MODELLING CAL IN THE TURKISH EDUCATIONAL SYSTEM

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Modelling CAL in the Turkish Educational System

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ABSTRACT

In this thesis I shall examine the relationship between computers and the main users of computers in Lycees in Turkey in order to create a model of computer use in Turkey.

Systems theory is used to define the sort of model or picture of users that a decision maker needs in order to provide a formal means of incorporating users and their needs into the system.

Data are gathered and combined into a rich picture of the users. The 'soft' systems methodology developed by Checkland is used to test the rich picture and link it with monitoring of computer effectiveness in schools. Application of the Checkland methodology is a crucial step which shifted the emphasis of the project from qualitative to conceptual modelling.

The methods of data collection and the results are described as the user survey. The following techniques are used: questionnaires, and semi-structured interviews. The data gathered by those methods presented a consistent picture in which the nature of the users' work, i.e. teachers, students, was the dominant influence on using computers in their learning and teaching.

Application of the Checkland Methodology and the conceptual models derived from it are described as the systems study. A detailed description of the use of computers in mathematics is necessary in order to generate performance criteria. In addition, the rich picture from the user survey is found to be a fair representation of reality. Comparisons of each model with real world dynamism are undertaken. The comparisons indicate there are appreciable differences. Some implications of the study's findings are presented.
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I am also very grateful to the Hacettepe University for their funding this project for three years.

Finally, I must thank my family in Turkey for their patience and endurance over the years I have been away from home.
This thesis is dedicated to the memory of Prof. Dr. S. Ertürk.
"One of the enemies of happiness is living with unchangeable truth in a changeable world"

Prof. Dr. S. Ertürk
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LIST OF ABBREVIATIONS

CAL  Computer Assisted Learning
CAI  Computer Assisted Instruction
CBL  Computer Based Learning
CMI  Computer Managed Instruction
CML  Computer Managed Learning
CM   Conceptual Model
EAO  Enseignement Assisté Per Ordinateur
RD   Root Definition
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INTRODUCTION

Information Technology (IT) has had a big impact on society. Although there have been criticisms of technology such as its dangers and cost; at the same time, technological changes have been seen as a panacea, offering new opportunities for jobs and social progress. Undoubtedly, new technologies have affected the social and educational system as well as the economic system. Thus technological changes are something to which society must adapt (OECD, 1988).

The rapid development of IT is leading to the establishment of what has been called "the information society". It is obvious that, nowadays, knowledge has become the key to economic development in the developed countries.

Technology has played an important role in assisting the educational process. Educators not only need to be aware of these changes within their subject, they must adapt to the changes in the society they live in.

The advent of microcomputers has had a great impact in education. With the reduction in cost and increase in capabilities of computers, the use of computers in education has grown rapidly. This revolution has not only demanded changes in the teaching and learning process but also posed great challenges for educators and computer professionals. Computers have a place in schools because of their deep influence on all aspects of our life.

As developing country, Turkey had to open her doors to new technology, which we believe has helped to improve the educational system, to improve the efficiency the learning and the teaching process.
This study is a 'systems' study looking at present relationships between computers and users in Lycees in Turkey. The philosophy behind this is to improve the use of computers in our Lycees.

The question of value judgements and objectivity are always a problem in social research. The choice of topic and research problem is a value judgement (Vedi, 1986). The research problem here is the development of a theoretical framework on the use of computers in mathematics and the evaluation of the effectiveness of the present use of computers in mathematics in Lycees in the Turkish Educational System. Computers have become very important in Turkey, and the Turkish Educational System is already involved in Computer Assisted Learning (CAL).

This study uses 'systems' ideas to elucidate the situation of the use of computers in education, and to find the sort of model or picture of the users that decision makers might maintain in order to provide them with the appropriate services. It further attempts to provide some formal means of incorporating the users and their needs. Thus, it is an attempt to contribute to the effectiveness of the use of computers in the Turkish Educational System.

The investigation was limited to the main users of computers in three Lycees, all in Ankara. The main users were taken to be eighteen teachers and two hundred and twenty-five students in the sample of three Lycees.

The aims of the survey were to

(i) study the patterns of use of computers in Lycees
(ii) identify the expressed computer needs of users in Lycees.

It was based on the premise that understanding the user/computer relationship is essential for effective learning and teaching.

This study started in 1989 and a survey was carried out in 1990. The present survey aimed to find answers to "Who are the computers users?", "Why are computers needed?", "How do users use computers?", "How are computers used?"
"How effective are computers at learning and teaching?" and "How effective do users perceive them to be?".

Data were collected through user questionnaires and semi-structured interviews in a co-ordinated design to give a rich picture.

In this research, Checkland's 'soft' systems methodology was used to create a model of the use of computers in CAL for Turkey.

The thesis is divided in 9 Chapters. The researcher takes a critical look at all the various definitions of using computers in education, and the literature review on using computers in education and mathematics in Chapter 1. In Chapter 2, the background of using computers in Turkey is examined and in Chapter 3 major objectives are drawn up. A critical analysis of the responses from the sampled is undertaken. Then, based on the structured and semi-structured interview and questionnaire schedule are conducted by the researcher, the design and conduct of the survey are explained in Chapter 4. Content and analysis of the questionnaire and interview are explained in Chapter 5.

In Chapter 6, conceptual models of using computers in mathematics were built, based on Checkland's 'soft' systems principles. In addition, all techniques of modelling as related to other systems thinking are considered. The conceptual models are based on the rationale that using computers in mathematics in Lycees are examined both from the users' and decision makers' point of view. Then, in Chapter 7 the comparison of each model with real world dynamism is undertaken. The comparisons indicate that there are significance differences. It is these differences that actually show the effectiveness or otherwise of using computers to teach mathematics in our sample Lycees. The current situation of using computers is compared with the conceptual model developed by the researcher. Chapter 8 contains an account of how the work described in Chapters 6 and 7 is conducted is given.

Having critically assessed the findings there is a need for a new approach using computers in mathematics in Lycees and recommendations are made based on findings in Chapter 9.
CHAPTER 1

THE USE OF COMPUTERS IN MATHEMATICS CLASSROOMS

The literature survey is a broad review of the many different aspects of the study. Of necessity, only selected topics are included. The literature is reviewed under the headings: Computers and education, computers and the curriculum, computers and mathematics.

1.1 Computers and Education

Education, which is as old as the human race, is a process which creates desirable and intentional changes in the people's behaviour (Ertürk, 1972).

The industrial revolution vastly extended the requirements for education. After the establishment of universality in education in the middle of the last century, educational technology such as textbooks, newspapers, magazines and photographs, films, radio records, television, and more recently in the classroom overhead projectors, video recorders and of course finally, computers. It has attracted researchers from several disciplines such as psychology, sociology, education, computer science, and engineering. These research studies are beginning to create a strong literature of 'microcomputer uses and effects' studies.

