COMPUTER LITERACY LEVELS AND ATTITUDES
TOWARD COMPUTERS OF THAI PUBLIC
UNIVERSITY STUDENTS

DISSERTATION

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By

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The purpose of this study was to investigate and analyze computer literacy and general attitudes toward computers of students at Thai public universities. The comparative study of computer literacy levels and attitudes toward computers among Thai students with various demographic classification was performed followed by the study of relationships between the two variables among the samples.

A fifty-eight-item questionnaire was adapted from the computer literacy questionnaire developed by the researchers at the Minnesota Educational Computing Consortium. The items were designed to assess knowledge and attitudes relative to computers. The questionnaire was administered to a random sample of 492 students who took at least one computer course from thirteen public universities in Thailand.

Statistical tests used to analyze the data included $t$ -test, one-way analysis of variance, and Pearson product moment correlations.
Based on the research findings, the following conclusions were drawn: (1) Thai university students exhibited a moderate computer literacy level. (2) While a higher proportion of female students enrolled in computer classes, male and female students reported similar computer literacy levels. (3) Graduate students had higher computer literacy levels than did other students from different educational levels. (4) Academic majors and academic performance (GPAs) were also factors affecting computer literacy levels. Education majors displayed higher computer literacy levels than mathematics majors and science majors. (5) Students with higher GPAs had higher levels of computer literacy than the groups with lower GPAs. (6) Computer literacy was not age dependent. (7) Generally, Thai university students showed positive attitudes toward computers. (8) Males and females both showed positive attitudes toward computers. (9) Graduate students exhibited more positive attitudes toward computers than all other groups. (10) The groups of students with lower GPAs displayed lower positive attitudes toward computers. (11) There was a strong positive relationship between students' knowledge and their attitudes toward computers.

It is recommended that computer education should be viewed in relation to its contribution to educational process as a whole. It should be relevant to the local
environment, work, individuals and society needs as well as
development of positive attitude toward manual skills. More
research is needed in the areas of teacher education,
evaluation techniques to assess students' progress in a new
teaching context, and ethical values relative to computers.
## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>LIST OF TABLES</th>
<th>v</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapter</td>
<td></td>
</tr>
<tr>
<td>I. INTRODUCTION</td>
<td>1</td>
</tr>
</tbody>
</table>

Computers in Education 	2
Statement of the Problem 	2
Purposes of the Study 	7
Research Questions 	8
Hypotheses 	9
Definition of Terms 	10
Background of the Study 	11
Limitations of the Study 	14
Basic Assumptions 	14
Summary 	14

II. Review of the Related Literature 	17

Educational Use of Computer 	17
Educational Research Applications 	17
Planning and Management Use of Computer 	21
Instructional Application 	24
Tutor Applications 	25
Tool Applications 	29
Tutee Applications 	32
Computer Literacy 	33
Computer Literacy in Higher Education 	39
Attitudes toward Computers 	41
Sex Variable 	45
The Thai Educational System 	49
Computer Literacy in Thai Higher Education 	52

III. METHODOLOGY 	57

Population and Sampling 	57
Instrumentation 	60
Construction of Survey Instrument 	61
Validation of Objectives 	61
Construction of Survey Prototype 	61
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilot Test</td>
<td>63</td>
</tr>
<tr>
<td>Procedure for Analysis of Data</td>
<td>64</td>
</tr>
<tr>
<td>IV. ANALYSIS OF DATA</td>
<td>67</td>
</tr>
<tr>
<td>Analysis of Computer Literacy Levels</td>
<td>67</td>
</tr>
<tr>
<td>Comparison of Computer Literacy Levels</td>
<td>70</td>
</tr>
<tr>
<td>Analysis of Attitudes toward Computers</td>
<td>77</td>
</tr>
<tr>
<td>Comparison of Attitudes toward Computers</td>
<td>80</td>
</tr>
<tr>
<td>Relationship of Computer Literacy and Attitudes toward Computers of Thai Students</td>
<td>87</td>
</tr>
<tr>
<td>Summary</td>
<td>90</td>
</tr>
<tr>
<td>V. SUMMARY, DISCUSSIONS, CONCLUSIONS, AND RECOMMENDATIONS</td>
<td>91</td>
</tr>
<tr>
<td>Summary</td>
<td>91</td>
</tr>
<tr>
<td>Discussion</td>
<td>98</td>
</tr>
<tr>
<td>Conclusions</td>
<td>102</td>
</tr>
<tr>
<td>Recommendations</td>
<td>105</td>
</tr>
<tr>
<td>Operational Recommendations</td>
<td>105</td>
</tr>
<tr>
<td>Recommendations for Further Study</td>
<td>108</td>
</tr>
<tr>
<td>APPENDIX A</td>
<td>111</td>
</tr>
<tr>
<td>APPENDIX B</td>
<td>113</td>
</tr>
<tr>
<td>REFERENCE LIST</td>
<td>129</td>
</tr>
</tbody>
</table>
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Percentage of Demographic Classifications of Students who Attended Introductory Computer Course at Thirteen Public Universities in Thailand</th>
<th>59</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Computer Literacy Levels Among Thai Public University Students</td>
<td>68</td>
</tr>
<tr>
<td>2</td>
<td>Comparison of Computer Literacy Levels Based On Computer Literacy Subtest Among Thai Public University Students by Sex Using t-test.</td>
<td>70</td>
</tr>
<tr>
<td>3</td>
<td>Comparison of Computer Literacy Levels Based On Computer Literacy Subtest Among Thai Public University Students by Age Group</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>Comparison of Computer Literacy Level Based On Computer Literacy Subtest Among Thai Public University Students by Educational level Classifications</td>
<td>72</td>
</tr>
<tr>
<td>6</td>
<td>Pairwise Comparison of Sample Means Contributed by Thai Public University Students at Five Different Educational Level Classifications on the Computer Literacy Levels</td>
<td>73</td>
</tr>
<tr>
<td>7</td>
<td>Comparison of Computer Literacy Levels Based On Computer Literacy Subtest Among Thai Public University Students by Majors</td>
<td>74</td>
</tr>
<tr>
<td>8</td>
<td>Pairwise Comparison of Sample Means Contributed by Thai Public University Students at Six Different Major Groups on the Computer Literacy Levels</td>
<td>75</td>
</tr>
<tr>
<td>9</td>
<td>Comparison of Computer Literacy Levels Based On Computer Literacy Subtest Among Thai Public University Students by Grade Point Average</td>
<td>76</td>
</tr>
<tr>
<td>10</td>
<td>Pairwise Comparison of Sample Means Contributed by Thai Public University Students at Three Different Grade Point Average Groups on the Computer Literacy Levels</td>
<td>77</td>
</tr>
<tr>
<td>Table</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>11. Attitudes Toward Computers of Thai Public University Students</td>
<td>79</td>
<td></td>
</tr>
<tr>
<td>12. Comparison of Attitude Toward Computers Based On Attitude Subtest</td>
<td>81</td>
<td></td>
</tr>
<tr>
<td>Among Thai Public University Students by Sex Using t-test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Comparison of Attitudes Toward Computer Based On Attitude Subtest</td>
<td>81</td>
<td></td>
</tr>
<tr>
<td>Among Thai Public University Students by Age Group Using One Way ANOVA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Comparison of Attitudes Toward Computers Based On Attitude Subtest</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>Among Thai Public University Students By Educational Level Classifications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Pairwise Comparison of Sample Means Contributed by Thai Public</td>
<td>83</td>
<td></td>
</tr>
<tr>
<td>University Students at Five Different Educational Level Classifications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>On the Attitude Toward Computers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Comparison of Attitudes Toward Computers Based On Attitude Subtest</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>Among Thai Public University Students By Majors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Pairwise Comparison of Sample Means Contributed by Thai Public</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>University Students at Six Different Majors On the Attitudes Toward Computers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Comparison of Attitudes Toward Computers Based On Attitudes Subtest</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>Among Thai Public University Students By Grade Point Average Groups</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Pairwise Comparison of Sample Means Contributed by Thai Public</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td>University Students At Three Different Grade Point Average Groups on the Attitudes Toward Computers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Correlation Between Computer Literacy Levels and Attitudes Toward Computers Based On Computer Literacy and Attitude Subtest for All Subgroups</td>
<td>89</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

The use of computers in education is a rapidly growing and changing field. Computers are generally viewed from three perspectives: (1) that computers offer potential for human betterment, (2) that they are, at the same time, fraught with great dangers to humanity, and (3) that neither the potential can be truly realized, nor the dangers avoided, without asking careful, far-reaching critical questions about computers in education (Sloan 1985).

Computers have become integral to our society. They have penetrated the areas of jobs, schools, and homes (McKay 1984). Computers have revolutionized communication, and society has been forced to come to terms with their presence. This extremely rapid infusion of complex technology has created an atmosphere of confusion and conflict. The need for new policies, based on technological facts and education principles has led educators to ask the following questions: In what areas can computers help? In what areas can computers prove counterproductive? What is the proper place of computers in education (Dreyfus and Dreyfus 1985)? The role of computers in education system has become a concern of educators and public decision-makers.
alike. The debate over the necessity of computer literacy accompanies this rising tide of concern and is one of the key factors behind the hundreds of computer education proposals before school boards, legislatures, and national decision bodies (Anderson and Hunter 1986).

Although not defined in current dictionaries, computer literacy has an immense and far-reaching influence on almost every facet of life. The term generally means understanding computers and being able to use them (Friedrich 1983). Computer literacy continues to evolve as educators and lay person struggle to sort out what computer literacy should include.

Computers in Education

The fundamental structure and activities of society are changing rapidly. These changes are rooted in the availability new ways of generating, sorting, communicating, and using information. People must obtain the understanding, skills, knowledge, and tools necessary to cope with these changes. Society is making a rapid shift from the production of material goods to the production, distribution, and application of knowledge and information. As a result, new skills and attitudes are needed. Those who know how to access and use information and how to use technology-based tools are the people with the power to control industry, economics, and social decision-making.
Those who do not know how to obtain and use information are becoming increasingly unemployed and alienated (Hunter 1981). In response to the growing number of jobs requiring for the ability to work with computers, colleges and universities must produce graduates who understand computers and their applications (Taylor 1981).

Before the advent of microcomputers, few were convinced that the masses needed to know about computers. Now that many homes and most schools have computers, computer literacy is no longer the province of a selected few (Seidel 1982). The central question is not whether one is for or against computers in education, but whether or not one can define the educational criteria and priorities that can humanize computer use (Sloan 1985).

The National Council of Supervisors of Mathematics includes computer literacy as one of ten basic skills areas:

It is important for all citizens to understand what computers can and cannot do. Students should be aware of the many uses of computers in society, such as their use in teaching/learning, financial transactions, information storage and retrieval. The 'mystique' surrounding computers is disturbing and can put a person with no understanding of computers at a disadvantage. The increasing use of computers by government, industry, and business demands an awareness of computer uses and limitations (National Council of Supervisors of Mathematics 1978, 147-152).

Although educators have recognized value of computers and have used large mainframe computers in public schools
for decades, they first began to realize the revolutionary impact of microcomputers in 1971. Less than a decade later, a survey conducted by the National Center for Educational Statistics (NCES) estimated that, nationwide, public schools used 52,000 microcomputers. In addition, the report indicates that about one-half of the nation's school districts provide students with access to at least one microcomputer or computer terminal (Department of Health, Education, and Welfare 1980). Americans, in general, seem to be receptive to the computer revolution and appear to be optimistic about its impact. Although many believe that unemployment and dehumanization are caused by computers, most believe that computers will ultimately raise production and living standards and will improve the quality of their children's education (Budin and others 1987; Cleveland 1986; Lengel 1987; Rhodes 1986; Kendall and Budin 1987a).

However, concern is evident as to how people actually use and react to computers (Goleman 1986). One researcher sought to test the hypothesis that frequent computer users rarely experience anxiety when asked to complete a task using a computer. It was found that, regardless of prior computer experience, subjects manifested increased anxiety caused by an inherent fear of the mechanics of computer terminal operation (Powers et al. 1973). Some writers argue that hands-on experience with the computers is the effective
method for dealing with computer anxiety (Clements 1981; Lauhawiriakramon 1983; Wilder 1985). According to these researchers, high school students generally express positive attitudes toward computers when they are used for computer-based instruction, game-playing, or LOGO turtle graphics. However, their attitudes toward computers when used for required instruction programming language—the typical use of computer in secondary schools—range from neutral to negative (Becker 1985). An example of these findings is provided by a study of 400 high school students enrolled in a required computer literacy course featuring instruction in BASIC. Fewer than half of the boys and one-third of the girls reported that they liked working with computers or programming (Lockheed 1985).

A study by Wilson and Trenary (1981) also supports the hypothesis that previous computer experience does not always change unreasonable and hostile attitudes toward computers. Advocates of the hands-on approach to computer literacy and attitudinal change need to be reminded that familiarity does not always breed contempt. They further conclude that students become computer literate only after changing their attitudes.

Zoltan (1982) investigated attitudes toward computers among certified public accountants, lawyers, pharmacists, and physicians. Her study shows that experienced computer
users usually stress the positive aspects of computers while inexperienced computer users often have negative attitudes toward computers.

Russell (1983) compared the attitudes of public school teachers who attended a computer literacy workshop with those who did not. He concluded that computer literacy workshops can be an important factor in bringing about significant, positive change in both teachers' attitudes towards computers and cognitive levels in relation to computers.

There has been little empirical research correlating computer literacy levels and attitudes of university students toward computers. Most studies have focused on secondary schools. However, college and university graduates are those who will enter the immediate work force and job market. Society, in general, and education, in particular, have little choice regarding the use of computers. The technology will have a lasting influence on many aspects of the educational environment; therefore, if the students are to fully develop and utilize this powerful tool, they must understand and appreciate its potential.

Like all other nations in the world, Thailand is experiencing rapid technological changes. Within the past few years, the use of computers at some educational levels has expanded, especially in higher education.
As a developing country, Thailand is in a desperate economic race with other advanced countries for its economic survival. If Thai people want to keep abreast with the world, they must take a critical look at computers in education, even more so than other countries. Even though interest in computer application has risen dramatically in the past few years, the computer literacy curriculum is still in its infancy (The Office of University Affairs 1979). With the rapid growth of computer technology and software, the amount of learning necessary to remain current increases annually. If Thailand is to develop appropriate and meaningful computer literacy curricula, it is worthwhile to gain an understanding of how a particular target group of students feels about computers and what degree of computer literacy they possess.

Statement of the Problem

This study assesses computer literacy levels, general attitudes toward computers and the effects of human-computer interaction in an instructional computing environment of Thai students at Thai public universities.

Purpose of Study

The purpose of this study is to investigate and analyze computer literacy and general attitudes toward computers of students at Thai public universities. The study is designed to determine the following:
1. The computer literacy levels among Thai university students who attend introductory computer courses.

2. The comparative computer literacy levels among Thai university students who attend introductory computer courses to determine whether any significances exist on the basis of their demographic classifications (gender, age group, educational level classifications, majors, and grade point average).

3. The attitudes and beliefs about computers when using computers as a part of the instructional process of Thai university students who attended introductory computer courses.

