selection of this instrument was based in large part on its use in the National Assessment of Educational Progress in 1977-78 and by the California Assessment Program in 1983 to establish a baseline in that state. As discussed earlier, the questions concerning attitude were more concerned with an informed opinion than with emotional disposition. When this perspective was combined with the sample population criterion for computer experience, the results of attitude scores were highly positive with relatively limited range, and could possible have been skewed toward independent variables emphasizing cognitive skills and away from physical characteristics.

Conclusions

Based on the findings described in this study, the researcher has drawn the following conclusions:

1. The majority of students across all boundaries of sex, ethnic background, learning style, or

computer literacy had a positive attitude toward computers.

2. Attitude toward computers was found to be a complex characteristic with many determinants involving everything from physical attributes to mental processes. For subjects with high levels of computer experience, cognitive skills, as defined by elements of the Learning Style Profile and computer literacy scores, were more important as determinants of attitude than the subjects physical characteristics. The review of literature cited several studies that indicated attitude toward computers was determined by gender, and this was clearly not the case for this study.
3. There was a strong relationship between the computer literacy of students and their attitude toward computers. Students with a high level of computer literacy had a statistically significant more positive attitude toward computers than students with a low level of computer literacy. This relationship held across sex and ethnic background characteristics. While this study didn't attempt to quantitatively hold socio-economic status constant, the sample population clearly was from a strata of limited width.

Findings in this study concerning computer literacy emphasized the cognitive skills aspect of knowledge concerning computers without the close correlation with socio-economic found in earlier studies.

4. Specific scales of the Learning Style Profile had a relationship with students' attitude toward computers. These scales were analytic skill, sequential processing skill, and manipulative preference. The different scales of the perceptual category of the LSP and the group preference scale had no relationship with attitude toward computers.
5. There was no statistically significant difference in attitude toward computers between male and females. These findings did not remove gender as a factor when investigating attitude toward computers, but they clearly indicated that attitude was not a gender only based characteristic. Since these finding differed from identified studies in the review of literature, a possible explanation might have been in the requirement for the sample population to have had at least two years of academic experience with CAI and the orientation of the attitude assessment instrument toward an informed opinion aspect of

attitude. Data was not collected concerning total computer experience of the subjects, but the schools involved have had comprehensive CAI programs for several years and many students may have had academic experience with computers for their entire academic life. Educators would expect that experience would decrease the effect of physical or cultural input to attitude and would increase the effect of cognitive skills or academic input. The results of this study indicated that trend.

8. There was no statistically significant difference in attitude toward computers between students with Filipino, Black, Hispanic, or White ethnic backgrounds. As with gender, ethnic background can't be ignored in designing and implementing CAI, but blanket assumptions concerning ethnic background didn't appear to be valid. The combination of gender and ethnic background appeared to be important. Males of all ethnic backgrounds had consistent attitude and computer literacy scores while the mean attitude scores and computer literacy scores of females varied considerably.
9. There was a relationship between sex and ethnic background of students when concerned with

attitude toward computers. These characteristics should be considered together.

Implications of Results for Practice

This study provided information to educators working with computers in education in a variety of ways. As has been known for some time, students have positive attitudes toward computers. Additionally, students with higher levels of computer literacy have very positive attitudes toward computers.

Based on the findings that computer literacy has a strong relationship with attitude and that student attitude is generally high to start with, computers acquire a characteristic that separates them from all other devices used in presenting educational material or subjects. Teaching a subject where the student commences with a positive attitude is different than when students start with a negative attitude. Since computers are predominantly tools in the educational environment, student affinity may make it a uniquely effective aid in the educational process. At the same time, computers will not help all students although there was no indication in this research that the academic performance of any student would be hindered.