Microelectronic technology has had a large effect on society. Due to the societies' immense complexity, the use of computer technology was forced upon societies
Computers are rapidly becoming accessible to everyone in a very short time. By the mid 1960's, children were studying reading, mathematics and other subjects at terminals connected to main-frame computers. The systems were expensive, cumbersome, and slow, but learning outcomes raised hopes for future CAL on microcomputers (Tucker, 1985). Just as the 1970's became the decade of computer technology, the 80's has become the decade of computer education. The last decade has seen the rapid spread of computer use for a great variety of applications in business, industry and science. The decrease in the cost of computing devices also helped in making them part of the daily life in education.

Today's children face an uncertain future in a rapidly changing world. The speed and uncertainty of this change make it impossible to predict with any precision the skills students will need to function as adults (Langhorne; Donharm; Gross and Rehmke, 1990). The need for students to cope with daily problems in a dynamic world has led many educators to conclude that having microcomputers in education too enriches the learning environment in schools (Bitter, 1985; Fredericson, 1984 and Pea and Kurland, 1984). Computers can make great changes in education, as well as enhance its quality.

Attempts to integrate the computer into the educational process are not new. There has been a steady stream of prospective candidates for more than thirty years; yet few can claim any large degree of success (and the computer's place in the classroom is still not well established). In many cases, computers came to education so rapidly that there was no time for careful planning. Of course, computers are not a panacea for today's educational problems. There is no single solution to problems as complex as these. Many unanswered questions plague those educators who are busy planning for the use of computers in schools. "What is the best way to use computers?", "Should computer classes be necessary?", "Why should schools use computers?", "How should we organize the classroom situation?", "Where can we find the material? or the time?", "How can teachers
best learn to use computers effectively?"

The use of computers in education is prey to a variety of misconceptions including the assumption that it is all about teaching about computers, or that computers teach rather than that children use them as a learning tool. What is, or can be the role of computers in education? It is necessary in general education to know something about computers, what they are, what they do and (perhaps as important) what they cannot do.

Large numbers of students, teachers and administrators in schools use computers for four main purposes:

". to become aware, at a basic level, of the uses and limitations of computers,
. to learn computer programming, usually in BASIC but sometimes other languages such as PASCAL, or LOGO,
. to learn the correct use of 'applications' programs, sometimes called 'productivity tools' because they have the potential to increase productivity for word processing, spreadsheet analysis, graphics, process control and information retrieval from databases,
. to learn selected topics from school subjects right across the curriculum, with the computer either complementary or temporarily replacing the teacher" (Hawkridge and Jaworski and McMahon, 1990, p. 15).

Whereas teachers use computers to teach students these aspects of knowledge, some teachers also use them to improve their own administrative efficiency, whether by preparing examination papers within word processing programs or by setting up students' marks using a spreadsheet.

Computers are also used to support managerial and administrative functions such as record keeping, scheduling and financial accounting in schools.

The new information technologies have improved and
changed the learning and teaching process in lots of ways. The introduction of microcomputers into schools has changed the manner of teaching and also brought about changes in what is taught.

"The advent of schools computing has added new words to the lexicon of school subjects, not only by adding the contents of whole new subjects like 'computer awareness', 'computer literacy' and 'computer science' to the school curriculum. It has also changed existing subjects. A few examples suffice to show how: commerce now includes word processing and more generic notions of 'keyboard skills' (from relatively humble uses of 'turtle graphics through to very sophisticated modelling and simulation exercises; geography, history and social science use databases and extend their use of quantitative methods; English, as well as language education in a very variety of subjects across the curriculum, may include the use of word processing as a key element of learning to write, creative writing and classroom publishing" (Kemmis, 1987, p. 38).

The use of the computer can bring about changes in how students learn and teachers teach. A number of studies have shown that students feel a sense of independence when working at the computer and satisfaction in their abilities to control the technology.

The level of motivation in students working with computers is usually high, and students learn more using computers and more quickly (OECD, 1986, 1987, 1989a).

Since the advent of microcomputers in the 1980's, major developments in the use of microcomputers have taken place in schools.

There have been some development programmes co-ordinated by the education authorities, the Ministry of Education, in some cases at the state or provincial level and in others at the national level.
Developments of programmes on the use of computers in schools have been concerned with three aspects, namely:

" . computers and information technology as subjects of study in their own right. This aspect has led to the development of various courses in computer science and IT;
 . computers and IT as an integral part of culture and society which all students should experience and become confident in using during their years of schooling. This aspect has led to the development of courses such as 'computer awareness' or 'computer literacy', which aim at giving students an understanding of the application of information technologies and their social implications and are often compulsory for all students at lower secondary level;
 . computers and IT as teaching and learning resources" (OECD, 1989a).

These aspects have led to the integration of IT into the curriculum.

Countries have concentrated considerable resources and programmes on these three aspects of computer usage. Some countries aimed at not only teaching computer science — whereas some countries aimed only at teaching computer science — but at teaching computer literacy at all levels of education and integrating the use of the computer in the curriculum in order to improve the teaching and learning process. In other words, some countries such as Australia and United States started from a computer awareness and computer literacy approach, some countries such as Japan, Netherlands and Norway started from a computer science approach, some of them such as Italy, Portugal, Spain started with computers as a tool to teach computing (OECD, 1989a).

The many potential uses of the computer give it an ambiguous status; Should we consider the computers as a subject (teaching about) or as a teaching tool (teaching
We have to make a distinction between computers as a tool, computer science (whether a separate or an integrated discipline) and computer literacy.

Peter Bollerslev and Nolan Esten in "Changes in Curricula and Institutional Structures" have analysed a few case studies which contributed to the field by participating the CERI project. The incorporation of the new technology related facets: teaching with computers (CAL), and teaching about computers (computer literacy, computer science, computer programming) have had a considerable effect on the elementary and secondary school curriculum (Bollerslev and Esten, 1984). The international case studies report wide variations in the extent which elementary or middle schools use the technology for these purposes, as well as in the level of student and subject matter targeted. Many of the schools and schools districts are in the initial phases of planning or implementing the use of technology for instructional purposes. Nevertheless, Bollerslev and Estes found it possible to make some valid generalisations.

It was found that changes in curriculum had taken place because teachers have started to use the technology as a classroom research tool in the that they have begun to experiment with varying curriculum materials for different students. Thus, the technology has given teachers a powerful tool with which to plan appropriate curriculum strategies.

Computer awareness and computer literacy courses have become part of the school curriculum in many countries because governments perceive an economic need to produce a computer literate society.

The most conspicuous change has been in the creation of new technology-related subjects such as computer literacy and computer awareness which aim to prepare students for the increasingly technological world they will face on leaving school.

What is computer awareness? What is computer literacy? As Olson indicated distinction between teaching about and teaching with computers have been seen to be cast in stone (1988). There are those who argue that any work with the computers contributes to an 'awareness' of it and
any 'awareness' of it contributes to an 'greater literacy'. Computer literacy can be derived from a wider use of the term literacy. The term computer literacy includes computer awareness because computer awareness usually means to make students know about computers, their uses, capabilities and possible effects on society rather than being able to use computer. In learning with new technology students may gain awareness. Therefore, the goal of know about computers is that students need to be prepared for the computer society of future, and that help with computer use develops generic problem solving and thinking skills (Olson, 1988).