4. The differences in attitudes toward computers among Thai university students who attend introductory computer courses with various demographic classifications (gender, age group, educational level classification, majors and grade point average).

5. The relationships between computer literacy levels and attitudes about computers of Thai university students who attended introductory computer courses.

6. How to develop a suggested model computer literacy program based on the information collected and analyzed in this study combined with documentations analysis.

The specific research questions are the following:
1. To what extent do Thai public university students express computer literacy levels as measured by a computer literacy subtest?

2. Do significant differences in computer literacy levels exist among Thai public university students from various demographic classifications?

3. To what extent do Thai public university students express attitudes toward computers as measured by an attitude subtest?

4. Do significant differences in attitude toward computers exist among Thai public university students from various demographic classifications?

5. What is the relationship between computer literacy levels and attitudes toward computers of Thai public university students?

Hypotheses

In this study of computer literacy levels and attitudes toward computers among Thai public university students, the following hypotheses were formulated:

1. No significant difference exists in computer literacy levels between or among the following Thai public university student groups: (1) male and female students; (2) students of differing age groups; (3) students of differing educational classification levels; (4) students with various majors of study; (5) students in differing categories of grade-point average.
2. No significant difference exists in attitudes toward computers between or among the following Thai public university student groups: (1) male and female students; (2) students of differing age groups; (3) students of differing educational classification levels; (4) students with various majors of study; (5) students in differing categories of grade-point average.

3. There is no significant relationship between computer literacy levels and attitudes toward computers of Thai university students.

**Definition of Terms**

Operational definitions of the following terms are included for this study.

**Algorithm** refers to a set of specific actions to take in order to solve a problem in a finite number of steps.

**Computer hardware** refers to physical computer components which can be classified according to their function in relation to data. Basic categories of hardware are input, output, processing, and storage.

**Input equipment** is used to get data into the computer.

**Processing equipment** is the part that does the actual computing, often referred to as central processing unit or CPU.

**Output equipment** is used to transfer data from inside the computer to some more permanent form.
Storage equipment is the device used to store the data that is not being used but can be called back when required.

Computer Software (also known as program) refers to a set or sets of instruction that run a computer from the physical component of the computer.

Computer literacy refers to the ability to understand and use computers appropriately. Each of the following is essential to students computer literacy: hardware concepts, programming and algorithms, application principles, social implication, and favorable or well-informed effective orientation.

Background of Study

Computers are rapidly being integrated into most significant social institutions: homes, workplaces and schools. The potential of these devices for information processing, problem solving, and communication has already begun to alter the social ecology in ways that are dimly perceived and poorly understood.

One of these dim perceptions is that the influx of computers into homes and schools of the affluent has added yet another disadvantage. This evaluation assumes a connection between familiarity with computers and good jobs, and that access to important information and problem-solving resources are available only to computer initiates (McKay 1984).
Because computer skills are presumed basic for effective functioning in society, the National Council of Supervisors of Mathematics made an important position statement:

An essential outcome of contemporary education is computer literacy. Every student should have first hand experiences with both the capabilities and the limitations of computers through contemporary applications. Although the study of computers is intrinsically valuable, educators should also develop an awareness of the advantage of computers both in interdisciplinary problem solving and as an instructional aid (National Council of Supervisors of Mathematics 1978, 147-152).

Developing or implementing plans for computer literacy for students became a reality in 1983 in at least thirty states of the United States. Major philosophical differences exist about the definition and purposes of computer literacy. However, the basic issues that the states are facing are similar. For example, Should computer literacy requirements be integrated into existing or modified curricula (as is done in most states) or should computer literacy labs be established? At what grade levels should computer literacy be introduced? How should computer literacy relate to computer science programs at some levels? Should computer literacy be required or mandated before graduation, as it is in some states? If a computer literacy program is implemented at all grade levels, what are the minimal competencies at each level (Blaschke 1986).
A view of computer literacy proposed by the Minnesota Educational Computing Consortium (MECC) provides the basis for the position on computer literacy and attitudes towards computers taken in this study. The MECC definition of computer literacy incorporates knowledge of computers, social implications of that knowledge, and a recognition of the need for skills in communicating with computers. Computer literacy, in this definition, is "whatever understandings, skills, and attitudes one needs to function effectively within a given social role that directly or indirectly involves computers" (Anderson 1981).

MECC views computer literacy as a two-dimensional concept. One dimension is cognitive in nature, relating to areas requiring knowledge about hardware, software, applications, and programming. The other dimension covers the effective domain and describes feelings of anxiety, efficacy, enjoyment, and educational value (Anderson 1981).

The MECC position on computer literacy was chosen as a basis for this study because the definition was broad enough to provide information about the knowledge as well as attitudes of the subjects. However, for the purposes of this study, the phrase computer literacy relates only to the cognitive dimension of the MECC view; and the phrase attitudes towards computers used in this study will only relate to the effective dimension of computer literacy.
Limitations of the Study

This study is limited to students at Thai public universities who attended at least one computer introductory class.

Basic Assumptions

This study is based on the following assumptions.
1. The students expressed their attitudes honestly on the questionnaire employed in the study.
2. The students honestly recorded their knowledge, skills, and perception of computer literacy on the questionnaire used.

Summary

New technology has affected education and the kind of knowledge an individual needs to participate effectively in society. The growing use of information technology throughout society is creating major new demands for education and training. As a significant link between the past and the future, education must continually adapt to social changes.

Computer literacy has become a common term, meaning the ability to communicate with computers. Widely diverse viewpoints exist as to what constitutes communication with computers, but the dominate educational ideology is that every student needs to be computer literate in order to
function productively in the computer age (Anderson and Hunter 1986). Today's educational curricula must be reassessed and restructured to take into account the skills and knowledge needed in an information-based society. These skills include formulating problems and problem-solving algorithms, using data and analytic tools to solve problems, and communicating and collaborating with others in solving problems.

In the world community, today's developing countries such as Thailand are already in a world-scale economic race. It is no longer possible just to know people around us. Interdependence with other countries will become the cornerstone of future business decisions, and global understanding can be enhanced through electronic access to international data (Kendall and Budin 1987b).

A careful study of computer literacy levels from a sample of Thai university students enrolled in introductory computer courses has the potential to provide significant information which will aid in curriculum development. Further, there is little evidence of the capability to integrate educational technology, learning theory and cognitive science to make reasonable value judgements. Thus extensive research in this area is a necessity.

The acceptance of a new technology is greatly influenced by one's attitude; and if computers are to gain
acceptance and widespread use, then research which can provide meaningful understanding and insight is also necessary. The analysis of attitudinal data conducted through this study can contribute to a better understanding of the subjects' attitudes toward computers which can, in turn, contribute greatly to the successful implementation of the technology within an educational context.
CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter relates to the major elements of the problem. The initial topic, which deals with educational uses of computers, is included in order to aid in better evaluating research findings presented in chapter four, which are related to the educational value and uses of computers. The second section addresses computer literacy, the third concerns the affective variable, attitudes toward computers, and the fourth part consists of the sex variable and computers. The fifth section deals specifically with computer education in Thailand.

Educational Use of Computer

Computers have been proposed for a variety of services within the educational system. A review of the literature reveals classifications that seem to cover the majority of applications. Discussions of educational uses of computers were most frequently identified as educational research, planning and management, and instructional use.

Educational Research Applications

Initially, and most commonly, the computer is assumed to be a device with enormous abilities to store, retrieve
and display information, and to perform calculations according to a preprogrammed set of rules—an algorithm. The recent advent of artificial intelligence applications, expert systems, word processing, and spreadsheet programs has made clear the computer's capacity as a symbol manipulator. Inherent in the computer and its software is the ability to manipulate concepts for which we can define a coherent set of symbols together with an appropriate and consistent set of rules of manipulation (Geiss 1986). With the passage of time, the computer has proven to be an essential tool for educational research.

A tremendous volume of research in the application of computers and computer-related technology in education is being undertaken throughout the world (Becker and associates 1988). However, current research seeks deeper understanding of the complex interaction of students, tools, and classroom learning environments. Early research in educational computing typically asked questions such as "Does the computer make a difference in learning x?" Current researchers seek to be more sensitive to the multidimensional nature of the learning process, learning outcomes and learning environments. It is becoming more and more obvious that technology is not an independent variable, that the ways in which given tools are used depend on the cognitive, effective, and social skills of learners, as well
as the social environment of the classroom, the school, and educational institutions (Michaels 1986). Some researchers are interested in processes as well as outcomes. For example, many studies on the role of word processors in writing are focused on the interaction of the tool with the nature of the writing process (Bruce, Michaels and Watson-Greggo 1985; Daiute 1985). Similarly, the impact of computers on science processes is of interest (Berger 1982). Many researchers are more interested in cognitive processes than in behavioral outcomes (Anderson et al. 1985; Barclay 1986; Collins and Gentner 1980; Dervin 1983; Fisher 1986; Hunter 1987, 1988; Malone 1981; Perkins 1984, 1985).

Ethics and values are also surfacing issues. These issues involve intellectual property rights, privacy, honesty in communication, and equity of access to information. As computers begin to pervade the learning environment, it becomes imperative that students be taught the ethical, legal, moral, and social aspects of the uses of these tools. Much work is needed in understanding social issues involved in use of electronic technology (Hunter 1988).

The role of teachers is becoming an increasing focus for attention. Many researchers (Cohen et al. 1986; Collins and Steven 1982; Copeland 1985; Hawkins and Sheingold 1986) seek to understand the new role that teachers create for
themselves as they introduce new tools and processes into the classroom. Meanwhile interactions between learners and ways in which information is represented by computers are of interest to some researchers. The more common question asked is How does this particular characteristic of knowledge representation help or hinder the learning process (Anderson et al. 1985; Eylon and Reif 1984; Krendle and Fredin 1986).

Computer applications seem destined as supplements to be integrated wherever appropriate into classroom instruction. However, an opposing, pessimistic view can be found in a recent book by Sloan (1985), in which the following claims are made about the negative effects of computers on students:

1. Computer utilization in education perpetuates an unwarranted emphasis on technical or utilitarian reasoning, neglecting other values and forms of thinking that should be part of a liberal education.

2. Computer education helps maintain a preoccupation with mechanistic imagery, neglecting that which is most fundamentally human.

3. Computers are dehumanizing because of the two previous arguments and because they foster emotional and empathic insensitivity.
4. Computers do not necessarily improve learning or teaching, and they may inhibit it through a diversion of attention and resources.

5. Computer skills do not necessarily prepare one for entry into the workplace, and they may not provide a significant personal advantage in other arenas.

6. Humane values and perspectives are threatened by the imposition of more computer technology within the educational system.

These arguments against the use of computer in education, as well as propositions of a more positive character, deserve to be fully investigated through empirical research. Anderson and Hunter (1986) suggest that such research should be ongoing, so as to continuously monitor and assess the consequences of computer innovations and computer institutions upon students, teachers, and society.

Planning and Management Uses of Computers

College and university administrations are currently faced with a major dilemma concerning the acquisition, deployment, and effective use of microcomputer technology. While this low-cost and convenient technology is making major and innovative contributions to both academic and administrative aspects of higher education, it is often acquired and used in an eclectic fashion (Stewart 1983).
Among the new technology developments are computer-based information systems (CBIS), designed to provide support for those who manage organizations. CBIS should be able to do three things in support of management: First, it should provide access to much of the data and information needed for making decisions and for understanding the workings of the organization. Second, it should provide a medium, or set of alternative media, that allows data and information to be assembled, manipulated, analyzed, and reported. Third, it should provide support for the thought processes, for the relating of assumptions, concepts, facts, and rules of thumbs, that are required for managerial understanding and decision making (Brinkman 1984).

It has generally been acknowledged that the typical management information system (MIS) application concentrates on objective structures and ignores the particular idiosyncratic needs of individual managers. The perceived characteristics have encouraged the development of other approaches—the database management systems (DBMS) and decision support systems (DSS).

DBMS generally refers to a set of software programs that, at a minimum, allow users to organize, maintain, and query data files and to generate custom-designed reports from files. There is a considerable range between the
capabilities of personal DBMSs that run on microcomputers and mainframe-based DBMSs.

Decision support system (DSS) refers to an interactive computer-based system that helps decision makers use data and models to solve relatively unstructured problems involving a strategic rather than a tactical perspective. These systems are more flexible, more under the control of the user, and more precisely attuned to differences in cognitive style and to the particular decisions that managers must make (Norris and Mims 1984).

The first practical alternatives to purely manual means of data processing, electromechanical and punched card (EDP) devices, are recent history. Electronic data processing appeared in the 1950s as the preferred alternative and remains a fundamental component of CBISs. EDP refers to an electronic system which processes—that is, records, stores, maintains, and recalls—data pertinent to the basic operation of an organization. The data typically are records of transactions and other events that recur, such as paying vendors, receiving donations, registering students, and checking out library books.

As it became apparent that organizations would do well to put more time and effort into organizing data and information resources in ways that could serve management coordination needs more directly, the era of management
information systems (MIS) began. MIS are information oriented rather than data-oriented. The systems produce a series of reports that enables managers to assess how well an organization is meeting its objectives. Monthly budget reports, course enrollment reports, and reports showing the cost per student credit hour by department are examples of MIS products in higher education institutions. MIS have proven to be useful for middle managers, but not very helpful to senior manager (Zeleny 1982).

Over the past several decades, CBIS have become increasingly supportive of management. While earlier systems focused on the needs of managers closest to everyday operations, newer systems are designed for the manager with broader, more long-range responsibilities. They have moved from providing mere data to providing the means for transforming data into information and to provide a versatile medium for presenting knowledge wherein managers can analyze data, formulate ideas, structure arguments, and build models (Brinkman 1984).

Instructional Application

There are many ways that computers may be used in instruction. However, the classification framework used in this study was originally proposed by Taylor (1980). He suggested that applications of computers be placed into one of three major classifications: tutor, tool, or tutee.
Tutor Applications

In tutor applications the computer performs a teaching role. In effect, the student is tutored by the computer. The process is as follows: (1) the computer presents some information, (2) the student is asked to respond to a question or problem related to the information, (3) the computer evaluates the student's response according to specified criteria, and (4) the computer determines what to do next based on its evaluation of the response. Tutor applications can be classified into four categories: drill and practice, tutorial, simulations, and games (Merrill et al. 1986).

Drill and Practice Applications

Drill and practice provided one of the earliest techniques of computer-based instruction. In this type of application, the computer is used to help students memorize the appropriate response to some stimulus. Drill and practice involves any exercise, physical or mental, which is performed regularly and with constant repetition. It is often associated with rote-memory learning and generally does not include instruction on how to do a particular task. Any necessary demonstration or expository usually comes before the drill and practice.

Some modern theories about how learners perform tasks suggest that, in order to perform efficiently, performance
of lower-level subskills must become automatic (Anderson 1980; Gagné 1982). This is generally referred to as "automaticity of subskills." The more one practices a skill the more automatic it becomes. As a subskill becomes automatic, it requires less attention and interferes less with ongoing cognitive processes (Spelke, Hirst and Neisser 1976). For some basic skills, drill and practice can be a fruitful way to learn.