Attitude toward computers is a complex student characteristic and designing programs involving computers based on simple attributes such as gender or ethnic

background alone will probably not be effective. At the same time, gender and ethnic background together may provide extremely useful information. Schools with predominantly White students may find that girls have a more positive attitude than boys and that girls produce higher scores in computer literacy, while schools where the student body is mostly Hispanic may find very little difference in attitude between the sexes. Schools with a large Black student enrollment may find a considerable difference in attitude toward computers between males and females, and may need special programs to assist the females.

Learning style information may be very useful in both helping to understand student performance when working with computers and in designing educational programs that involve computers. When the correct aspects of learning style are applied, they provide more general explanatory or planning information than either sex or ethnic background. In particular the correlation between the manipulative preference scale of the LSP and attitude toward computers may provide very practical information that would be easy and reliable to obtain. Students may not work well on computers if they haven't been adequately trained in the use of the keyboard. Some of the more commonly used aspects of learning style such as visual, auditory, and emotive response had no statistically significant relationship with attitude toward computers in this study. However, findings

concerning these modalities may have been impacted by the computer experience of the sample population.

The educational system in this state generally rewards the sequential learner and while the results in this research indicating sequential skill correlated with attitude toward computers does not preclude the same thing with simultaneous processing skill. However, the suspicion exists that computers enhance the existing system.

Recommendations for Further Research

Based on the results of the present study, factors worthy of further exploration include the following:

1. Since this research utilized only a select number of the available scales of the Learning Style Profile, further efforts should be made to explore all scales of the Learning Style Profile as possible determinants of attitude toward computers.
2. A particular scale of the Learning Style Profile that should be investigated as a possible of determinant of attitude and computer literacy should be the simultaneous processing skill scale.
3. The results of this research have surfaced computer experience as a possible factor in attitude and in computer literacy. Further investigation of the variables in this research

with different levels of computer experience would be extremely beneficial in understanding the student interface with the computer.

4. Computer literacy should be fully investigated as the dependent variable with a wide selection of possible determinants.
5. The further quantitative investigation of interaction between sex and ethnic background as they relate to attitude toward computers and computer literacy is warranted.
6. The relationship between computer literacy and socio-economic status should be further investigated with control for experience with computers.
7. Due to the orientation of the attitude instrument utilized in this research toward the informed opinion aspects of attitude, replication of this work with a modified instrument or with an attitude instrument with a broader perspective would contribute significantly to the available information.
8. Researchers must step forward and produce useful data so that individual schools can make an intelligent decision as to how much of what in the way of technology they need to purchase, followed by information on how to best use it. Useful data

specifically means relative simple instruments that provides definitive information concerning educational programs.

The Study in Perspective

Our educational community needs assistance in many forms. Our schools are having difficulties solving the problems handed them by society and have become the frequent target of media bashing. The application of technology in education not only has real educational merit, but because of the unique stature given to technology in our society, offers assistance to our schools in such difficult areas as credibility. However, the knowledge of computers by the parents of our students may be growing more rapidly than the knowledge by teachers and administrators. This inversion in knowledge portends greater loss of credibility if we don't address the problem quickly. We have a relatively small time window to take full advantage of this tool, and we dare not fail. The purpose of this research was to help educators, in some small way, better understand the relationship between the computer and the student with the hope that both the student and the school will prosper.

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**125-129 Computer Attitude Scale
130-137 Computer Literacy Questionnaire**

University Microfilms International

Appendix D

Consent To Release Information

Wayne Connell, a Doctoral student at the University of San Diego, has requested the results of surveys conducted at school. These surveys concerned learning style, attitude toward computers, and computer literacy. Wayne desires to use the results of these surveys in his research where he is attempting to determine if different student characteristics make a difference in their attitude toward computers.

The release of this information will be on an anonymous basis only, meaning that no names will be included in the data and that each persons privacy will be protected at all times.

We understand that consent is totally voluntary and we can change our minds anytime up until the data is released.

We, the undersigned, understand the above explanations and, on that basis, give consent for the results of surveys concerning learning style, attitude toward the computer, and computer literacy to be anonymously released.

Signature of Parent or Guardian

Date

Signature of Student

Date