Computer Awareness

Computer awareness is to become aware of the potential and pitfalls of computers and of the variety of ways in which they may be used in society (Watson, 1987a). Becoming aware of the extent to which computers are part of our lives and society in which we live in might include a study of the history of computers, how a computer works, what computer do, where they are used, the impact they are likely to have an society (Mackay; Young and Beynon, 1991). This is integral part of teaching about computers, and place this within the domain of computer studies. Briefly, awareness includes living with computers the effects on everyday life and their future social impacts.

Computer Literacy

Computer literacy means that ability to be user of computers. Computer literate students should understand what computers systems are and use computer vocabulary, know what a program is and why it works, use of applications of computing such as wordprocessing, data base, spreadsheets to manage and manipulate information is of obvious importance in an information society. As the students use them in a variety of subjects areas, she/he gains an understanding of the capabilities, and the limitations of computer technology.

To prepare students for adult life computer literacy can give students skills that are important tools for use within the school system (Ragsdale, 1982).
Programming can be part of computer literacy, but it is not the only component for students. Programming can help students to develop logical approaches to problem solving, assist them as an alternative mode of understanding process, and provide practice in the use of good techniques for organizing and presenting material.

Computer awareness and computer literate courses aim to students an understanding of the applications of the IT and their social implications, and their computers and IT can be used as teaching and learning resources.

A number of terms are also used to refer to the use of the computer as a resource in the teaching or learning process. The most commonly used are Computer Assisted Learning (CAL), particularly in the United Kingdom, Computer Based Learning (CBL), Computer Assisted Instruction (CAI) in the United States, and Enseignement Assisté par Ordinateur (EAO) in France. Computer Managed Instruction (CMI) and Computer Managed Learning (CML) refer, with various shades of meaning, to the computer as a tutor teaching new concepts, as an exerciser giving the learner individualised practice in concepts or skills, or as the means of providing opportunities to acquire new knowledge and skills through a range of uses such as simulations, the use of data bases, problem solving, data analysis or other techniques made possible by the computer.

Different definitions and usages of these term(s) are made and discussed in the literature. The literature includes synonyms which are often confused such as Computer Aided Instruction and Computer Aided Learning which are sometimes used interchangeably but for some authors have subtle differences of meaning.

While Wellington (1985) broadly defined Computer Based Learning (CBL) as

"... used to mean any sort of learning related to the use of computers either as a direct teaching aid, or as an aid to administration or management" (p. 21).

Whereas he defined Computer Assisted Learning (CAL) as
"... this is often seen as one aspect of CBL. It usually means using a computer directly as an aid to learning" (p. 21),

Watson (1987b) explained CAL as

"It refers to using to computer as a learning resource to assist students in the totality of their tasks" (p. 126).

Chambers and Sprecher (1983) define CAI as

"The use of computers to provide course content instruction in the form of drill and practice, tutorials and simulations" (p. 199).

CAL is used synonymously with CBL, CBI and CAI and CAL and is defined as a term synonymous with CAI namely used in the UK (Chambers and Sprecher, 1983, p. 200).

Rushby (1979) and others (e.g. Forthergill, 1988) also referred to CBL, and even CBE, but it is not apparent how either CBL or CBE can be distinguished from, or are subsets of CAI. However in 1981 Rushby noted that,

"There are two main aspects of CBL. The first, Computer Assisted Learning (CAL), concerns learning with the aid of the computer, and its impact is largely restricted to the student, the teacher and the department. Beyond it is general promotion, the only implications that are likely to be considered, accepted or rejected, at an institutional level, are those concerning the resource that it may require the other aspect, Computer Managed Learning (CML), concerns the use of computer such as tasks, assessment, record keeping, reporting and routing students, through complex courses of study" (Rushby, 1981, p. 17).
Bruke defined the relationships between CAI and CML as

"CML refers to any system in which a computer is used to perform overall instructional management. It usually includes a testing evaluating function, a planning function, and a record keeping function. All CAI has elements of CML built in, but CML usually refers to a more complete. Stand alone system" (Bruke, 1982, p. 185),

and CAI as

"... any method of learning which a computer is the primary delivery system. The definition has been narrowed somewhat, by tradition, so that for most people it probably means direct, interactive instruction in which the student is on-line to a computer" (Bruke, 1982, p. 187).

According to this, in CML, the computer is typically used to administer and grade test, and assists in the development of an instructional prescription for the remedy of any knowledge deficiencies that are discovered. The computer is there used for recording, record keeping and report writing. Most CAI (or CAL) includes at least a minimum amount of CML.

According to Rushby, the differences between CAL and CML are more significant, but more difficult to define. CAL has been described (1979) as teaching with the aid of a computer. This is the term most commonly used in the United Kingdom. CML has been described as the use of the computer to assist the teacher, instructor and administrator with the routine management tasks in teaching and learning such as assessment, guidance, record keeping and reporting.

While using CAL, students are presented with learning material, in CML, computers are used to monitor and record student program. The differences between two concepts is therefore blurred. Computer Managed Learning (CML)
differs in that computers are used to manage the learning sequence; the computer can define the students' task, identify appropriate teaching materials, mark the work, record the results, issue reports, and assess. Wellington (1985) noted that this is often seen as one part of CBL. It may involve storing and processing pupils' exam, classroom organization, registering or timetabling, or more specifically, guiding a learner through a learning route or body of subject matter, and CAI is defined as

"... more narrowly, this is one aspect of CAL. It involves direct instruction, or even training with computer. CAI often involves so called "skill and drill" programs and is therefore related to the programmed learning area by many people" (Wellington, 1985, p.21).

According to Watson, it is feasible for every classroom to have a microcomputer. A new generation of software is being developed in CAI and CML Watson explains CMI as

"... the use of microcomputer for diagnostic work, for the creation and administering of tests, and for keeping records, can indeed be a timesaving aid to the teacher provided the programs have been properly developed" (Watson, 1987b, p. 130).

In the Commonwealth Guidelines (Commonwealth Secretariat, 1987) terms such as computer education, computer studies, computer assisted learning are defined as:

**Computer Education**, the broadest term, covers teaching about computers or use of computers and teaching of other subjects with computers;

**Computer Studies**, covers teaching about computers and computer languages, whether at a basic level (computer awareness) or at a slightly more advanced
Computer Assisted Learning (CAL) is the term reserved for learning about other subjects through a computer. Americans call this Computer Assisted Instruction (CAI).

To justify using computers in schools firstly, students should be aware and unafraid of how computers work, because computers are pervading industrial societies and are likely to be important in all countries. Since schools prepare students for life, they should prepare them to deal with computers. Students need to become literate, and they need also to know something about computers. All students should have courses on 'computer awareness'. Secondly, students should be user of computers, at least a basic level. Teaching students programming gives them some confidence in their ability to control computers. Teaching students how to use applications programs does not require them to learn programming, but does give them skills that may be useful to them as students and possibly when they move into jobs. Students should take courses in 'computer literacy' and 'computer studies' or even 'computer science', thirdly, students should be able to use computers in any subjects, particularly where Computer Assisted Learning offers advantages over other methods. CAL can improve teaching and learning. Lastly, schools can be changed for the better by the introduction of computers. Teaching, administrative and managerial efficiency may also be improved (Hawkridge; Joverski and MacMahon, 1990).