**Tutorial Applications**

The primary purpose of tutorial applications is to teach new information. Tutorial computer applications seek to place the computer in the role of a tutor, one that carries the full instructional burden of guiding a student to the achievement of a specified set of objectives. Tutorial programs should incorporate most of the nine events of instruction: gaining attention, presentation of objectives, recall of prerequisites, presentation of stimuli, providing guidance, eliciting performance, providing feedback, assessing performance, and enhancing retention and transfer. In order for a tutorial lesson to be better than a book, it must be interactive and sensitive to the needs of learners. The responses elicited need to be directly related to the skills learned. Lessons which are sensitive to student responses incorporate sophisticated learner-control or adaptive strategies. Sensitive lessons continuously diagnose the instructional needs of each
student and prescribe appropriate instructional events to meet those needs. Unfortunately, these guidelines are very difficult to achieve. However, they are goals toward which tutorial designers to strive, and serve as a standard for evaluating existing software. Although some research has been done in this area (Park 1984; Tennyson, Tennyson and Rothen 1980; Tennyson, Youngers and Sieubsonthi 1983), additional research needs to be conducted in order to increase knowledge regarding the design and development of efficient and effective tutorial programs (Merrill et al. 1986).

Simulations

A simulation is a representation or model of a real object, system or phenomenon. It is an imitation of reality. In a simulation, the student interacts with the computer to help produce the outcome. Active simulations allow students to dynamically interact with and manipulate a phenomenon under study. Simulations are valuable tutor application for these reasons:

1. There is less risk in a simulation than a reality.
2. Training costs are reduced.
3. Simulations are frequently more convenient than the real life situation.
4. Simulations minimize the negative effects of time.
5. The ability to focus on specific aspects of phenomenon is frequently increased.

6. The experiences in a simulation are repeatable.

Games

Games usually involve some elements of competition or challenge against an opponent or task and are governed by a definite set of rules.

In teaching concepts in many areas, computer games may be used to teach higher-order skills. The choice of the term game for such programs, while accurate, is unfortunate, because of the negative connotations which many people apply to games. Sometimes concepts and skills can be taught by participating in games which are analogs of the context in which the skill, once learned, is to be applied. The proper balance of challenge, curiosity, control, fantasy, cooperation, competition, and recognition contributes to a game's effectiveness in motivating students. Although many computer-based instructional games have been developed, only recently have researchers begun to study them seriously (White 1984). Researchers at Stanford University (Lepper and Malone 1983; Malone 1980; Malone and Lepper 1983) have attempted to identify attributes of educational computer games which optimize their intrinsic motivational power. They suggest useful criteria for selecting educational computer games for the classroom.
Tool Applications

In tool applications, computers are used to assist administrators, teachers, or students in performing tasks. By changing the set of instructions or computer program stored in the memory of the computer, its function changes dramatically. Word processing, database management, calculating, electronic spreadsheets, graphics, and communication are a few examples of the many tool applications. Educators have repeatedly pointed out that computer technology can facilitate the attainment of many curricula goals (Budin and Cunniff 1988).

Hunter (1987) notes that as more teachers become computer literate, and, as more appropriate software tools become available, the uses of computers as a tool in learning and teaching is grows rapidly. The reasons for their use range from a straightforward desire to expose students to the tools of the information age, to more ambitious goals of reforming the basic curriculum and pedagogy in order to make it more process-oriented and reflective of real-world complexity.

Tools are usually used to support process-oriented learning including inquiry, writing, problem-solving, decision making, collaboration, and other applications of higher-order thinking skills. They are also used to support concept learning and to provide access to information and
algorithms (Hunter 1988). Educators (Fapert 1980; Patterson 1986; Tucker 1985) have many reasons for providing tools as a part of learning environments. There are some themes of philosophy that serve as the base line for much of the work with tools. These themes include: (1) constructivism—the learner is viewed as an active constructor of knowledge, is active and can relate new information to existing knowledge (Hunter 1987); (2) conceptual understanding—the learner should be taught about the concept underlining procedures or the concept should be discovered if the student is to be able to apply procedures to situations beyond those taught (Brown et al. 1982); (3) self-monitoring and self-management of learning—learners are viewed as taking responsibility for their own thinking and learning activities; and (4) lifelong learning—education must be an ongoing process throughout life (Hunter 1988).

There are many recent works concerning tool applications. Among the more common computer-based tools are those used to support the writing process (Collins 1986; Gerrard 1987). Survey results from Becker's study (1986a) show that among high school English teachers using computers, 69 percent indicated that students had improved their writing, editing, or proofreading skills by using computers. In addition, more business education teachers indicated improvements in students' writing than indicated any other learning effect from use (21 percent).
In one of Becker's surveys involving some 8,000 teachers and principals, teachers who were using computers perceived computers as helping students to enjoy their school experience more and as motivating them to pay closer attention to academic work. Four out of ten believed that student enthusiasm in school subjects for which they used computers was much improved because of computers (Becker 1986b). They also perceived computers as being highly useful to special populations, such as gifted and special education students. However, most did not perceive computers as useful, at the time of the survey, to average students. Only 7 percent reported that learning in the usual curricula areas was much improved for average students.

In schools with a high proportion of available computer time devoted to word-processing, teachers indicated more learning by above-average students than in schools with a smaller amount of time devoted to word-processing. Drill and practice, on the other hand, was primarily considered beneficial for lower achieving students. The amount of time spent in programming was not perceived to contribute to an improvement of learning outcomes in school subjects (Becker 1988). Daiute (1985) examined the computer in writing instruction, and proposes that the introduction of computers into the writing process changes the nature of the activity because it provides the writer with more power. She
concludes that the positive effects of computers on writing are attributable to recent changes in writing philosophy and approaches to using computers in education as much to the actual use of computer itself.

Tutee Applications

In the role of tutee, the computer offers an opportunity to learn by teaching. It adds flexibility to problem-solving processes each time the person writing instructions (the program) for the computer meets the challenge of teaching the machine to perform a new task. Problems can be tried and retried with new dimensions and with changing patterns and relationships. Computer programming is problem solving (Merrill et al 1986).

The idea of teaching programming skills to general student population by some computer experts is not intended to make professional programmers out of everyone, but rather to broaden perspectives and provide basic skills necessary for individuals to instruct computers to perform tasks they need. Such skills increase the individual's control over computers. Perhaps even more valuable than programming skills acquired are the problem-solving and thinking skills which are automatically enhanced through experiences in programming the computer.

Many languages exist for teaching or programming computers, each with its own purposes and characteristic
strengths and weaknesses. Some examples of languages are FORTRAN, COBOL, LISP, BASIC, APL, PROLOG, Pascal, Smalltalk, PILOT, Modulla 2, and LOGO.

**Computer Literacy**

If one peruses the literature in this area, it soon become apparent that authors place priorities on different aspects of computing. An assortment of definitions arise from differences in educational philosophy.

At one extreme, authors emphasize knowledge and concepts related to hardware and programming; at the other extreme, emphasis is on an awareness of applications and issues. This is not to say that the literature can be easily divided into two disjointed sets--most authors espouse some combination of these ideas (Johnson, Anderson, Hansen, and Klassen 1980).

The term computer literacy is an established title in the Educational Resources and Information Clearinghouse (ERIC) (McKay 1984). It is not surprising that the term computer literacy shares the semantic ambiguity of language literacy. Communication with a computer via a computer language is directly analogous to interpersonal communication via ordinary language, the conjunction of computer and literacy has had an intuitive appeal (Anderson and Klassen 1981).
It has also been suggested that the word computer may not last forever (Zamora 1973). Some believe that its name no longer fits the machine's uses and neither adequately describes the blurring among components (hardware and software, for example) nor their growing integration with other devices (audio, video and telecommunication networks) (McKay 1984).

Discussion about computer literacy began appearing in the literature in the mid-1970s. A number of these discussions took a middle-ground approach to the definition of computer literacy. The Conference Board of Mathematical Sciences (1972) released a report recommending a junior high school course in computer literacy, which was defined as an understanding of computer capabilities, applications, and algorithms. This definition, however, largely ignores issues of social impact. Some writers, including Lykos (1974), Moursund (1976), and Rawitsch (1978) argue that computer literacy includes emphasis upon social issues. Moursund conceptualized computer literacy as "A knowledge of the non-technical and low-technical aspects of the capabilities and limitations of computers" (Moursund 1976, p. 2). He proposed that students best acquire low-level knowledge by a combination of programming and non-programming instructional materials (Billings and Moursund 1979; Moursund 1978). Hunter defined computer
literacy as follows "... whatever a person needs to be able to know about and do with computers in order to function effectively in our information-based society" (Hunter 1981, p. 3).

This definition points out that the skills, knowledge, and attitudes needed vary from person to person and from time to time, depending on what is being done. This definition also points out that computers are tools for service in other work, not an end in themselves. Klassen (1981) has the same perspective of computer literacy.

Some authors (Papert 1980; Turkle 1984) view computer literacy as the ability to make use of ideas from the cultures surrounding computer programming and computer applications as part of an individual's collection of strategies for information retrieval, communication and problem solving. This aspect of computer literacy corresponds to the effect on intellectual functioning of learning to read and write, and is probably the most difficult to incorporate specifically into educational programs since the effects are not understood. Some define computer literacy as the ability to understand the growing economic, social and psychological impact of computers on individuals, on groups within society, and on society as a whole (Kling 1983).
Horn and Poirot define computer literacy as an area of knowledge that includes:

(1) an understanding of the technology used when processing information, (2) an understanding of the effects that computers have had and will have on society, and (3) an understanding of how computers are problem-solving-tools (Horn and Poirot 1980, p.20).

Nationally, the confusion continues over what it means to be computer literate. According to various authors (Johnson, Anderson, Hansen, and Klassen 1980; Klassen 1980), computer literacy instruction means imparting knowledge about handling information, dispelling fears and myths associated with computers, developing skills in using and programming computers, developing procedural learning, and addressing the ethical and societal issues raised by computing. On the other hand, Luehrmann (1980) and Molnar (1978) tend to equate computer literacy skills with programming skills. These skills include (1) the ability to control and program a computer to achieve a variety of personal, academic and professional goals; (2) to write programs in one or more computer languages; (3) to read, understand, and modify more complex computer programs, (4) to use a computer as a problem solving tool; and (5) to analyze information generated by a computer program in terms of how the program operates and particular data chosen at program input, while Hunter (1981) stresses developing procedural or algorithmic solution to problems. The
procedure or algorithm developed may or may not be implemented in the form of a computer program. Hunter explains that students can only derive computer skills, knowledge, and attitudes from analyzing what they need to be able to do with a computer to function effectively in their careers or as citizens. The following general categories of skills, knowledge, and attitudes are included under the phrase computer literacy:

Feeling comfortable and in control when using a computer system, using computer programs and databases and communications, developing procedural or algorithmic solutions to problems, analyzing social issues that relate to computers communications and their social impacts (Hunter 1981, p. 3).

Other discussions focus on additional meanings of computer literacy. Some view literacy as a matter of being well-informed about general aspects of computers. Ball and Charp (1977) exemplify this point of view by proposing to make a person computer literate with fewer than 100 pages of instruction, consisting mainly of drawings. Rawitsch (1978) suggests that students should also learn how to access computers and have some understanding of the social issues, but does not insist that students learn how to program in order to be considered computer literate.

At its root, computer literacy requires a commitment to learning both about and by using computers. Most importantly, it requires learning the art of putting one's
thoughts to work by using computers. In a fundamental sense, computer literacy ranks with the three R's in importance in Western society. At the abstract level, computer literacy presents few problems. It is an honorable goal with few negative connotations. It is seen as providing a basis for improving national productivity and the well being of all citizens. It is one of the cornerstones of a society built on technology (Klassen 1981).

The diversity of these views of computer literacy is obvious although its significance may be overrated. If one adopts the perspective that computer literacy is a matter of functioning effectively within a given role (Klassen 1980, Hunter 1981), then it becomes more obvious why some people need low-levels of understanding and others (e.g., students and engineers) need higher-levels of understanding.

This study adopts Anderson's perspective on computer literacy. He noted:

Computer literacy is best defined as whatever computer knowledge and skills one needs to function effectively in a given role. This includes the ability to evaluate appropriate use of computers, to plan and execute various applications of the computer, and most importantly, the ability to understand how computers are impacting us socially, psychologically, culturally and ethically (Anderson 1981, p. 131).
Computer Literacy in Higher Education

Numerous research projects have measured attitudes, knowledge, and skills related to computers, but rarely have these studies included samples beyond one or two classrooms. Some noteworthy exceptions are studies conducted in Minnesota (Klassen 1981) and Nebraska (Steven 1980). The AFIPS/TIME, Inc. (1971) survey of attitudes toward computers is the only nationwide computer-related survey of adults conducted in the United States in the past decade. Its results show that at the beginning of the decade the populace felt generally favorable toward computers, although they expressed considerable ambivalence and hesitancy. Many survey questions determined awareness of general applications of computers in society. The survey also indicates that the public had a general awareness of computer capabilities but many people held misconceptions about computers.

After several associations and commissions studied the use of computers in higher education, the President's Science Advisory Committee concluded that if educational computing is to find a useful place in colleges and universities, course material in the various disciplines will need substantial revision (National Science Foundation and Development of Education 1980). Many reasons have been cited for using computers in higher education; foremost
among them are the individualization of instruction, a mean for educational reform, emphasis on analysis, and more quality material available to more people (International Federation for Information Processing 1974).

Change is occurring so rapidly that educators are not asking whether computers will enter classrooms, lecture halls, and laboratories, but rather, at what rate microcomputers will enter the classroom. How can decision-makers select the most appropriate system? What is the best way to train teachers to use computer-assisted-instruction (CAI)? How does one build an informal contact between students and microcomputer systems? What evaluation methods are required to assess the effectiveness of computers in the classroom (Billings and Moursund 1979)?

Research on educational computing is increasing markedly, and the quality is improving considerably. Roblyer, Castine, and King (1989) reviewed research conducted between 1980 and 1987, and report that three-fourths of the studies found were conducted between 1985 and 1987. Several observations have been made of research characteristics during this period:

1. Only about 40 percent of the achievement studies were able to accomplish the most desirable of research condition: random assignment of students to experimental and control groups.
2. Most studies that used random assignment also used pretest-posttest control group designs. Those which could not randomize used quasi-experimental methods. Others used a non-equivalent pretest-posttest control group design.

3. Although it is very helpful in controlling for Hawthorne effects, fewer than 30 percent of the studies had the control group use some form of computer applications.

4. On measures of achievement, researchers used a variety of tests, about 30 percent of which were locally developed, almost always by the experimenter. Reading and mathematics studies often used subtests of the SRA, CTBS, ITBS, or CAT. Word processing studies most often used a wholistic scoring method designed by the experimenter. Where student attitudes and cognitive skills were being studied, no two experimenters seemed to use the same instrument.

5. The number of students in the studies varied from a low of 16 to a high of about 4,000. Most studies had a total of around 100 students. Sample sizes were generally lower in dissertation studies.

**Attitudes Toward Computers**

The pervasiveness of computers today demands that societal attitudes should be studied for at least two reasons: to better understand and correct the fallacious and irrational attitudes toward computers, and to better
understand the rational attitudes against computers and
their uses so that individuals and society may be protected
(Matthews and Wolf 1979).