In this study, CAL is used as "Teaching with the aid of a computer", and the researcher uses CAL for application of computers in education, and CAL is seen as synonymous to IT.

Using IT in the Classroom

It is necessary here to review development in the educational use of computers. How have computers entered the education world? Why have they entered the education world? Today's children live in a rapidly changing world.
This changed dramatically since nearly everyone in advanced industrialized societies gained access to television, radio and at a rapidly growing rate, computers (Harper et al, 1987). After the appearance of the first cheap microcomputers, the use of these machines has gradually spread throughout the educational system. Microcomputers have brought about widespread and fundamental changes in education. There is considerable evidence in research showed that CAL enhance student learning, and performance over more traditional means.

Nowadays, microcomputer technology has been available for applications in the classroom and it has been introduced into all phases of education with promises of great changes to the form and quality of education. There are a number of reasons why computers have become important in schools.

"Schools are in the grip of computer mania. Ordinarily conservative and slow to change, schools are embracing new technology and new educational methods more rapidly than they can learn use to them. During the past few years, the influx of microcomputers in education has grown from a mere trickle to a torrent" (Watt, 1982, p. 118).

The urge to use computers in schools came from a variety of sources such as advertising efforts by computer hardware and software manufacturers, politicians and administrators wishing to be seen as modern, professors and teachers wanting to display expertise in a new field, and from pressure from parents (Harper, 1987). Many parents hope their children will acquire skills which will be useful in a world where computers are destined to play a very important role in the work place. Thus they are willing to spend money to buy a machine which they can use privately, and insist that schools make computers available to students. Besides, many educationalists believe that schools should reap the benefits that technology can bring to learning in all subjects across the curriculum.
These factors help account for many schools buying computers before knowing what to do with the machines. They had no clear idea about what the schools should be doing with computers. Such buying habits, which fail to fit purchases into a reasoned instructional plan, may well impede effective classroom use.

It is clear that microcomputers are being purchased at a rapid pace by schools in advanced industrial societies. It is also clear that prophecies of a few years ago about the major role computers would play in learning programmes have not been fulfilled. Briefly, despite the increase of computer hardware at school and at home, computer education research, and computer publications, the impact of computers on existing curricula is still quite limited (OECD, 1986 and 1987). Although the result of research gave an incomplete and impressionistic picture, by and large they support the view that information technologies have considerable potential to enhance education. However, it is clear that the potential is not being realised in schools in most countries. Much of what is happening can be categorized as small-scale experiments and basic computer awareness and literacy.

In an advanced society, there is confusion about the effective roles computers can play in education. At the same time, computers continue to create opportunities for great deal of experimentation with their potential educational roles.

The use of microcomputers in education has brought as yet very few qualitative and quantitative changes where we can use this new medium. The capital cost of microcomputer facilities is lower than the cost of computing with mini-or main frame- based time sharing systems. The initial cost of a CBL delivery system and the cost of changing it are also lower and within reach of a much larger number of institutions.

Research studies for the use of computers in education have come a long way in the last 20 years. Researchers in the area believed CBL would bring lots of benefits to the students and teachers such as comfortability, faster learning, learning at one's own pace.
and convenience, opportunities to work with richer materials and more sophisticated problems, personalised tutoring for students; updating instructional materials, more accurate appraisal and documentation of student programmes, more time for contact with learners for teachers.

A Conceptual Framework

The literature review has focused on two main areas: effects on learning and student achievement, and cognitive effects.

Effects on Learning and Student Achievement

Has Computer Based Learning provided such benefits? After computers were introduced to the educational world, educational researchers started to evaluate their impact. These studies provided quite valuable information on the effects of CAL, but all studies differed in experimental design, settings, and in the types of computer applications they investigated. Evaluation results differed from each other, but all studies brought lots of support to this subject.

Microcomputers have brought a variety of instructional applications such as drill and practice, tutorial CAL, simulations, games, information retrieval and word processing. The tradition of CAL research from the beginning of the microcomputer era continues into 1980s. Hundreds of results have compared CAL with conventional classroom teaching, and generally have found that CAL is more effective in teaching (Lieberman, 1985).

The way computers are used by students is generally quite different for each school level. In the elementary schools, computers are generally used for drill and practice and tutorial purposes whereas in high schools almost half of the computer time is on computer programming. It was observed that the amount of time a student can use a computer in relation to the total school time available is marginal in the USA and some European Countries (Moomen, 1987). Niemiec and Walberg (1987) studied the comparative effects of Computer Assisted Learning to traditional methods
and produced synthesis of all the reviews done in the USA. They report that the average effect on learning of such microcomputer based studies is 0.43 standard deviation higher at the college level. At the elementary school level, the effect is much more higher. The effects of CAL on learning seemed to vary with students' level and instructional model.

Several research projects conducted as a meta analysis of research help summarize general trends by pooling the findings of a collection of studies. Most meta-analyses of CAL examine students' achievement test scores and measure, in standard deviation units, to use a common scale of effect size.

Kulik, Kulik and Cohen (1980) used meta-analysis to reach a conclusion about the effectiveness of computer based college teaching. They found that Computer Based Instruction raised the examination scores of college students by approximately 0.25 standard deviation. Computer Based Teaching also had a moderate effect on the attitudes of students towards instruction and toward the subject they were studying. Finally Kulik et al reported that Computer Based Instruction needed substantially the same amount of time needed for instruction.

In another study, Kulik, Bangert and Williams (1983) researched the effects of Computer Based Teaching raised students' score on final examinations, and the effect found by 48 secondary school CAL evaluations was a rise in average of 0.32 of standard deviation, which is equivalent to a jump from the 50th to 63rd percentile. They found thirty nine which reported better scores for CAL groups receiving conventional teaching, twenty five having significantly high scores.

Hartley (1978) found that the average effect across 35 mathematics CAL evaluations was an increase in students' achievement test scores of 0.41 standard deviation, a rise from the 60th to 66th percentile. Other meta-analysis indicate that CAL significantly improved achievement test scores, increased positive attitudes towards computers and toward the subject matter and reduced instructional time (Kulik, Kulik and Bangert, Drowns, 1984; Burns and Bozeman,
Kulik (1984) points out that CAL studies show a rise in mathematics achievement test scores of 0.40 standard deviation at the elementary level, 0.30 standard deviation at the secondary level, and 0.10 standard deviation at the college level, indicating that younger children make the strongest learning gains.

Another piece of research introduces a new note into reviews of the effectiveness of Computer Based Learning. Bass, Ries and Sharpe (1986) concluded that after CAL students achievement is equal or better than after traditional teaching and more positive attitudes are developed, especially among below average students. One of their most significant findings was that students achieved these results in less time than was necessary for learning by conventional methods.