Attitudes concern feelings about particular social
objects-physical objects, types of people, and policies
(Nunnally 1967). Attitudes toward computers refer to
individuals' feelings about personal and societal use of
computers in appropriate ways. Positive attitudes include
an anxiety-free willingness or desire to use the computer,
confidence in the ability to use a computer, and a sense of
computer responsibility (Simonson et al. 1987)

The attitudes of participants in any activity are
important to its success. In a learning environment,
unmotivated students are difficult to teach regardless of
subject matter or teaching style (Clements 1981).
Similarly, students' attitudes toward using computers in the
learning environment may be important to the success of
computer-based projects. Taylor (1988) places the emphasis
on attitude rather than on learning about rules, definitions
and law. He reasons that, in a climate of change, no
individual can be an expert in every branch of the subject,
not even at graduation. By the time one learns all the
rules and facts, he may find that they have been replaced.
It is much more important to be trained to think, to adapt
and to improvise in a scientific way than to be exhaustively
familiar with one narrow field.
One of the factors affecting the rate of adoption of the computer was "computerphobia." The complexity of innovations make some people believe that they will never be able to control these devices and so they prefer to avoid them. One might expect such beliefs to be negatively related to people's intention to use computers. Hill, Smith and Mann (1987) investigated the relationship between a sense of efficacy regarding computers and a readiness to use them. They report that beliefs of efficacy regarding computers exert an influence on the decision to use computers. A significant relationship was also found between general beliefs of personal efficacy and the use of other electronic devices.

Students enrolled in college-level classes may possess a degree of computer anxiety. This anxiety has many causes and is related to a number of factors including fear of the unknown, fear of embarrassment or ridicule, a hesitancy to ask questions, uneasiness caused by seeing younger people who are more so comfortable with computers, and unpleasant initial experiences (Rivizzingo 1980; Wildmer and Parker 1983).

Relationships have also been found between computer anxiety and the length of computer exposure or amount of computer knowledge. In high school and college students, the amount of previous experience and the level of computer
knowledge is hypothesized to be inversely related to the level of computer anxiety (Bitter and Davis 1985; Loyd and Gressard 1984).

Wallace studied the effects of computer experience on computer anxiety. The subjects were university students enrolled in an introductory computer science class. She hypothesized that exposure to and use of computers during the introductory course would lower computer anxiety levels by eliminating fear of the unknown and by increasing computer experience and knowledge levels. In addition, the effect of a seemingly overwhelming amount of new information should be alleviated by the structured presentation of material in a classroom setting. This hypothesis is supported by some previous studies (Thompson 1985; Wresch and Hieser 1984). The results show that the students with the least computer anxiety at the end of the course made the highest grades. Subjects who earned the highest course grades had the largest decrease in computer anxiety (Wallace 1988).

Taylor noted that the healthy growth of science and technology in any country critically depends upon the availability of technically and scientifically trained manpower which, in turn, depends primarily on attitudes toward careers in science and technology. He noted that,

The attitudes of the public at large are determined by first introductions to science at a very early age; these attitudes can be disturbed
by prejudice and traditions in the home. Teaching in universities influences teachers at school; and good practical teaching and research in a university depends on a supply of trained technicians. This, in turn, depends on good technical teaching, but even more so on the development of positive attitudes towards careers in science and technology. So we see how convoluted the processes are. The only hope of breaking the circle is a simultaneous attack at all levels (Taylor 1984, 141-42).

In addition, he noted, science and technology education for the world of tomorrow must somehow avoid creating a mental block by removing some of the mystique, by presenting science as a way of looking at the world around us that can accessible to all, and by explaining the positive contributions of science and technology to the well-being of the people of the world.

**Sex Variable**

While much of the attention to microcomputers in education arises from their potential cognitive benefits, there is a growing concern that the advantage offered by these technologies will not extend to all social groups. The familiar question involves the equity and availability for use of an important educational technology. It is common to find more males than females, in various age groups, taking computer classes, attending computer camps, and indicating greater interest in computers at both home and school (Chen 1986, Paisley and Chen 1984).
There is evidence that girls and women constitute lower enrollment ratios in computer courses (Hawkins 1985; Lockheed 1986;). These studies which most commonly examine enrollments in computer programming and computer science courses, report male/female ratios from 3:2 to upwards of 5:1, with higher proportions of males in more advanced programming classes.

A study by Linn and others (1984) reported student enrollment in BASIC courses at six California middle schools. Sixty-four percent of the students were boys. In addition, among 51,481 high school students in California enrolled in courses involving computers, 42 percent were females.

In another study, females comprised 86 percent of the students in word processing courses and 37 percent in programming courses. This proportion corresponds with data obtained from the National Longitudinal Study of 1982-1982, in which 40 percent of high school students taking programming courses were females (Rock et al. 1982).

A nationwide survey conducted by Becker (1986b) provides some useful information. Data were collected in the spring of 1985 from primary computer-using teachers in a national probability sample of over 2,300 elementary and secondary schools. The percentage of male users was highest among voluntary computer activities before or after school,
where teachers' estimates of the percentage of male users was over 75 percent at both elementary and secondary levels. The percentage of female users was highest for word processing courses,--almost one half of all students using word processors at both levels. At the elementary level, a larger gender difference was found for programming uses, with females accounting for less than 20 percent, while at the secondary level, teachers reported almost equal proportions of males and females.

The previous study by the Minnesota Educational Computing Consortium (MECC) (Anderson 1987) reported little evidence of sex difference in computer literacy among a sample of eighth-and eleventh-grade students. Girls and boys were roughly equal in overall computer literacy and programming test scores. Girls scored higher than boys for items presented as word problems, however.

Results from the National Assessment of Educational Progress (NEAP) indicate that, overall, less than 25 percent of the thirteen- and seventeen-year-olds were able to perform tasks such as reading a simple flowchart or completing a simple exercise in BASIC correctly. Lower levels of computer ability as well as computer exposure were found for female students, minorities, rural students and those in the Southeastern states (Carpenter et al. 1981). Similar to the NEAP findings, the California State
Department of Education found that knowledge of computer programming was low for sixth and twelfth graders from California. Although boys scored higher than girls at both levels, the higher scores among males were associated with greater exposure to computers.

Eastman and Krendle (1984), at Indiana University emphasize the importance of locating gender differences in specific types of computer uses. In a study of eighth graders' accessing an online video encyclopedia to write a science essay, few differences were found between male and female abilities for the computer task. Gender differences at pretest in attitudes about boys versus girls' abilities were non-significant at posttest.

Sex differences with related to computer anxiety have also been noted in some studies (Dambrot 1985; Vredenburg 1984; West 1987).

In two studies where significant differences were found, female students were more negative toward computers than male students. However, in the study comparing the anxiety levels of males and females at the beginning of an introductory computer course, West (1987) found that males were more anxious than females.

Wallace (1988) studied the effects of computer experience on computer anxiety. She noted that the effect of completing an introductory computer service course on
computer anxiety level is sex dependent. The experiences is sufficient to significantly reduce computer anxiety levels in males but has no effect on computer anxiety levels in females. This conclusion is in accord with Dambrot (1985) who reported that females had higher computer anxiety levels than the males.

A report by Roblyer and colleagues (1989) on the results of a meta analysis of the impact of computer-based instruction indicates that there is no firm evidence to show a significant difference between males and females in achievement with computer-based methods, but the inconclusive nature of the data points out the need for careful attention to this area.

The Thai Educational System

Education is a governmental function in Thailand. Three government ministries, The Office of the Prime Minister, The Office of University Affairs (OUA), and The Ministry of Education, administer Thai education. The OUA coordinates higher education institutions and the government. The Ministry of Education is responsible for elementary and secondary school education and most of the teacher and vocational technical education. The National Education Commission, under the Office of the Prime Minister, is responsible for the Educational Development Plan.
The present structure of the Thai educational system is derived from the 1977 National Scheme of Education, which introduced many fundamental changes in Thai education. The scheme and implemented the following pattern of action (Department of General Education 1979).

1. Pre-school education, consists of two or three grades of kindergarten, or a one-year pre-primary education organized in elementary school.

2. Elementary education consists of first grade through sixth grade. All children above seven years of age are required to be in school until the end of the sixth grade. Public primary schools can be classified as follows: municipal schools, and government schools, which are affiliated with teacher training colleges and the college of education of some universities.

3. Secondary education comprises either the junior grades (I-III) or junior and senior grades (IV-VI).

The secondary school curriculum is divided into two distinct tracks: academic and vocational. The academic track prepares students for college or university work, and the vocational track provides specific training for students to enter the labor force as skilled (or at least semi-skilled) workers. The academic track consists of six years of study: three lower and three upper grades. The vocational track consists of three years of lower grades and
three years of study at senior grades (IV-VI). After students finish the lower levels of the academic track they may transfer to the upper levels of the vocational track. Recently a new type of secondary school--the comprehensive secondary school--was developed, based on the principle of providing a range of options--academic, scientific and vocational/technical--in the same school.

4. Higher education in Thailand corresponds to the education continuing from grade twelfth or equivalent (senior grade VI). Four years of study are required for a Bachelor of Arts degree and four to six years for a Bachelor of Science degree. Two years of post-graduate study are required for the master's degree and another three years for the doctoral degree.

The first Thai university, Chulalongkorn, was established in Bangkok in 1917. Four more universities were opened in the 1940s: Thammasart University in 1947, Silpakorn University in 1943, Mahidol University in 1942, and Kasetsart University in 1943. All are located in Bangkok, the capital of Thailand (Watson 1981).

In 1964, the Ministry of Education opened the College of Education at Prasarnmitr, Bangkok. Through gradual expansion, the college now consists of eight campuses, four in Bangkok and four in other parts of the country. In 1974, the college and its campuses were upgraded to university status and are now called Srinakharinwirot University.
From 1964 to 1968, three new universities were established: Chiangmai in 1964, in the north; Khonkaen in 1965, in the northeast; and Prince Songkla in 1968, in the south. In addition, there are the National Institute of Development Administration (NIDA), a post-graduate institute specializing in public administration, business administration, development economics, applied statistics, and research training and the Asian Institute of Technology, the first technological university. Two open-admission universities, Ramkhamhaeng and Sukhothai Tammathirat were established in 1971 and 1978, respectively.

Computer Literacy in Thai Higher Education

In general, higher education institutions are the only establishments that offer computer education (Computer Review 1984). Even though computers were introduced in Thailand over twenty years ago, at Chulalongkorn University and the National Statistical office, computer education has been taught at the university level for only about eight years (Sunthanapun 1984). Three public universities offer programs: computer engineering at Kasetsart University, computer and control engineering and King Mongkut's Institute of Technology, and computer engineering at Chulalongkorn University (The Office of University Affairs 1979). These programs produce eighty to ninety graduates annually.
Other university-level programs offered are computer science programs at Khonkaen University, Songkla
University, Thammasart University, and Kasetsart University, plus the computer education program at Chulalongkorn University.

Three graduate programs in computer science are offered by Thai higher education institutions: computer science at Chulalongkorn University, applied computer and statistics at the National Institute of Development Administration (NIDA), and computer application at the Asian Institute of Technology (AIT). It is estimated that between 2,000 and 3,000 students have taken computer courses. The average number of credit hours taken by each student is six credit hours. Approximately 240 to 260 students graduate each year in computer science in Thailand (NIDA 1984).

During its relatively short life, the computer has been closely associated with the university. In most cases, computers were justified, based on their contribution to engineering and the physical sciences, but as their potential was realized, they were increasingly put to use in other areas.

Over time, computers have proven to be essential tools in educational research, especially in higher education. Computers have performed a variety of tasks associated with manipulating numbers. The statistical analysis of
educational data is also a typical research application of computers. The computers' ability to handle large and complicated arrays of data with speed provide a system which can aid the development and better understanding of teaching and learning processes.

Most Thai public universities have computing centers which serve their administrators, faculty, and students. The centers generally provide (1) computing services to administrators, faculty, and students; (2) training in both computer applications and programming to administrators, faculty, government officials, and students; (3) strong support in administrative, instructional research computing to institutions; and (4) various programs resulting from research studies, such as a word processing program which helps graduate students with their work on theses and dissertations (Jungsakul 1984).

The growing use of computers in education can be seen in governmental support. The Thai government recently appointed a computer administrative committee to coordinate computer applications in Thailand. The committee's maximum effort to improve computer usage includes reviewing computer usage proposals from both government and private sectors.

Thai university administrators have applied computers to student-oriented services and facilities. Starting in the early 1970s, governmental offices and public institutions used computers to partially support
administrative operations. Computers are used to maintain and update student files, report grades, and schedule classes. They have also been applied to other areas of finance and business such as budgeting, payroll, and accounting (Lauhawiriyakramon 1983; NIDA 1984).

Research-related uses have led to developing and extending the technology into the classroom. Computers have spawned a variety of pedagogical approaches that deserve attention. For example, the computer engineering department of Chulalongkorn University has been developing hardware to accommodate the Thai language using a Thai keyboard to input the data; the output, and print-outs are also in Thai. As yet, Thai language software is still needed (Suwan-o-pasakul 1983).

Because of increased demand, Thailand is rapidly expanding computer applications. More Thai students are required to take computer-related or computer literacy courses. Tungwongsan, the director of the computing center at Mahidol University, believes that higher education institutions should be the main resource for providing formal computer education and training (Jungsakul 1984).

Because computer applications are increasing dramatically, microcomputers are available at every educational level. Computers have often been misused by inexperienced persons because of a shortage of the trained
computer professionals at all degree levels. Tungsupanich (Computer World 1984) points out that the major problem in Thailand is the lack of "peopleware." In his opinion, there is enough computer hardware but more efficient programmers, system analysts and system designers are needed. It appears that computer literacy programs are desperately needed in the Thai higher education system.

This study is directed toward Thai students in higher education institutions in an attempt to identify, quantify and analyze levels and general attitudes toward computers thereby establishing a baseline of knowledge for future decisions regarding the integration of computers in higher education.
CHAPTER III

METHODOLOGY

This chapter presents research procedures employed in this study. It includes population and sampling techniques, procedures for collection of data, instrumentation, and analysis of data.

Population and Sampling

Students who attended introductory computer courses at the following thirteen public universities in Thailand were included in this study: Agricultural Institute of Technology, Chiangmai University, Chulalongkorn University, Kasetsart University, Khon Kaen University, King Mongkut Institute of Technology, Mahidol University, National Institute of Development Administration, Ramkhamhaeng University, Silpakorn University, Prince Song Kla University, Sri Nakharinwirot University, and Thammasart University. A total of 500 students was randomly selected, using the random number table, to be the subjects of this study. The sample selected is equivalent to 35.5 percent of the students enrolled in introductory computer courses. A Thai version of the computer literacy questionnaire (CLQ) along with a letter was sent to a research assistant at Ramkhamhaeng University in Bangkok, Thailand. The research assistant duplicated the questionnaire and mailed them.
along with stamped envelopes, to the co-research assistants in each geographic region outside Bangkok. The co-research assistants administered the questionnaires to the selected subjects. For the public universities located in Bangkok, the research assistant used the same procedure to collect the data. An additional follow-up was done a week later. The research assistant and co-research assistants personally collected the returned questionnaire and mailed them to the researcher at University of North Texas in November, 1988. In total of 492 questionnaires were returned; thus 98.40 percent of the sample participated in this study.