CAL evaluations have methodological weaknesses (Clark, 1984). Few evaluations control for instructional content. The in-class lesson may be entirely different from the CAL lesson used as a comparison. Studies that do try to control for content, by using software developed by the classroom teacher, find smaller differences in student achievement between the methods. Another problem with CAL evaluations is a potential novelty motivated to attend to computer delivered lessons simply because the technology is interesting and new. To support this hypothesis, Clark shows that strong learning gains appear in short term studies comparing CAL with classroom teaching, while gains are used or insignificant in studies that deliver a greater number of CAL censors to students over longer period of time.

In an evaluation of four educational interventions, supplementary CAL was compared with reducing class size, and increasing instructional time (Levin; Glass and Meister, 1984). Data on CAL came from an extensive Educational Testing Service evaluations of mathematics and reading a CAL (Ragosto, 1983). The most academically effective intervention was in descending order by CAL, reducing class size, and increasing instructional time.

To take account these studies, it may be concluded that Computer Assisted Learning can be as or more educationally effective than conventional methods of
teaching on end-of-course achievements and on retention, that effects are greater for younger and for lower achieving students than for older students and those of higher ability (Kulik, 1981) that time to learn is greatly reduced.

Cognitive Effects

Some of the benefits identified to date in the use of computers for learning are: reduced learning time, increased retention time, and increased motivation to learn. It is obvious that problem solving and thinking skills can be learned and these skills can be transferable.

The microcomputers, commonly considered a tool to assist and enhance thinking (Brown, 1983; Leuehrmann and Peckham, 1983), can affect children's development of thinking skills. The cognitively demanding process of writing computer programs, with its requirements for procedural, analytic, abstract thinking, improves children's problem solving abilities (Paisley and Chen 1985). It may also accelerate children's cognitive development (Papert, 1980). Research on cognitive effects measures children's gain in thinking skill after learning programming. Other studies in this area examine the effects of various instructional design formats on children's thinking strategies and abilities. The use of computer programming to teach problem solving skills has been popularized by the introduction of the programming language LOGO. LOGO

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1Seymour Papert developed LOGO, a programming language in which young children can explore concepts and developed ideas through graphics. While providing a philosophy for the LOGO language, in his book, Papert describes how LOGO could develop a child's intellectual structures and how the computer could be used to expand the human mind. Instead of using the computer to teach children, Papert helps students learning programming by empowering them with the ability to teach a turtle (The turtle is merely an abstract object on the computer screen). By teaching the turtle new words or commands, the child can direct the turtle's movements. The child can also begin to develop a structured system of thinking, problem solving and decision making. According to Papert, the computer makes it possible to elaborate upon the Piagetian structures (1980, p.7) thus implying that explorations with the turtle will provide a child with appropriate and interesting tasks to enhance cognitive development.
a graphics programming language for children is the basis of a large number of LOGO studies on the cognitive effects of learning how to program. Children, as young as preschool aged, can use LOGO with adult assistance, and some simple versions of the program have single key commands so that children will not need to type words on the keyboard. Many educators have been excited by the claims of Seymour Papert (1980) who, in his book Mindstorms, has promoted LOGO as a tool for learning powerful ideas, skills and heuristic which can, presumably, be applied to a wide range of problem solving situation. According to Papert (1980) LOGO stimulates children's development of problem solving skills and engages them in experimental learning. Children learn the task's underlying logic by programming the computer to complete a mathematical operation.

Many research studies have focused on the use of LOGO, and its effect on children's learning. Most of them conclude that beneficial effects do occur, that children are highly motivated, that they learn to follow and give instructions clearly, and they are more able to identify ambiguity, that their use of language and knowledge of certain elements of mathematics is enhanced, and that they engage more readily in cooperative, problem solving behaviour (Clements, 1986 and 1987; Miller and Emilhovich, 1986).

Research and case studies testing LOGO programmers' cognitive development show that children can acquire specific problem solving and logical reasoning skills after using LOGO.

Cognitive skill gains appeared in an experiment by Clements and Gullo (1984) with eighteen first grades. The children were randomly divided into a treatment group that used LOGO for 30-40 minutes twice a week for twelve weeks, and a control group that used CAL instead. Children worked in groups of two or three, under the guidance of a classroom teacher, and were encouraged to explain their plans, decisions and errors. In post-tests the control group did not change in any of the cognitive skills tested whereas LOGO group improved in language fluency, divergent and reflective thinking, and ability to give directions. No
changes appeared in either group in the cognitive domains of classification, seriation, right left orientation, or verbal or numerical memory.

Positive effects of LOGO on cognitive skills appear in another study. Among fifth graders, logical reasoning ability in the use of conditional statements improved after students learned the LOGO 'if then' construct (Seidman, 1981). Another study showed that low ability school children seemed to profit from LOGO experience. After learning to write simple programs, they demonstrated new skills in structuring mathematical operations, using coordinates, establishing, hierarchies of procedures, developing patterned procedures, using recursion and looping and using variables in procedures (Papert; Watt; DiSessa and Weir, 1979). Perlman's study concluded that pre-schoolers learned mathematical concepts and thinking strategies by using simplified version of LOGO called TORTIS (for Toddler's Own Recursive Turtle Interpreter System; Perlman, 1976). Over a ten week period TORTIS facilitated pre-schoolers' ability to use number concepts, frames of reference, procedures, recursion, and effective problem solving strategies.

Tetenbaum and Mulkeen (1984) suggest that one possible explanation for the massive influx of microcomputers in schools was the expectation that they would facilitate learning and problem solving. The phenomenal growth in the take-up of the programming language LOGO, in particular, may lie not so much in its programming potential as in the claims that it is a language for learning how to think.

Papert saw in programming a distinctive route toward the development of generalizable problem solving skills ('powerful ideas'), and emphasised the individual constructive activity of the child him or herself in acquiring such skills. Programming in a high level language such as LOGO requires the pupils to have precise and formal representation of all the necessary steps to a particular goal (Papert, 1980).

"By programming the computer to create graphics displays, abstract ideas can be made concrete,
and the means of manipulating the world made personal and apparent" (Underwood and Underwood, 1991, p. 35).

Papert's view was that the writing, testing and 'debugging' of programs offer a uniquely powerful resource for the development of abstract thought and high level problem solving abilities. The intellectually constructive aspect of computer use, then is to be found in the creative engagement of the child with the computer program.

A few studies indicate programming has no apparent effects. On one hand, studies such as those by Tetenbaum and Mulkeen (1984), and Clements (1986) have shown that LOGO has positive effects on the development of cognitive skills and academic achievement. On the other hand research by Pea (1983), Pea and Kurland (1984) has indicated that there is little, if any, transfer of learning from the LOGO situation to non-LOGO tasks.

In Pea, Kurland and Hawkins' study (1985), after a year of LOGO programming work, there was no change in elementary school children's performance in tasks that involved planning. In a pilot study Turkel and Podel (1984) found that eight students using LOGO were more focused, organized on task and logical in their problem solving behaviour than before. Gorman and Bourne (1983) found that a group by fourth graders were better able to understand the concept of recursion after some LOGO training but did no better in a number of other areas. Kurland and Pea (1985) reported that one year learning to program using LOGO did not improve a group of thirty-two students planning skills. Hawkins (1985) in a qualitative study of the use of LOGO by two teachers began by see in LOGO as an environment for learning general problem solving skills but by the second year saw LOGO mainly as way for students to learn about computers and computer programming. These teachers did not also see transfer of effects of LOGO to other cognitive domains. In other study Vaidya (1985) conducted a longitudinal investigation of the qualitative changes shown by fourteen pre-school children in the development of programming knowledge about LOGO over a period of 8 months.
The finding of the study do not support the claims made by Papert about learning in LOGO environments for preschool children be designed by taking into consideration developmental levels of children and individual differences among children.

Many other studies could be cited as well as to illustrate the conflicting nature of research results.

As Papert has suggested that

"The computer presence could contribute to mental process not only instrumentally but in more essential, conceptual ways, influencing how people think even when they are far removed from physical contact with a computer" (Papert, 1980, p. 4).

The excitement LOGO has generated, then cover not so much from a perceived value of learning to program in LOGO, children's cognitive capabilities can be greatly expanded and they can develop higher level cognitive skills which can generalize or transfer to other content areas.

Microcomputers can enhance learning. Children can learn problem solving and abstract thinking skills from microcomputers. In one of Underwood's studies (1986), an experiment was carried on to research whether microcomputers can be an effective stimulus to children's acquisition of classificatory skills by using a binary tree classificatory system and a matrix data base methods of classification. Nine and eleven years old primary school children were taken as subjects for a work project using either a binary tree or matrix database. While half of the children classified their information by using computers, the other half simulated the computer software by hand. They were tested and retested at the beginning and end of the project. While there was no difference between the pre and post test scores for children using the two methods, children's performance was significantly better than the non-computer users in the post test.

In another study, Underwood (1988) researched the effectiveness of information handling packages in the
classroom encouraging open-ended problem solving education. In eighteen classrooms, a number of computer based information handling packages which were being used by teachers and pupils, were investigated. The expressed objectives of teachers using data bases were compared against recorded classroom outcomes. Pupils were aged 5-18 years old. The results were encouraging. This study showed that the use of computer based information handling package in schools would be useful. Children can develop valued skills and knowledge through powerful learning situations. Information handling packages can encourage problem solving education.

The advent of microcomputers has brought significant changes to education (Rushby, 1981). Besides, the use of microcomputers in schools had to change in the school curriculum, and also brought new methodologies that teachers are beginning to employ in order to operate more effectively in the classroom. Consequently, microcomputers are causing the teachers and students who use them to engage in new classroom activities, learning strategies, and skill acquisition. Computers and curriculum will be discussed in detail in next section.

1.2 Computers and the Curriculum

The introduction of the IT into the curriculum has brought about a number of changes in the curriculum itself such as forms of instruction, students' motivation, classroom organization and management.

Relationships between new technology and curriculum affect all aspects of education. It is necessary to consider how to make changes and how it is organised and managed. The role of educational technology is characterized by Rowntree (1982). It is a very general and fundamental approach to the important and underlying issues in education.

"For educational technology is as wide as education itself; it is concerned with the design and evaluating of curricula and learning process and with the problems of
implementing them and renovating them. Essentially, it is a rational, problem solving approach to education, a way of thinking sceptically and systematically about learning and teaching" (Rowntree, 1982, p. 1).

The introduction and use of new technologies may change the very essence of education. Computers have affected education and curriculum directly and indirectly due to changes which they bring in society.

In 1954, B. F. Skinner concluded a speech entitled "The Science of Learning and the Art of Teaching" with this statement:

"We are on the threshold of an exciting and revolutionary period in which the scientific study of man will be put to work in man's best interest. Education must play its role" (Chiang, 1967. p. 32).

Since Skinner's speech, studies of science and research have generated a computer technology for education, and many research studies have been conducted on the experimental analysis of human behaviour in the field of learning coordinated with increased technical knowledge about computers. This rapid development in educational technology more than 20 years has affected the use of computers in education, and microcomputers have brought some changes in curriculum practices. The increase in the number of computers in education in any discipline at least brought two effects on the curriculum. As Wellington stated:

"... at one extreme it could lead to increasingly narrow subject specialism in the hope that a given teacher specialist could cope with that area. On the other hand, it may lead to a welcome erosion of the teacher as a subject authority figure: infallible, expert and all knowing. Teachers need no longer adopt this
role in the eyes of pupils" (Wellington, 1985, p. 207).

The relationships between microcomputers and curriculum is a complex issue. How the microcomputer can effectively be integrated with classroom curriculum is currently one of the pressing issues of computer use in education. It seems likely, however, that the process of integration will also be one of change. The task is not merely to put two matching pieces, a curriculum and a computer together. Rather, it is to actively mold the pieces so that they complement each other.

The use of microcomputers in education curriculum should grow very rapidly, due to the increasing role computers are playing in all activities of life. It is inevitable that curriculum should recognise this increased role of computers in our lives and somehow get some type of computer education or training in the curriculum.

As mentioned before, computers have affected teaching and learning styles, students' motivation, and classroom organisation. Morrison (1988) reported that using IT in the classroom is opening a window for teachers to look at children's learning in a new way. He points out that many developers have seized opportunities to use IT as a means of fostering substantial changes in educational aims and the classroom experiences of students and their teachers.

There are as many ways of using computers in the classroom as there are varying teaching styles and that asking how teachers use computers and what effects computers have on teaching are questions almost as broad as "How do teachers use books and how do books affect teaching?"

Teachers' use of computers depends on their instructional goals, teaching approach, training software and hardware available to them, and the instructional setting in which they use them.

"One of the most significant impacts of the use of computers in the classroom is change in teaching style. Teachers can go beyond the traditional information delivery mode whereby
they are presenters of ready made knowledge and become facilitators of students’ learning. With computers, students can work on problems individually or in small groups while the teacher acts more like a coach circulating among them and giving assistance. Some teachers find that they are able to observe more of the learning process when watching students interact with computer based materials. Some teachers welcome the opportunity to learn alongside their students. For many, this is a significant change from how they were taught to teach.

... Teachers who use the computer as a medium that students can manipulate individually or in small groups find their students become more actively engaged in learning and thinking. Such teachers use the computers to give students more responsibility for their own learning. Students can work at their own speed and can give out more for themselves" (OTA, 1988, p. 15).

The use of computers in classrooms offer opportunities for enhancing teaching at every level and in many subject areas - opportunities that are being missed because many teachers, at all levels, are not aware how to use computers in the classroom and are not prepared to teach about their impact on our society.

To use computers successfully, teachers must know what they want the machine to do in their classroom. They need information on the development of microcomputer use in schools, and on available educational software to make their own decisions about equipment and software. To be usable tools, they must be employed in a manner consistent with the philosophy of the teacher and the curriculum of the school. Teachers can consider themselves liaisons between computer and students. They cannot become hardware experts or programmers, but they will know enough to teach students how to use the equipment. Drill programmes, tutorials, games and simulations can be written to fit into almost any curriculum, but teachers must determine the ratios of these
different uses, the amount of "hands on" experience and possibility of programming.