The students were classified by sex, age, educational level, major, and grade point average, as shown in Table 1. This table also shows frequencies and percentages of students in each subgroup based on demographic variables. Analysis of data revealed the following characteristics of the sample. (1) The number of male students (37%) was less than that of female students (67%). Most subjects (72%) were twenty years old or younger. (2) Only 1 percent of the subjects were thirty-six years of age or older. Sixty-two percent of the students were freshmen, 17 percent were sophomores, and only 7 percent were graduate level students. (3) Among the respondents, 6 percent were art majors, 18 percent were science majors, 21 percent were business majors, 14 percent were mathematics majors and 12
TABLE 1
DEMOGRAPHIC CLASSIFICATIONS OF STUDENTS WHO ATTENDED INTRODUCTORY COMPUTER COURSE AT THIRTEEN UNIVERSITIES IN THAILAND BY PERCENTAGE

<table>
<thead>
<tr>
<th>Classification</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>180</td>
<td>37</td>
</tr>
<tr>
<td>Female</td>
<td>310</td>
<td>63</td>
</tr>
<tr>
<td>Not shown</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td><strong>Age:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 years or less</td>
<td>355</td>
<td>72</td>
</tr>
<tr>
<td>21 to 25 years</td>
<td>93</td>
<td>19</td>
</tr>
<tr>
<td>26 to 30 years</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>31 to 35 years</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>36 years and older</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td><strong>Educational Classification levels:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freshman</td>
<td>306</td>
<td>62</td>
</tr>
<tr>
<td>Sophomore</td>
<td>82</td>
<td>17</td>
</tr>
<tr>
<td>Junior</td>
<td>53</td>
<td>11</td>
</tr>
<tr>
<td>Senior</td>
<td>16</td>
<td>3</td>
</tr>
<tr>
<td>Graduate</td>
<td>35</td>
<td>7</td>
</tr>
<tr>
<td><strong>Major:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Art</td>
<td>31</td>
<td>6</td>
</tr>
<tr>
<td>Science</td>
<td>89</td>
<td>18</td>
</tr>
<tr>
<td>Business</td>
<td>105</td>
<td>21</td>
</tr>
<tr>
<td>Education</td>
<td>137</td>
<td>28</td>
</tr>
<tr>
<td>Mathematics</td>
<td>69</td>
<td>14</td>
</tr>
<tr>
<td>Other</td>
<td>61</td>
<td>12</td>
</tr>
<tr>
<td><strong>Grade point average:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 2.5</td>
<td>150</td>
<td>31</td>
</tr>
<tr>
<td>2.5 to 3.0</td>
<td>285</td>
<td>58</td>
</tr>
<tr>
<td>Greater than 3.0</td>
<td>56</td>
<td>11</td>
</tr>
<tr>
<td>Not shown</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>492</td>
<td>100</td>
</tr>
</tbody>
</table>
percent had other majors. (4) The number of students with grade-point-averages of less than 2.5 equaled 31 percent, while 58 percent had grade-point-averages ranging from 2.5 to 3.0. A fraction of 11 percent had grade-point-average greater than 3.0.

**Instrumentation**

The nature of the problem suggested the need for an instrument to be developed or located that would assess both cognitive and effective dimensions dealing with computers. A review of literature confirmed the assumption that the perception of what computer literacy should be varies from expert to expert. However, the basis for the position on computer literacy chosen in this study was developed by the Minnesota Educational Computing Consortium (MECC--at present, The Minnesota Educational Computing Company). It has gained acceptance by the academic community and was also quantifiable.

This study maintained the MECC objectives with minor modifications from the original study. The objectives selected were representative of both the effective and cognitive dimensions and could be considered applicable to situations encountered by students at Thai public universities.
Construction of Survey Instrument

The development of the survey employed in this study included the following procedures: (1) the identification of a panel of experts to verify face and content validity of the objectives, (2) the construction and content validation of a survey prototype, and (3) pilot testing to determine instrument reliability.

Validation of Objectives

The objective and related items used in this study were derived from the MECC study. While they had been verified by a nationally recognized panel of experts, a need was felt to validate the objectives and items in the context of the purposes of this study with regard to the Thai computer curricula and Thai students. Therefore, to verify that the items chosen were representative of the various domains of computer literacy, a panel of three experts was identified and asked to review the selected objectives. The panel's suggestions and recommendations are reflected in the modified objectives and the items used in this study.

Construction of Survey Prototype

The first part of the instrument used in this study contained items designed to collect information about students' attitudes toward computers. The areas assessed were computer usage experience, students' feeling of control
(efficacy), and educational support. These areas were represented by twenty-nine items.

The cognitive assessment dealt with students' knowledge about computer hardware, software and data processing, computer applications, social impact of the computer, and computer programming. Items which assessed these areas were either selected from the MECC instrument, modified from the MECC instrument, or designed to match selected objectives. All items were selected, modified and designed, based on information gathered from the review of Thai public universities' computer curricula, with Thai students in mind.

The prototype survey was reviewed by the panel of experts to verify content and face validity. Panel members were asked to review and rate all items based on appropriateness and degree of alignment with respective objectives. Items which were rated as being poor were rewritten or replaced until the instrument was reviewed by the panel as being satisfactory. This process produced an instrument that contained a total of fifty-eight items: twenty-nine attitude items and twenty-nine knowledge items. All items were presented in a multiple choice format with five alternatives for each item. The response choices for the attitudinal part were given the following weights: SD = strongly disagree, D = Disagree, U = Undecided, A = Agree, and SA = strongly agree.
In addition to the attitude and knowledge questions, six demographic items were included at the beginning of the instrument. They included items on sex, age, educational level, major, grade-points average, and name of institution the students attended. The English version of the questionnaire was translated to a Thai version by the researcher. The content of the questionnaire was then reviewed by a panel of three experts. The instrument was then revised.

Pilot Test

The pilot test of the questionnaire was conducted to obtain psychometric information of the instrument. The reliability of the instrument was determined using a sample of thirty students from various universities with different demographic information in Thailand. The students were asked to respond to the items on the instrument. The attitude items were coded and the cognitive items were checked for correct responses. Using the KR-20 method (Borg and Gall 1979; Lord and Novick 1968), the computer literacy subtest was found to have a reliability coefficient of 0.812. For the attitude subtest, the alpha reliability was calculated (Lord and Novick 1968). It was found to have coefficient alpha of 0.957, which was well within an acceptable limit and, therefore, suitable for use in this study.
The validity of each item in the attitudinal scales was also determined. According to Edwards (1957), the method of summated ratings using item analysis procedure was employed. The frequency distribution based upon the responses to all items was considered. The 25 percent of the subjects with the highest total scores and also the 25 percent of the subjects with the lowest total score were determined. These two groups are assumed to provide criterion groups in terms of which to evaluate the individual statements. An analysis using a t-test between the two groups was performed. The significant level was set at .05. The value of t is a measure of the extent to which a given statement differentiates between the high and low groups. Results of the t-test showed significant t-value are presented in Appendix A. Comments and information from the pilot group pertaining to ambiguities were also used to modify the instrument in order to produce the final version.

**Procedures for Analysis of Data**

Upon the return of the questionnaires, each was examined for stray marks and completeness. Any abnormalities were remedied and items coded. The effective items were coded using a one to five scale ("1" for extremely negative responses to "5" for extremely positive responses). The cognitive items were scored using a key, and the cognitive subtest and total scores were determined.
1. To determine the computer literacy levels among Thai students, the responses to the cognitive part of the questionnaires were scored and totals for the subtests were determined. The number of correct items for the computer subtest score was obtained by comparing the individual subject responses to a key. The item responses and the number which were correct for the subject and a total score constituted the raw score for each subject.

The statistical analysis required the use of standard descriptive statistics to report the levels of computer literacy. The mean and standard deviation for the subtests were determined for each subgroup, along with statistics for the total sample.

2. To compare literacy levels among the subjects in different groups, an analysis of variance (ANOVA) (Kirk 1982) was conducted to determine if any of the observed differences in the subgroup means were significant. A conclusion drawn was based on F-value with, a probability less than 5 percent (p < 0.05). If any significant differences were found while testing the hypothesis using one-way ANOVA, a Scheffé (Kirk 1982) test was employed to find the significant pairs. At this point the significant level was set at 0.05.

The Scheffé posteriori test was appropriate for this study because it permits the comparison between groups of unequal members and is more rigorous than some others.
3. To determine the attitudes toward computers of Thai university students, the responses to attitude subtests were coded and the total was determined. The statistical analysis required the use of standard descriptive statistics to report the attitude levels. The mean and standard deviation for each subgroup and the total sample are also reported.

4. To determine if significant differences in attitude toward computers exist among Thai public university students with different demographic classifications, a one-way analysis of variance (ANOVA) statistical procedure was employed. The significant level was set at 0.05. If the F-value was larger than that of the critical value set, the Scheffé posteriori test was conducted.

5. To determine the relationship between computer literacy levels and attitude towards computers among Thai public university students, Pearson Product Moment Correlation Procedure (Kirk 1982) was computed. The significant level was set at 0.05. Conclusions were based on degree of relationship between the respective variables.
CHAPTER IV

ANALYSIS OF DATA

This chapter contains the presentation and analysis of the data. Discussion and interpretation of data are also presented. The chapter consists of six sections: (1) computer literacy levels of Thai university students; (2) comparison of computer literacy levels among those with different demographic classifications; (3) attitudes of Thai university students toward computers; (4) comparison of attitudes toward computers among students with different demographic classifications; (5) relationship of computer literacy and attitude toward computers of Thai university students; and (6) summary of findings.

Analysis of Computer Literacy Levels

The purpose of this section is to present the levels of computer literacy of Thai public university students. The first research question is restated:

To what extent do Thai public university students express computer literacy, as measured by the modified form of the Minnesota Computer Literacy and Awareness Assessment?

Data in table 2 represent the total sample and different subgroups on measures of computer literacy.
### TABLE 2

**COMPUTER LITERACY LEVELS AMONG THAI PUBLIC UNIVERSITY STUDENTS**

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>180</td>
<td>20.25</td>
<td>4.41</td>
</tr>
<tr>
<td>Female</td>
<td>310</td>
<td>20.50</td>
<td>3.63</td>
</tr>
<tr>
<td><strong>Age group</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 years or less</td>
<td>355</td>
<td>20.45</td>
<td>3.88</td>
</tr>
<tr>
<td>21 to 25 years</td>
<td>93</td>
<td>19.91</td>
<td>4.28</td>
</tr>
<tr>
<td>26 to 30 years</td>
<td>25</td>
<td>21.28</td>
<td>2.92</td>
</tr>
<tr>
<td>31 to 35 years</td>
<td>13</td>
<td>19.69</td>
<td>4.84</td>
</tr>
<tr>
<td>36 years and over</td>
<td>6</td>
<td>22.00</td>
<td>2.82</td>
</tr>
<tr>
<td><strong>Educational Classifications</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freshman</td>
<td>306</td>
<td>20.02</td>
<td>3.91</td>
</tr>
<tr>
<td>Sophomore</td>
<td>82</td>
<td>20.40</td>
<td>3.56</td>
</tr>
<tr>
<td>Junior</td>
<td>53</td>
<td>19.76</td>
<td>3.76</td>
</tr>
<tr>
<td>Senior</td>
<td>16</td>
<td>19.94</td>
<td>2.54</td>
</tr>
<tr>
<td>Graduate</td>
<td>35</td>
<td>24.77</td>
<td>3.27</td>
</tr>
<tr>
<td><strong>Major</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Art</td>
<td>31</td>
<td>21.52</td>
<td>2.93</td>
</tr>
<tr>
<td>Science</td>
<td>89</td>
<td>19.11</td>
<td>4.44</td>
</tr>
<tr>
<td>Business</td>
<td>105</td>
<td>20.57</td>
<td>3.16</td>
</tr>
<tr>
<td>Education</td>
<td>137</td>
<td>21.28</td>
<td>3.36</td>
</tr>
<tr>
<td>Mathematics</td>
<td>69</td>
<td>18.97</td>
<td>5.50</td>
</tr>
<tr>
<td>Others</td>
<td>61</td>
<td>20.98</td>
<td>2.97</td>
</tr>
<tr>
<td><strong>GFA</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 2.5</td>
<td>150</td>
<td>16.95</td>
<td>4.60</td>
</tr>
<tr>
<td>2.5 to 3.0</td>
<td>285</td>
<td>21.33</td>
<td>1.78</td>
</tr>
<tr>
<td>Greater than 3.0</td>
<td>56</td>
<td>24.75</td>
<td>2.86</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>492</td>
<td>20.39</td>
<td>3.94</td>
</tr>
</tbody>
</table>

*one missing case*

The data revealed that the mean score for the total sample was 20.39 out of the total possibility of 29.00, with
the standard deviation of 3.94. Mean scores from different groups ranged from 16.95 for the group of students with GPAs less than 2.50 to 24.77 for the group of graduate students. Standard deviations ranged from 1.78 to 5.50.

Males and females tended to have very small differences on computer literacy. Among the age group variables, the majority of students, which were 20 years or younger, scored a moderate level of 20.45, whereas the smallest group, those who were 36 years and over, has a slightly higher score of 22.00. Even though freshman enrollment exceeded the number of students in other educational levels, they exhibited similar computer literacy levels. There was one outstanding case, however, graduate students had a highest mean score of 24.77, which accounts for about 85 percent of the total possibility. Students in all majors revealed slight differences in computer literacy levels when compared with the overall mean score of 20.39 and when compared among themselves. Surprisingly, mathematics majors showed a markedly low mean score of 18.97.

The computer literacy levels varied remarkably among the groups by GPA. Students with GPAs less than 2.50 had a low mean score of 16.95. In contrast, students who had GPAs greater than 3.00 had a high mean score of 24.75. The others tended to have computer literacy levels slightly different from the overall sample.
Comparison of Computer Literacy Levels

This section is a response to research question 2: Do significant differences in computer literacy levels exist among Thai public university students from various demographic classifications?

A statistical analysis focused on sex variable was performed to determine whether male and female students differ significantly in computer literacy levels. Data in Table 3 present the results of the t-test of differences between the means for male and female students. Males indicated a mean score of 20.25; females a indicated mean score of 20.52 ($t = 0.68, p = 0.05$).

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t</th>
<th>df</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>180</td>
<td>20.25</td>
<td>0.329</td>
<td>0.68</td>
<td>488</td>
<td>0.05</td>
</tr>
<tr>
<td>Female</td>
<td>310</td>
<td>20.50</td>
<td>0.206</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

While a higher proportion of females enrolled in computer classes, male and female students reported no significant difference in computer literacy levels.
The differences among students' computer literacy levels from various age groups were assessed through an analysis of variance. The results are shown in Table 4.

**TABLE 4**

**COMPARISON OF COMPUTER LITERACY LEVELS BASED ON COMPUTER LITERACY SUBTEST AMONG THAI UNIVERSITY STUDENTS BY AGE GROUP**

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>4</td>
<td>64.22</td>
<td>16.06</td>
<td>1.036</td>
<td>.39</td>
</tr>
<tr>
<td>Within groups</td>
<td>487</td>
<td>7549.02</td>
<td>15.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>491</td>
<td>7613.24</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data in Table 4 provide a comparison of computer literacy among students in different age groups. Analysis of variance for group means indicates that the differences among groups were not significant. (F (4, 487) = 1.036, p = ns.) There is no firm evidence to show that students from different age groups differed on computer literacy levels.