Computers should be of direct and indirect assistance to teachers in supporting individual learning needs of their students. Teachers can be helped directly by having tutorials and simulations which students can use at their own level and pace. The development of software for constructing and operating simulations, and the availability of materials will allow students, individually and in small groups, to exercise their imagination without the teacher having to assume such a large responsibility in managing details of what students are doing. Use of these tools should result in the more effective development of problem solving skills (OECD, 1987).

One of the most striking changes that computer can bring to the classroom is the need for new patterns of classroom organisation and management. Using computers extensively affects the structure of the classroom communications, the form of assignment, the grouping of students, the nature of evaluation, and the scheduling of the various learning activities. Teachers need time and support in establishing new teaching routines. Teaching styles (methods) are very much affected on how much equipment is available. With one computer in a classroom, one or more machines may be dedicated during certain units of study to monitoring or data analysis while others could be used for writing, simulations, programming and other activities (Langhorne, M; Donham, J; Gross, J. F and Rehmke, D. 1990).

There is an urgent need to identify some educational concepts for a basis in curriculum. Computer literacy, computer awareness, and computer science should be understood by all students of all abilities. Creating related subjects in IT into curriculum which aim to prepare students for increasingly technological world they will face on leaving schools.

Another important thing is to develop in students the information handling skills so that they can require more information coming to them by electronic means (Anderson, 1987). Use of IT in classrooms may help acquire
these skills.

Computer awareness, and literacy should be taken into each major subject of the core curriculum.

It was already mentioned that vocational side of IT should be carefully taken into consideration. Vocational computer courses aim to prepare students for work. Such courses include substantial knowledge of how computers are used, plus-hands on experience of applications such as word processing, spreadsheet analysis and possibly some elementary knowledge of programming like BASIC.

If computer courses are related to future jobs in schools, necessary vocational needs for developing countries can be met and related skills should be developed. More attention should be given to the task of building a resource of people skilled in IT.

How is vocational education built into the system? Effort is needed to increase the integration of academic and vocational elements of the curriculum. Two steps are necessary: making the academic more relevant by linking principles, theories and laws with applied work and practical daily situations; and making the vocational more accessible to all students by allowing parallel study of vocational and academic options within a common curriculum.

Of course, it is not an easy task to make changes in curriculum due to new technologies in a short term. Major changes can be made gradually. At the beginning, IT can be integrated into curriculum by a lot of supporting material and the parts of the curriculum can be changed at different rates. It makes sense to provide for easy revision of the factual content of the courses. Some subjects can be dropped, reorganised or presented in more appealing forms.

1.3 Computers and Mathematics

Teachers of mathematics were among the earliest users of microcomputers within the educational setting. As computers have become cheaper and available to larger number of students, more attention has been paid to using them to assist in the teaching of mathematics. Mathematics demonstrates perhaps more clearly than in any other subject
the interplay of the new technology and major changes and curriculum objectives.

A computer can support the teaching and learning of mathematics but it should be available in the right place at the right time (Ball, 1986). The use of carefully and appropriately designed learning packages could promote better student understanding of mathematics and encourage them towards problem solving and investigation work. Computers are increasingly being used to support the teaching of mathematics and many teachers and educationalists now set the use of computers as a way of introducing new styles of teaching and learning. Computers appear to encourage pupils to discuss mathematics and also seem able to provide situations which lead them to solve problems and investigate mathematics for themselves.

The world is rapidly changing; solving problem is the most essential of all basic skills needed in our complex, changing world, and learning to solve problems that involve mathematics is the most fundamental goal in mathematics education. Cockcroft's report (1982) suggests that if children are to learn mathematics effectively, a variety of teaching styles need to be used at all levels. Paragraph 243 states that:

"mathematics teaching at all level should include opportunities for

- exposition by teacher
- discussion between teacher and pupils and between pupils themselves
- appropriate practical work
- consolidation and practice of fundamental skills and routines
- problem solving including the applications of mathematics to everyday life
- investigational work" (p. 71).

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2Cockcroft's report on the teaching of mathematics was published in 1982 under the chairmanship of Wilfred Cockcroft.
The Cockcroft Report (1982) recommended changes in teaching and learning styles, with more attention given to discussion, investigational work and applied problem solving. Computers can be used to support all these styles of mathematics teaching.

The use of microcomputers has also had an impact on mathematics teaching styles. The change in teaching styles has been gradual but the new styles of teaching require the development of higher level thinking skills, particularly problem solving because of societal needs in the developing world. The National Council of Teachers of Mathematics stated that 'problem solving must be the focus of school mathematics in the 1980s' (NTCM, 1980, p.1).

A basic goal of teaching mathematics is to enable students to solve real-life problems. New national standards for mathematics place heavy emphasis on the teaching of problem solving. Problem solving is also necessary to show the relationships between mathematics and real-life applications. This idea was shown in mathematics from 5 to 16 in section 1.3

"The aim is to encourage the effective use of mathematics as a tool in a wide range of activities within both school and adult life" (p. 13).

How computers contribute to mathematics teaching and learning are described in mathematics from 5 to 16. As Price stated (1989), in Mathematics from 5 to 16 objectives are listed in detail: 5 major categories facts, skills, conceptual structure, general strategies (for problem solving and investigations) and personal qualities.

The main idea behind this is that students must become mathematical problem solvers and that they must learn to reason and communicate mathematically (NTCM, 1987). These goals indicate changes in traditional textbooks/lecture/homework approach and a movement to mathematics teaching in which students are actively involved in discussing, discovering, and using mathematics in different ways. When computers are properly integrated and creatively used, they
can be a powerful tool.

In England, 1991 the General Certificate Examination of Secondary Education (GCSE) requires students to respond orally to questions in mathematics; to discuss mathematical ideas and to carry out mental calculations, and to carry out practical and investigational work (DES, 1985, pp. 2-3).

"In England, the examination system is being used as an instrument to bring about large-scale change not in syllabus content, but in teaching and learning methods, and in advance of general classroom practices" (Price, 1989, p. 381).

Straker states that the microcomputer can be used in at least three ways:

1. as a teaching aid
2. as a learning resource
3. as a tool for the pupils to use in doing mathematical tasks (Straker, 1989, p. 135).

The power of today's microcomputers has implications for the practice of mathematics teaching that are so extensive that it is difficult to present a balanced appraisal without seeming to exaggerate (Fletcher, 1983). The computer has an impact on the classroom environment and if it is used intelligently, it can allow students to learn mathematics more easily.

The use of computers has a considerable importance for the learning mathematics. Computers should play an increasingly central role in mathematics teaching. To use computers effectively, adequate teacher education and provision of sufficient hardware and software should be provided in mathematics classroom. One of the many positive features of the microcomputer is that by using appropriate software, mathematical situations can be presented to students in an open, unpredetermined way (Ernest, 1988). This means that the microcomputer opens the possibility of a new approach to the process aspect of mathematics in the
The purpose of using computers in mathematics is to encourage learners' interest and involvement in their mathematical learning.