Further analysis attempted a comparison of mean scores for students' computer literacy levels by educational levels. As shown in Table 5, an analysis of variance was employed to determine significant differences among group means.
TABLE 5

COMPARISON OF COMPUTER LITERACY LEVELS BASED ON COMPUTER LITERACY SUBTEST AMONG THAI UNIVERSITY STUDENTS BY EDUCATIONAL LEVEL CLASSIFICATION

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>4</td>
<td>737.85</td>
<td>184.46</td>
<td>13.06</td>
<td>.01</td>
</tr>
<tr>
<td>Within groups</td>
<td>487</td>
<td>6875.42</td>
<td>14.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>491</td>
<td>7613.26</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The data in Table 5 result from an analysis of variance for group means. It is evident that there is a significant difference in mean score for students from different educational levels: freshmen, sophomores, juniors, seniors, and graduates, \((F(4, 487) = 13.06, p = .05)\).

A pairwise comparison using Scheffé method to determine which group contributed to the significant difference was performed. Data in Table 6 reveal the results of this posteriori test.

It is clear that graduate students scored higher than junior students, senior students, freshman students, and sophomore students, respectively. Significant differences emerged between groups of graduate students and junior
students; graduate students and senior students; graduate students and freshman students, and graduate students and sophomore students, at the significant levels of .05. No other significant pairs were found.

**TABLE 6**

PAIRWISE COMPARISON OF SAMPLE MEANS CONTRIBUTED BY THAI PUBLIC UNIVERSITY STUDENTS AT FIVE DIFFERENT EDUCATIONAL LEVEL CLASSIFICATIONS ON THE COMPUTER LITERACY LEVELS

<table>
<thead>
<tr>
<th>MEAN</th>
<th>GROUP</th>
<th>3</th>
<th>4</th>
<th>1</th>
<th>2</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.75</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.94</td>
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<td>4</td>
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</tr>
<tr>
<td>20.02</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.04</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.77</td>
<td></td>
<td>5</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

Group 1 = freshman, 2 = sophomore, 3 = junior, 4 = senior, 5 = graduate.

Differences in academic major may lead to differences in students' computer literacy levels. To determine the variation of group means, a comparison using an analysis of variance was conducted. The results are presented in Table 7.
The data suggested that significant differences occurred among group means for Thai public university students from various academic majors, \( F (5, 486) = 6.22, p = .05 \). This indicated that academic major is an important factor affecting differences in computer literacy levels among the groups. These groups include arts, science, business, education, mathematics, and others.

**TABLE 7**

COMPARISON OF COMPUTER LITERACY LEVELS BASED ON COMPUTER LITERACY SUBTEST AMONG THAI PUBLIC UNIVERSITY STUDENTS BY MAJOR

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>( F )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>5</td>
<td>458.17</td>
<td>91.64</td>
<td>6.22</td>
<td>.01</td>
</tr>
<tr>
<td>Within groups</td>
<td>486</td>
<td>7155.13</td>
<td>14.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>491</td>
<td>7613.30</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Subsequently, a pairwise comparison was performed to determine the significant pairs. Results of a pairwise comparison using Scheffé method for the six major groups regarding computer literacy levels are shown in Table 8. The significant differences appeared between education majors and mathematics majors. Education majors also
differed significantly from science majors. The results suggest that students with education majors have higher computer literacy level than do students with mathematics majors. Similarly, education students possess higher computer literacy levels than students with science majors at the significant level of .05. No other pairs showed significant differences.

**TABLE 8**

**PAIRWISE COMPARISON OF SAMPLE MEANS CONTRIBUTED BY THAI PUBLIC UNIVERSITY STUDENTS AT SIX DIFFERENT MAJOR GROUPS ON THE COMPUTER LITERACY LEVELS**

<table>
<thead>
<tr>
<th>MEAN</th>
<th>GROUP</th>
<th>5</th>
<th>2</th>
<th>3</th>
<th>6</th>
<th>4</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.97</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.11</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.57</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.98</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.28</td>
<td>4</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.52</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Group 1. art, 2. science, 3. business, 4. education, 5. mathematics, and 6. others.
The students' levels of academic performance may affect their computer literacy levels. An analysis of variance was conducted to determine a significant difference among group means for students with different grade-point-averages. Relevant statistical data are presented in Table 9.

**TABLE 9**

**COMPARISON OF COMPUTER LITERACY LEVELS BASED ON COMPUTER LITERACY SUBTEST AMONG THAI PUBLIC UNIVERSITY STUDENTS BY GRADE POINT AVERAGE**

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>2</td>
<td>30878.88</td>
<td>1543.94</td>
<td>167.28</td>
<td>.01</td>
</tr>
<tr>
<td>Within groups</td>
<td>488</td>
<td>4504.14</td>
<td>9.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>490</td>
<td>7592.02</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The results of an analysis of variance for students with different grade-points-averages groups regarding computer literacy levels. \( (F (2,488) = 167.28, \ p = .05) \), suggest a significant difference between mean scores of different groups.

A Scheffé pairwise comparison of group means represented in Table 10 resulted in significant differences among group means for computer literacy levels.
TABLE 10
PAIRWISE COMPARISON OF SAMPLE MEANS CONTRIBUTED BY THAI PUBLIC UNIVERSITY STUDENTS AT THREE DIFFERENT GRADE POINT AVERAGE GROUPS ON THE COMPUTER LITERACY LEVELS

<table>
<thead>
<tr>
<th>GROUP</th>
<th>MEAN</th>
<th>GROUP 1</th>
<th>GROUP 2</th>
<th>GROUP 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.95</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.33</td>
<td>2</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.75</td>
<td>3</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

Group 1: GPA less than 2.5, 2. GPA 2.5-3.0, 3. GPA greater than 3.00.

Students with GPAs greater than 3.0 have higher computer literacy levels than students with GPAs from 2.50 to 3.00 and those with GPAs less than 2.50, respectively. Students who have GPAs greater than 3.00 are higher in computer literacy levels than students in the group with GPAs between 2.5 and 3.00, at the .05 significant level. No significant differences between students with GPAs less than 2.50 and those with GPAs 2.5 to 3.0 was found.

Analysis of Attitudes Toward Computers

This section reports the analysis of attitudes toward computers by Thai public university students in response for research question 3: To what extent do Thai public
university students express attitudes toward computers as measured by an attitude subtest? Relevant descriptive statistics for the total sample and different subgroups regarding the attitudes toward computers are shown in Table 11.

It is clear that all students exhibit affective reactions toward computers. The data indicate that the mean score for the total sample was 87.86, with a standard deviation of 19.12. The group with GPAs of less than 2.50 exhibited the lowest mean score of 72.34, while graduate students showed the highest mean score of 113.03. Standard deviation ranged from 10.90 to 24.96. Males and females tended to have positive attitudes toward computers and differences between them were minimal. They also indicate a similar mean score of attitudes to that of the overall sample. The majority of students, 20 years or younger, illustrate a slightly higher group mean than the overall sample mean. The groups which was 21 to 25 year old and 31 to 35 years old showed the smaller mean scores than the average, while the group of 26 to 30 years old and the group which was 36 years and over indicated much more positive attitudes toward computer.

Graduate students presented the highest mean scores. This suggests that graduate students have a strong positive feeling toward computers. Despite a large enrollment, students from the freshman level revealed a slightly lower
TABLE 11
ATTITUDES TOWARD COMPUTERS OF THAI PUBLIC UNIVERSITY STUDENTS

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>MEAN</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>180</td>
<td>87.97</td>
<td>21.28</td>
</tr>
<tr>
<td>Female</td>
<td>310</td>
<td>87.88</td>
<td>17.76</td>
</tr>
<tr>
<td><strong>Age group</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 years or less</td>
<td>355</td>
<td>88.01</td>
<td>18.88</td>
</tr>
<tr>
<td>21 to 25 years</td>
<td>93</td>
<td>85.90</td>
<td>19.99</td>
</tr>
<tr>
<td>26 to 30 years</td>
<td>25</td>
<td>92.64</td>
<td>16.20</td>
</tr>
<tr>
<td>31 to 35 years</td>
<td>13</td>
<td>84.76</td>
<td>24.96</td>
</tr>
<tr>
<td>36 years and over</td>
<td>6</td>
<td>96.16</td>
<td>15.50</td>
</tr>
<tr>
<td><strong>Educational classifications</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freshman</td>
<td>306</td>
<td>85.84</td>
<td>18.13</td>
</tr>
<tr>
<td>Sophomore</td>
<td>82</td>
<td>87.11</td>
<td>17.96</td>
</tr>
<tr>
<td>Junior</td>
<td>53</td>
<td>84.51</td>
<td>17.00</td>
</tr>
<tr>
<td>Senior</td>
<td>16</td>
<td>86.50</td>
<td>12.14</td>
</tr>
<tr>
<td>Graduate</td>
<td>35</td>
<td>113.03</td>
<td>18.61</td>
</tr>
<tr>
<td><strong>Major</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Art</td>
<td>31</td>
<td>92.00</td>
<td>17.87</td>
</tr>
<tr>
<td>Sciences</td>
<td>89</td>
<td>82.72</td>
<td>20.95</td>
</tr>
<tr>
<td>Business</td>
<td>105</td>
<td>88.62</td>
<td>16.42</td>
</tr>
<tr>
<td>Education</td>
<td>137</td>
<td>91.61</td>
<td>17.54</td>
</tr>
<tr>
<td>Mathematics</td>
<td>69</td>
<td>82.35</td>
<td>23.55</td>
</tr>
<tr>
<td>Others</td>
<td>61</td>
<td>89.80</td>
<td>16.50</td>
</tr>
<tr>
<td><strong>GPA</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 2.50</td>
<td>150</td>
<td>72.34</td>
<td>18.91</td>
</tr>
<tr>
<td>2.50 to 3.00</td>
<td>285</td>
<td>91.07</td>
<td>10.90</td>
</tr>
<tr>
<td>Greater than 3.00</td>
<td>56</td>
<td>112.63</td>
<td>18.21</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>492</td>
<td>87.86</td>
<td>19.12</td>
</tr>
</tbody>
</table>

*1 missing case

The mean score of 85.84 and junior students showed a much lower
mean score than average.

Students who were mathematics majors and science majors showed a surprisingly low mean score of around 82.00, while all other majors exhibited higher mean scores. This shows that mathematics and science majors have less positive attitudes toward computers.

A contrast was found among students with different academic performance (GPA). A mean score of 112.63 shows that students who have GPAs of greater than 3.0 are more positive while those who have GPA less than 2.5 seem to have the least favorable attitudes toward computers.

Comparison of Attitudes Toward Computers

This section is an attempt to answer research question 4: Do significant differences in attitude toward computers exist among Thai public university students from various demographic classifications?

To determine whether differences in students' attitudes toward computers were affected by gender, a t-test was employed.

The results of the t-test for attitudes toward computers of Thai public university students by gender are shown in Table 12. No significant difference was found, \( t (489) = .05, p = \text{ns} \). Males and females exhibited similar attitudes toward computers.
**TABLE 12**

COMPARISON OF ATTITUDES TOWARD COMPUTERS BASED ON ATTITUDE SUBTEST AMONG THAI PUBLIC UNIVERSITY STUDENTS BY SEX USING T-TEST

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>180</td>
<td>87.97</td>
<td>21.28</td>
<td>.05</td>
<td>488</td>
<td>.962</td>
</tr>
<tr>
<td>Female</td>
<td>310</td>
<td>87.89</td>
<td>17.76</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Beside gender variable, age groups variable was also a focus of an analysis. Differences in students' attitudes toward computers were assessed through analysis of variance. The results are illustrated in Table 13.

**TABLE 13**

COMPARISON OF ATTITUDES TOWARD COMPUTERS BASED ON ATTITUDE SUBTEST AMONG THAI PUBLIC UNIVERSITY STUDENTS BY AGE GROUP USING ONE-WAY ANOVA

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>4</td>
<td>1474.17</td>
<td>368.54</td>
<td>1.00</td>
<td>.4025</td>
</tr>
<tr>
<td>Within groups</td>
<td>487</td>
<td>177961.94</td>
<td>365.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>491</td>
<td>179436.09</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Data in Table 13 present the results of an analysis of variance for attitudes toward computers of Thai students in different age groups. The data revealed that differences among age groups were not significant. \((F (4, 487) = 1.00, \ p = \text{ns.})\) In other words, students in different age groups showed similar attitudes toward computers.

Table 14 contains a comparison of attitudes toward computers of Thai public university students from different educational classifications. Analysis of variance for group means (with \(F (4, 487) = 18.88, \ p = .05\)) showed a significant difference among group means. Students of different educational levels exhibited different attitudes toward computers.

TABLE 14

COMPARISON OF ATTITUDES TOWARD COMPUTERS BASED ON ATTITUDE SUBTEST AMONG THAI PUBLIC UNIVERSITY STUDENTS BY EDUCATIONAL LEVEL CLASSIFICATIONS

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>4</td>
<td>24090.74</td>
<td>6022.69</td>
<td>18.88</td>
<td>0.01</td>
</tr>
<tr>
<td>Within groups</td>
<td>487</td>
<td>155345.85</td>
<td>318.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>491</td>
<td>179436.59</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A pairwise comparison was employed to determine which pairs differed significantly. The results of Scheffé analysis shown in Table 15 indicate that graduate students exhibited more positive attitudes toward computers than students in all other educational levels. No other significant difference was found. Students in freshman, sophomore, junior, and senior levels presented similar attitudes toward computers.

**TABLE 15**

PAIRWISE COMPARISON OF SAMPLE MEANS CONTRIBUTED BY THAI PUBLIC UNIVERSITY STUDENTS AT FIVE DIFFERENT EDUCATIONAL LEVEL CLASSIFICATIONS ON THE ATTITUDE TOWARD COMPUTERS

<table>
<thead>
<tr>
<th>MEAN</th>
<th>GROUP</th>
<th>3</th>
<th>1</th>
<th>4</th>
<th>2</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>84.51</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>85.84</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>86.50</td>
<td></td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>87.11</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>113.03</td>
<td></td>
<td>5</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

Group 1 = freshman, 2 = sophomore, 3 = junior, 4 = senior, 5 = graduate.
Variation in academic interests can be a factor affecting students' attitudes toward computers. A comparison of mean scores was conducted to determine whether differences among group means exist.

Results of an analysis of variance for attitudes toward computers of Thai public university students of different academic majors is presented in Table 16. The results showed a significant difference among group means. (F (5, 486) = 4.06, p = .05.)

### Table 16

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>5</td>
<td>7193.38</td>
<td>1438.68</td>
<td>4.06</td>
<td>.0013</td>
</tr>
<tr>
<td>Within groups</td>
<td>486</td>
<td>172244.05</td>
<td>354.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>491</td>
<td>179437.41</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A Scheffé range test was performed to determine the pairs with significant differences.

Review of Table 17 reveals that students in education majors had more positive attitudes toward computers than
those of science majors. The students who were art majors also exhibited more positive attitudes toward computers than students from science majors at the significant level of 0.05. No other significant difference was found.

**TABLE 17**

PAIRWISE COMPARISON OF SAMPLE MEANS CONTRIBUTED BY THAI PUBLIC UNIVERSITY STUDENTS AT SIX DIFFERENT MAJORS ON THE ATTITUDES TOWARD COMPUTERS

<table>
<thead>
<tr>
<th>MEAN</th>
<th>GROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td>82.35</td>
<td>5</td>
</tr>
<tr>
<td>82.72</td>
<td>2</td>
</tr>
<tr>
<td>88.62</td>
<td>3</td>
</tr>
<tr>
<td>89.80</td>
<td>6</td>
</tr>
<tr>
<td>91.61</td>
<td>4</td>
</tr>
<tr>
<td>92.00</td>
<td>1</td>
</tr>
</tbody>
</table>

Group 1 = art major, 2 = science, 3 = business, 4 = education, 5 = mathematics, and 6 = others.

An analysis focused on the influence of students' academic performance on their attitudes toward computers was conducted. An analysis of variance was used to assess the differences among group means as shown in Table 18.
### Table 18

Comparison of Attitudes toward Computers Based on Attitude Subtest Among Thai Public University Students by Grade Point Average Groups

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>2</td>
<td>73411.84</td>
<td>36705.91</td>
<td>170.22</td>
<td>.01</td>
</tr>
<tr>
<td>Within groups</td>
<td>488</td>
<td>105232.67</td>
<td>215.64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>490</td>
<td>178644.50</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The data show the results of an analysis of variance for attitudes toward computers of Thai public students with different grade-point-averages. It is clear that there is a significant difference among mean scores from different groups. \((F (2, 488) = 170.22, p = .05)\)

Further analysis using the Scheffé test in an attempt to determine the pairs of significant differences are displayed in Table 19.

The pairwise comparison reflected the significant differences among means. Students who had GPAs greater than 3.00 were more positive toward computer than students with GPA rankings from 2.50 to 3.00, and those with GPAs of less than 2.50. Similarly, students from the group with GPAs of 2.50 to 3.00 had more positive attitudes toward computers.
than students from the group with GPAs of less than 2.50, at the significant level of .05.

**TABLE 19**

PAIRWISE COMPARISON OF SAMPLE MEANS CONTRIBUTED BY THAI PUBLIC UNIVERSITY STUDENTS AT THREE DIFFERENT GRADE-POINT-AVERAGE GROUPS ON ATTITUDES TOWARD COMPUTERS (SHEFFÉ RANGE TEST)

<table>
<thead>
<tr>
<th>GROUP</th>
<th>MEAN</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>72.34</td>
<td>1</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>91.07</td>
<td>2</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>112.63</td>
<td>3</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

**Relationship of Computer Literacy and Attitudes Toward Computers of Thai Students**

This section is a response to the question pertaining to the relationship of computer literacy and attitudes toward computers of Thai public university students. This was accomplished through the use of Pearson Correlation procedure based on the total sample and on all the subgroups.

The data indicate a positive relationship between students, knowledge and attitudes toward computers. The
computer literacy and attitudes toward computers variables are positively correlated with an $r = 0.9218$ ($p = .05$) which is considered a strong relationship.

The Pearson product-moment correlation between computer literacy levels and attitudes in different groups toward computers of Thai university students is presented in Table 20.

The Correlation coefficients ranged from .8371 ($p = .05$) to .9636 ($p = .05$). These results show strong positive relationships between computer literacy levels and attitudes toward computers in all subgroups. This suggests that if students know about computers they are likely to have good attitudes toward computers. On the other hand, if students had good attitudes toward computers they would likely know more about them.

Some of the highest correlations found were in the group of students who were 31 to 35 years of age; $r = .9636$ ($p = .05$), and the group of junior students; $r = .9529$ ($p = .05$). When compared within the subgroups, males exhibited a slightly more positive relationship ($r = .9296$) than females ($r = .9155$). Students who were 31 to 35 years of age showed the highest positive relationship ($r = .9636$) while students who were 26 to 30 years of age showed the lowest positive relationships ($r = .8762$) among the age groups. Graduates and junior exhibited higher correlations ($r = .9566, .9529$)
<table>
<thead>
<tr>
<th>Variables</th>
<th>Correlation Coefficient (r)</th>
<th>N</th>
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than those of senior and sophomore students ($r = .8779$, .8888). However, the relationships are still considered strong.

**Summary**

The following major findings are based on the information and knowledge gained from the study:

1. The average score for computer literacy for the total sample was 20.39 out of a possible 29.00, which is 69.62 percent of the total score.

2. While a higher proportion of female students enrolled in computer classes, male and female students reported no significant difference in computer literacy levels.

3. In general, there was no evidence to suggest that major differences in computer literacy levels existed among students from various age groups.

4. Graduates students had higher levels of computer literacy than did other students from different educational levels.

5. Students with education majors displayed higher computer literacy levels than mathematics majors students and science majors.

6. Students with GPAs higher than 3.00 exhibited higher computer literacy levels than students with GPAs of 2.50–3.00 and those with GPAs less than 2.50 respectively.
7. Mean scores for attitudes toward computers of the total sample of Thai university students was 87.86. Graduate students exhibited more positive attitudes toward computers than all other groups, while the group of students with GPAs of less than 2.50 displayed the lowest positive attitudes toward computers.

8. Males and females showed positive attitudes toward computers, with no significant difference between males and females.

9. Students from different age groups showed positive attitudes toward computers with no significant differences among the groups.

10. Graduate students exhibited more positive attitudes toward computers than students of all other educational classifications.

11. Students from education majors and art majors had more positive attitudes toward computers than students with science majors.

12. Students with GPAs greater than 3.00 had more positive attitudes toward computers than students with GPAs ranging from 2.50 to 3.00, and those with GPAs of less than 2.50.

13. There was a positive relationship between students' knowledge and their attitudes toward computers. The computer literacy and attitudes toward computers variables were positively correlated with an $r = .9218$ ($p = .05$).
14. The correlation coefficient for computer literacy levels and attitudes toward computers ranged from .8371 to .9636 (p = .05). These results show strong positive relationship between computer literacy levels and attitudes toward computers in all subgroups.

15. Some of the highest correlations found were within the group of students who were 31 to 35 years old (r = .9636), and the group of junior students (r = .9529) at the significant level of .05.
CHAPTER V

SUMMARY, DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

This chapter culminates in an effort to assess computer literacy and attitudes toward computers of Thai public university students. It includes a summary of the purposes, methodology and procedure followed by discussion of major findings. The conclusions and recommendations are also presented based on the knowledge and insights gained from an examination of the findings from this study.

Summary

The purpose of this study was to investigate and analyze computer literacy and general attitudes toward computers of students at Thai public universities. The comparative study of computer literacy levels and attitudes toward computers among Thai students with various demographic classifications was performed followed by the study of relationships between the two variables among the samples. An attempt was made to develop a suggestion for computer literacy programs for Thai public universities based on the information collected and analyzed in this study combined with documentation analysis.
Previously cited studies have questioned whether a significant difference in computer literacy levels between Thai public university students with different demographic classification exists. The literature recommends a closer look at differences in attitudes toward computers among males and females and other groups with different demographic classifications. The literature also emphasizes the importance of the relationships between computer literacy and attitudes toward computers.

With these considerations in mind, this study was designed to investigate computer literacy and attitudes toward computers of a sample of students randomly selected from a group of students who took at least one computer course from thirteen public universities in Thailand. A survey instrument was adapted from Computer Literacy Questionnaire (CLQ) developed by researchers at MECC (Anderson 1979). It was translated into the Thai language and used in pilot study. The questionnaire was administered to the 492 students who participated in this study.

Three main categories of data were collected:

1. Student background and demographic data such as sex, age, educational level, major, and grade-point-average.

2. Computer literacy—a twenty-nine-item questionnaire include knowledge about computers and the use of computers in classroom settings;
3 Students' attitudes toward computers—a twenty-nine-item questionnaire include an interest in computers, perceived skills with computers, and degree of comfort when working with computers.

Basic descriptive statistics were used to analyze, describe, and summarize computer literacy levels and attitudes toward computers. A t-test was employed to determine differences between the groups by sex, and a one way analysis of variance procedure was performed to test the significant differences among mean scores from different groups according to age, major, educational level, and GPA. A Pearson Product-Moment Correlation Procedure was also used to determine the relationship between computer literacy levels and attitudes toward computers of Thai public university students.

The following major findings are based on the information and knowledge gained from the study:

1. The average score for computer literacy for the total sample was 20.39 out of a possible 29.00, which is 69.62 percent of the total score.

2. While a higher proportion of female students enrolled in computer classes, male and female students reported no significant difference in computer literacy levels.
3. In general, there was no evidence to suggest that major differences in computer literacy levels existed among students from various age groups.

4. Graduates students had higher levels of computer literacy than did other students from different educational levels.

5. Students with education majors displayed higher computer literacy levels than mathematics majors and science majors students.

6. Students with GPAs higher than 3.00 exhibited higher computer literacy levels than students with GPAs of 2.50-3.00 and those with GPAs of less than 2.50 respectively.

7. Mean scores for attitudes toward computers of the total sample of Thai university students was 87.86. Graduate students exhibited more positive attitudes toward computers than all other groups, while the group of students with GPAs of less than 2.50 displayed the lowest positive attitudes toward computers.

8. Males and females showed positive attitudes toward computers, with no significant difference between males and females.

9. Students from different age groups showed positive attitudes toward computers with no significant differences among the groups.
10. Graduate students exhibited more positive attitudes toward computers than students of all other educational classifications.

11. Students from education majors and art majors had more positive attitudes toward computers than students with science majors.

12. Students with GPAs greater than 3.00 had more positive attitudes toward computers than students with GPAs ranging from 2.50 to 3.00, and those with GPAs of less than 2.50.

13. There was a positive relationship between students' knowledge and their attitudes toward computers. The computer literacy and attitudes toward computers variables were positively correlated with an $r = .9218$ ($p = .05$).

14. The correlation coefficient for computer literacy levels and attitudes toward computers ranged from .8371 to .9636 ($p = .05$). These results show strong positive relationships between computer literacy levels and attitudes toward computers in all subgroups.

15. Some of the highest correlations found were within the group of students who were 31 to 35 years old. ($r = .9636$), and the group of junior students ($r = .9529$) at the significant level of .05.
Discussion

The healthy growth of science and technology of any country critically depends on the availability of technically and scientifically trained manpower. It is the responsibility of the indigenous educational system to provide such manpower.

The emergence of technology as a component of general education has been observed. It is clear that many countries have embarked upon efforts to introduce technology into the basic curriculum for all students. Each country develops its technology education using a different approach based on its domestic assessment. In Thailand, it has been recognized that science and technology education are important contributors to the nation's development. Various attempts have been made to encourage schools, colleges, and universities to provide students with a high quality technological education.

The field of educational computing in Thailand is so young that relatively little published research can be found. Even in the United States, which is a highly developed information-based country, very few research studies have been done to assess how schools and colleges use computers for instruction. However, computer literacy has been a concern of the public for decades.
Widely diverse opinions exist on the meaning of computer literacy, but the dominant educational ideology is that every student needs to be computer literate in order to function productively. Attempting to respond to this need, courses and programs are being developed from preschool through graduate levels, and a large amount of more research is being conducted in this area.

From this study, it was found that Thai university students exhibited moderate computer literacy levels; however, this result cannot be contrasted with students in the United States because of students' vastly different backgrounds.

Gender differences in computer education have received considerable attention. A statewide assessment by Anderson and others (1982) and an experiment by Lockheed, Neilsen and Stone (1983) reported that young women in secondary schools were less likely than young men to spend time with computers and to enroll in computer classes. A portion of this difference between males and females results from cultural socialization and some structural factors in school that inhibit females from taking advantage of computer opportunities (Demetrialias et al. 1985, Granstam 1988, Linn 1985).

Contrary to earlier findings, this study suggests that the number of females enrolled in computer literacy classes
was greater than males, and no evidence was found that the two genders were significantly different in computer literacy levels.

In general, students from various age groups were not different in computer literacy levels. This indicates that computer literacy is not age-dependent.

Data from this study suggested that graduate students possessed higher computer literacy levels than did students from other educational levels. A chief source of this difference might be a greater willingness or interest in computer education to motivate anticipation in computer experiences.

A striking finding is that education majors displayed higher computer literacy levels than did mathematics and science majors. It is possible that education majors value computer education more than any other group of students because most education majors take some teaching jobs after graduation. Education majors were more likely to believe that skills with computers were a source of respect from students, peers, and parents. They also realized that the capability of using computers could enable them to highlight the subject-matter content in their classrooms.

Levels of academic achievement is one of the factors effecting computer literacy levels. Generally, students with higher GPAs also had higher computer literacy levels.
In other words, students who performed well in all other subject-matter performed well in computer classes. Self-confidence may be a plausible explanation for the differences.

Further analyses were attempted in order to determine attitudes toward computers. Overall, males and females showed positive attitudes toward computers. However, differences were not significant among the two groups. This finding is not consistent with some studies conducted in the United States. A factor analysis study by Chen (1986) reported that males exhibited more positive attitudes toward computers. Controlling for amount of experience, however, differences were not found in levels of interest in computers among males and females with similar amounts of exposure to computer technology. Males, especially those with the most experience, continued to report greater confidence and less anxiety with computers than females with similar experience. His study was supported by Wallace (1988) who also concluded that experience with computers resulted in more positive attitudes regarding computer technology.

This study also suggested that graduate students exhibited more positive attitudes toward computers than students from other groups. Similarly, students with education majors had more positive attitudes toward
computers than students with science majors. It is possible that utility of the computers in the classes provides a more direct avenue to encouraging computer interests than class with a more technical emphasis.

The overall relationships between computer literacy levels and attitudes toward computers revealed strong positive relationships between the two variables. While causality cannot be determined, it is noted that if students know how to use computers they are likely to have positive attitudes toward computers, and vice versa.

Conclusions

The purpose of this study was to investigate and analyze computer literacy and general attitudes toward computers of students at Thai public universities. The comparative study of computer literacy levels and attitudes toward computers among Thai students with various demographic classification was performed followed by the study of relationships between the two variables among the samples.

A fifty-eight-item questionnaire was adapted from the computer computer literacy questionnaire developed by the researchers at the Minnesota Educational Computing Consortium. The items were designed to assess knowledge and attitudes relative to computers. The questionnaire was administered to a random sample of 492 students who took at
least one computer course from thirteen public universities in Thailand.

Statistical tests used to analyze the data included t-test, one-way analysis of variance, and Pearson product moment correlations.

Based on the research findings, Thai university students exhibited a moderate computer literacy level. Although computer education has been taught in Thailand for longer than two years, there are still some more areas that needed to be developed and improved. Since freshman and sophomore students added up to the largest total of students enrolled in computer classes, more attention should be put when designing or developing computer literacy program.

While more female students enrolled in computer classes than male students, their computer literacy levels appeared similar. This showed that female students had as much interest in computer education.

Educational levels, academic major, and academic performance (GPAs) had some influence on computer literacy but not age variable. Graduate students showed a higher levels of computer literacy than any other students in various educational levels. It is noted that education majors displayed higher computer literacy levels than mathematics majors and science majors students. This finding suggested that education majors placed more emphasis
on computer education so that it might enable them to gain respect from students, peers, and parents and at the same time they can use computers as tools to convey and to highlight the subject matter content in the classrooms.

Generally, Thai university students expressed positive attitudes toward computer with graduate students showed more positive attitudes toward computer than all other groups. Similarly, students with education majors were more positive toward computers. It is possible that experiences gained through utility of the computers in the classes had encouraged computer interest among the students.

A strong relationship between computer knowledge and attitudes toward computer has been found. This suggested that there was a strong bond between what students knew and how students felt about computers. Increasing attention has been placed on instructional applications of computers. Deeper understanding and better theories about how students think and learn in complex problem-solving situations are needed. The use of computers in teaching all subject matters provides a better basis for those who will face the exciting and rapid change of tomorrow's world, and at the same time generate new phenomena and issues. This creates new questions about how to evaluate students' progress and how to diagnose their individual needs for learning.

Attempts to integrate technology into the curriculum will
have limited benefits unless curricula are reassessed and modified. New methods of evaluating the characteristics of computers and their effects on the learning process also need to be developed. However, there is no curriculum change, no rearrangement of topics, no sophisticated computer-based learning system, that will suddenly start educating students for change, awareness, individuality, and adventure. Technology should not be a curriculum in itself but should instead be integrated into the curriculum and instructional structure that addresses both old and new concerns. In the end it all depends on those who put new ideas into practice.

**Recommendations**

The following recommendations are based on the insights and experiences gained through all the events that accompany a study of this nature. More questions have been raised than were answered. These questions have resulted in the following recommendations and suggestions for further study.

**Operational Recommendations**

1. Since universities are a prime source for the immediate work force of the society, and the data presented indicate a great deal of support for the inclusion of computer literacy courses in all university levels, it is recommended that universities reassess programs of study in
order to provide for the growing use of computers in education.

2. The review of literature support the idea that educational use of computers will continue to grow, especially the use of computers as tools to aid teaching and learning. The problem for most universities will be how to respond to this growth. The recommendation is made that many different models of classroom environments and teacher roles need to be experimented with in order to gain enough information for creating and assessing these approaches. Long-term projects are needed to design, develop, and evaluate computer applications in education.

3. More attention should be placed on computers for undergraduate students at all levels. Students should be encouraged to gain more computer experience.

4. Even though the data revealed moderate levels of computer literacy among Thai university students, there is still more room to grow. Hands-on experience should be considered when determining the teaching methods.

5. Based on this study, a strong relationship between computer literacy levels and attitudes toward computers has been found. Since technology in education is always in a climate of change, the emphasis should be placed on attitudes. Methods should be developed to assist students to learn how to learn and then relearn, and enjoy doing it.
Students should be encouraged to think, to adapt and to improvise in a scientific way rather than to be exhaustively familiar with one narrow field.

6. New subjects are now being introduced at university levels in Thailand. This means that greater numbers of teachers are needed. The training of teachers to adapt to the new situations that are arising will probably have the most important contribution to shape the future. Not only are radically new approaches to basic training needed, but also more or less continuous inservice training.

7. From the documentation review and information gained from this study, the following steps are suggested to assist designing and developing a model computer literacy program: (1) systematic reassessment of curriculum content and methods; (2) formulating problems, discussing problems with others; (3) locating sources of information related to the problem defined; (4) developing algorithmic methods, selecting or modifying procedures to solve the problems; (5) collecting data and/or using available data and analytic tools in solving problems; (6) estimating whether solutions are reasonable; (7) iterating and refining the process; (8) designing and developing evaluation methods; (9) collaborating with others in all processes and communicating with others; and (10) implementing solutions and evaluations in both formative and summative manners.
In addition to the previous steps, these suggestions should be considered:

Computer education should be viewed in relation to its contribution to the educational process as a whole.

Computer education should be relevant to the local environment, work, individuals, and community needs as well as development of positive attitudes toward manual work and skills.

It is interesting that science and mathematics majors possess medium levels of computer literacy and positive attitudes toward computers. In applying computers in education, the interaction of science, mathematics and computers should be emphasized.

The development of skills related to decision-making, problem-solving, design, and fabrication should form an integral part of computer education.

Recommendations for Further Study

The following recommendations for further study are based on the findings, unanticipated questions and unforeseen events experienced in this study:

1. This study focused on public university students in a classroom environment. The teacher is also a very important element and a study designed to assess teacher's computer literacy and attitudes toward computers would provide for an interesting investigation. The information
gained from such a study could aid in preventing misconceptions that often come with the influx of new technology. A study could be designed to provide feedback that can be used as a guideline for designing training for teachers.

2. What skills, knowledge and values are needed in the information age, both within and between disciplines is another question that has arisen. Technology in education changes so rapidly that, in order to make the best benefit from technology, curricula need to be reassessed and modified. Recommendation is made that some research in this area needs to be conducted periodically.

3. Evaluation is an important process in teaching and learning. The curricula reassessment will create a new phenomena which will call for a new method of evaluating students' progress, diagnosing individual needs, and evaluating computer-based learning. The norm-based, paper-and-pencil test with multiple choice answers needs to be reassessed in the light of emerging process-oriented goals in education. Alternative evaluation methods and instruments need to be explored and experimented with.

4. Ethical values are among the issues arising in computer-based education. It is imperative that students should be taught the ethical, legal, moral, and social aspects of computer use. More research is needed in
understanding social issues involved in the use of computers.

5. In this time of rapidly changing technology, there is a discrepancy in the capabilities of the available machines. Research and development are needed on software support for collaboration in the educational environment.
APPENDIX A

VALIDITY OF ATTITUDE SCALES
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University of North Texas

June 5, 1988

Dear Student:

I would appreciate your help by having you answer the questions in booklet. There are three parts: the first part asks general information about you and your institution, the second part asks for your opinions and attitudes and the third part is a test of your knowledge about computers. Keep in mind that in the second part (the attitudes questions) there are no right and wrong answers; just select the answer that best expresses how you feel. In the third part (the computer knowledge test) there may be items you have not yet learned. Just answer as many as you can. Keep in mind that the right answer is your best choice for each question. Your responses will remain in confidence and only group statistics will be used in the study. I will be glad to share the results of the research upon request.

Sincerely yours,

Jatuvan M. Skulkhu
PART 1

DIRECTIONS:
Please respond to each item by checking the appropriate alternative that best describes or applies to you.

1. Your sex:
   ______ (a) Male
   ______ (b) Female

2. Your age:
   ______ (a) 20 years or less
   ______ (b) 21 to 25 years
   ______ (c) 26 to 30 years
   ______ (d) 31 to 35 years
   ______ (e) 36 and over

3. Your classification:
   ______ (a) Freshman
   ______ (b) Sophomore
   ______ (c) Junior
   ______ (d) Senior
   ______ (e) Graduate

4. Your major:
   ______ (a) Art
   ______ (b) Science
   ______ (c) Business
   ______ (d) Education
   ______ (e) Mathematics
   ______ (f) Other (please specify)

5. Your grade-point average:
   ______ (a) less than 2.5
   ______ (b) 2.6 to 3.0
   ______ (c) greater than 3.0

6. Name of your institution
   ____________________________
PART 2

DIRECTIONS:

Please respond to the following statements by circling SA—strongly agree, A—agree, U—undecided, D—disagree or SD—strongly disagree to indicate the degree to which you agree or disagree with each statement.

1. I would like to learn more about computers.  
   SA A U D SD

2. Working with a computer would probably make me feel uneasy or tense.  
   SA A U D SD

3. I feel helpless around a computer.  
   SA A U D SD

   SA A U D SD

5. I would very much like to have my own computer.  
   SA A U D SA

6. I like the idea of taking computer courses.  
   SA A U D SD

7. I enjoy using computers in my class.  
   SA A U D SD

8. Walking through a room filled with computers would make me feel uneasy.  
   SA A U D SD

9. I feel uneasy when I am with people who are talking about computers.  
   SA A U D SD

10. I enjoy working with computers.  
    SA A U D SD

11. I feel confident about my ability to use computers.  
    SA A U D SD
12. It is my guess that I am NOT the kind of person who works well with computers.

13. On the whole, I can cope with computers in my daily living.

14. I am able to work with computers as well as most others my age.

15. Computers are gaining too much control over people's lives.

16. In general, females can do as well as males in computer careers.

17. More females than males have the ability to become computer specialists.

18. Using computers is more for males than for females.

19. Studying about computers is just as important for females as for males.

20. Males make better engineers and scientists than females do.

21. Falsifying computer information is a serious crime.

22. Access to personal information in computer files is a serious problem.
23. Organizations should NOT be allowed to create secret computer files containing detailed information regarding people's personal lives.

24. Because of computerized information files too many people have information about other people.

25. To protect people's privacy it is necessary to have laws regarding computer files that contain personal data.

26. Every university student should be able to write a simple program.

27. Every university student should have a minimal understanding of computers.

28. Every university student should learn about the role that computers play in our society.

29. Computers can be useful instructional aids in many subject areas other than mathematics.
PART 3

DIRECTIONS: Please circle the correct response.

1. Computers are NOT good for tasks that require:
   a. speed
   b. accuracy
   c. intuition
   d. something to be done over and over again
   e. I don't know

2. If your charge account bill has an error, it was probably caused by:
   a. break down of a computer
   b. mistakes made by people
   c. poor design of the computer
   d. general weaknesses of the machines
   e. I don't know

3. The main duty of a computer programmer is to:
   a. operate the computer
   b. prepare instructions for a computer
   c. schedule jobs for a computer
   d. design computers
   e. I don't know

4. The computer-related job closest to that of a typist is:
   a. computer operator
   b. keypunch operator
   c. systems analyst
5. Which of the following people is most likely to be associated with the design of computers?
   a. keypunch operator
   b. computer operator
   c. computer programmer
   d. computer scientist
   e. I don't know

6. A basic use of computers in libraries involves:
   a. process control
   b. simulation and modeling
   c. information storage and retrieval
   d. computation
   e. I don't know

7. A basic use of computers in the design of airplanes is:
   a. simulation and modeling
   b. process control
   c. making computations
   d. keeping inventory
   e. I don't know

8. The most questionable use of large scale computer files is:
   a. government planning
   b. research
   c. checking on people
d. administration of social programs

e. I don't know

9. Which of the following is a limiting consideration for using computers?
   a. cost
   b. software availability
   c. storage capacity
   d. all of above
   e. I don't know

10. Which is NOT a characteristic of most information systems?
    a. a large volume of information is stored and used
    b. the information stored is organized
    c. the basic purpose is to provide reports and summaries of data
    d. they contain only alphabetical data
    e. I don't know

11. The first decade of extensive manufacturing of computers was:
    a. 1860s
    b. 1890s
    c. 1920s
    d. 1950s
    e. I don't know

12. Computer software is the term describing:
    a. electronic components encased in soft plastic or rubber
    b. computer programs
c. people who work with computers
d. mechanical and electronic parts of a computer system
e. I don't know

13. In addition to input and output equipment, computers contain:
   a. terminals, paper, transistors
   b. memory units, control units, arithmetic units
   c. telephones, keyboards, television screens
   d. printers and typewriters
e. I don't know

14. A computer SYSTEM is best described as:
   a. processing
   b. programming input and output
   c. input and output
   d. input, processing, and output
e. I don't know

15. The physical parts of a computer are referred to as:
   a. programs
   b. hardware
   c. software
   d. manuals
e. I don't know

16. When in operation, a computer:
   a. follows a set of instructions written by people
   b. thinks just like a person
   c. recalls answers from memory
d. translates data from digital to analog code

e. I don't know

17. Computers CANNOT run without:
a. blinking lights
b. keyboards
c. instructions
d. all of above
e. I don't know

18. In order to program a computer, a person:
a. can use any English language words
b. can use any English or foreign language words
c. must use programming language numbers not words
d. must use the words from a programming language
e. I don't know

19. At any given moment, a computer's memory unit can store:
a. programs
b. data
c. answers
d. all of the above
e. I don't know

20. Data processing is best described as:
a. a collection of data
b. producing reports
c. manipulating data according to instructions
d. using punch cards in a keypunch machine
e. I don't know
21. A computer program is:
   a. a course on computers
   b. a set of instructions to control the computer
   c. a computer-generated presentation
   d. a piece of computer hardware
   e. I don't know

22. Computer processing of data may involve:
   a. searching
   b. summarizing
   c. deleting
   d. all of the above
   e. I don't know

23. The computer must have two types of information to solve a problem:
   a. the problem and the answer
   b. the name of the program and the user number
   c. the data and the instructions
   d. the name of the program and your name
   e. I don't know

24. A newspaper publisher has the following information about subscribers stored in the computer. They are name, address and renewal date. How would you arrange the information to be most useful to the delivery person?
   a. ordered listing by address
   b. ordered listing by renewal dates
c. alphabetical listing of streets

d. ordered listing by zip code

e. I don't know

25. Choose the correct output for the procedure described below:

   a. List the three names Brown, Anderson and Crane in alphabetical order
   b. Remove the last name from the list
   c. If only one name is left, stop. Otherwise, go on to step 4
   d. List the remaining names in reversed order
   e. Go back to step 2

Output

   a. Anderson, Brown, Crane
   b. Brown
   c. Anderson, Brown
   d. Anderson
   e. None of these
26. An algorithm (flowchart) to determine the weekly wages of employees in a bakery is shown below. Employees are paid $4 per hour up to 40 hours per week.

Employees are also paid "time-and-a-half" ($6 per hour) for overtime (hours worked over 40). How would you extend the flowchart below to include overtime pay? Select answer a, b, c, d, or e.

a.) Multiply T by 6, call this B
    Print B

b.) Multiply T by 6, call this B
    Print B

c.) Multiply T by 2, call this B
    Print B

d.) Multiply T by 2, call this B
    Print A + B
27. Choose the correct output for the computer program shown below:

```
1 LET A = 3
2 LET B = 4
3 LET C = A
4 LET B = C
5 LET A = B
6 PRINT A, B
7 END
```

Output

a. 3 4
b. 4 3
c. 3 3
d. 4 4
e. I don't know

28. When run on a computer, the following program will:

```
1 INPUT A, B, C, D, E
2 LET S = A+B+C+D+E
3 LET M = S/5
4 PRINT S,M
5 END
```

a. Calculate the sum of five input values
b. Calculate the average of five input values  
c. Print the sum and average of five input values  
d. all of the above  
e. I don't know  

29. This program instructs the computer to count by two.  

10 LET M = 0  
20 LET M = M + 2  
30 PRINT M  
40 IF M<100 THEN 20  
50 END  

Which change will produce a program which can be used to count by A? (For example, A=3, 5, or 8.)  

a. 5 READ A  
7 DATA 3,5,8  
b. 5 LET M = A  
30 PRINT A  
c. 5 INPUT A  
20 LET M = M + A  
d. 5 LET X = A  
20 LET M = X + A  
e. I don't know


Procedural Skills for Complex System Maintenance, CA: Intelligent System Laboratory, Xerox Palo Alto Research Center.