"To achieve these, learners need to be in control of what they are doing. At present turtle geometry and the use of relatively limited software packages appear to be most effective for this" (Ball, 1987).

In addition, the use of microcomputers can be encouraged by provision of software consisting of simulations, investigation and support materials. Using computers to support the teaching and learning of mathematics requires careful planning, good software and appropriate back up material.

Wishart's study (1990) shows that users are interested in controlling the computer, perceiving challenge from the computer, exploring the complexity of computer software. When the program was controlled by users, it was important to create involvement, and involvement affected active learning.

Software should be very important in mathematics teaching and learning, in particular problem solving. Hypothesizing, organising data, drawing inferences, using inductive and deductive reasoning, and comparing and contrasting can be taught for teaching problem solving.

Recent studies using traditional methods of teaching show that while students may attain a mastery of an operation such as multiplying whole numbers, they often have little idea of when to use this knowledge (Driscoll, 1988). Students must not only know "how" but also "why" and "when".

The use of database and spreadsheets in mathematics provides an opportunity for students to participate in realistic problem solving activities within the school setting. Database and spreadsheet have important applications in mathematics. Students must understand when it is appropriate to use these tools for problem solving. There are potentially powerful computer tools, but
considerable work is necessary to improve problem solving skills. If they are going to be designed for mathematics classroom, and when this work is done with suitable hardware, students may be able to solve their own mathematical problems.

Programming can also be used as one method of allowing students to experience real world problem solving. NTCM (1987) suggests that

"Computer programming activities in mathematics classes should be used to support mathematics instruction" (NTCM, 1987. pp. 1-2).

In constructing a procedure, or program, for execution by a computer, students must follow a problem solving model: defining the problem, testing the solution, and revising the program. These are fundamental to all problem solving.

There is an urgent need to move away from the heavy emphasis on learning and practising procedures to an emphasis on teaching students how to apply mathematical thinking to real life problem situation.

Computers can help students in creative thinking and problem solving at cognitive level. Therefore, computers should be integrated in mathematics curriculum in ways that make them possible for students to grasp concepts more quickly, and for students to spend less time learning mathematics and more time doing mathematics. Since computers have appeared with increasing rapidity in school, many schools see their own main needs as obtaining computers. The place of computers in classrooms is no longer disputable. However, there is no need not only to put computers in schools, but to make the appropriate application to teaching and learning. If computers are not used properly, they cannot help in mathematics teaching and learning.

There have also been lots of research to show the effectiveness of the use of computers in mathematics.

Wright (1983) examined whether students involved in CAI in mathematics showed a greater gain score than conventional instruction in three classes during the summer
The quasi experimental design was statistically analysed using a one way ANOVA and Scheffe tests enabled analysis of students' pretest and posttest performance level on the comprehensive test of basic skills using means and standard deviations. The major focus of this design was on the independent variable of computers in instruction as the treatment and the dependent variables of mathematics achievement test scores.

The experimental treatment of CAI was administered in two experimental groups during a six weeks summer school session. The control group was traditional classroom instruction. An analysis of data from this study shows that CAI produced significantly higher achievement as compared to conventional classroom instruction in these particular classrooms in two selected California school district with similar populations.

Another study was made to show teaching concepts and properties of parallelograms by a CAI program and a traditional classroom setting by Austin (1983). This study compared the performance of 32 pre-service elementary teachers, who received instruction about parallelograms from a computer assisted instruction program, written for this study and 37 pre-service elementary teachers, who received the same instruction from a teacher in a classroom setting. The instruction used was identical for both groups. After one week, the students were given post-test. These scores were used as a measure of the students' achievement and were compared using an analysis of variance procedure. The results indicated that the CAI group had significantly higher mean post-test scores than the students in the teacher's classroom group.

In Heig's study (1984), an exploratory effort designed to generate grounded hypotheses concerning the use of the microcomputer as a tool to implement a recorded introductory calculus curriculum. Traditional introductory courses in calculus manipulative skills were organized before concepts in emphasis as well as in sequence. The experimental curriculum emphasized concepts, applications, and problem solving, and used sophisticated computer software (including a symbol manipulator, a function
graphics, and other calculus demonstration programs) as the primary executors of basic calculus skills.

Data were gathered on the experimental group as well as on a traditionally taught comparison group. When the comparison was made, experimental class students showed remarkably deep and broad understanding of course concepts. The microcomputer as a tool appeared to play a significant role in concept development and in encouraging a variety of mathematical explorations.

Sasser (1984) examined the relationships between methods of CAI in mathematics and the learning modality preferences of students. In his study, the instructional methods, which were visual tutorial, visual auditory tutorial and programming problem solving, were compared for effectiveness in improving algebra skills and attitudes towards mathematics. The sample consisted of 79 seventh-graders enrolled. Each student was randomly assigned to one of the three methods. A modality preference test was used to determine subjects' preferred learning channels; visual, auditory, or non-preferenced. Results showed that programming group achieved significantly higher gain scores than the visual tutorial group. As a result, the study proposed the introduction of programming into CAI mathematics programs.

The effectiveness of CAI in mathematics in the middle school was researched in Romera's study (1987). He aimed at determining the effectiveness of CAI as an alternative instructional medium in middle school settings using the drill and practice format as an instructional strategy. The 4 middle school CAI mathematics labs studies were implemented. The district CAI coordinator initially trained four CAI resource teachers and four CAI proctors in the operation of CAI labs. They in turn were responsible to train and help the participating CAI teachers and students. Approximately half of the first and second quartile students were assigned to the CAI mathematics labs on a change basis, with the remaining half used as a control group which received the regular classroom mathematics instruction. The Metropolitan Advanced Mathematics Test Scored was used as the pre-post instrument for both groups.
Results displayed that changes in the achievements pattern for mathematics showed significant differences between CAI and non CAI students. CAI students had higher scores than others.

As has already been mentioned, Wishart's study (1990) also showed that educational computer games may significantly increase learning but only if the learner can control over the action, and in the Schroder study (1988), elementary school students' development and application of probability concepts were assessed while they were playing and discussion two strategy games on a microcomputer. The question of the study included whether students developed their understanding of probability concepts as a result of experience playing, and whether they develop their understanding as a result of discussing the games with an adult, and whether transfer occurs from one made of learning to another. The methodology of 'a teaching experiment in the experiencing mode' was adopted. Quantitative data were collected by routines in the computer programme, qualitative data collected from the children's verbal reports. It was concluded that the games are suitable activities, and that discussion of them is valuable for mathematics teaching and learning.

The design of the software is extremely important. It is essential for each package to have clearly designed objectives. Educational software could be more useful if it provides user with the opportunities to control and offer a generator variety of challenge (Wishart, 1990).

Computers have become an important tool in the mathematics teaching and learning but if they are not used properly there cannot be any effect on learning and teaching. Some studies showed that there is gain in learning and teaching with computers.

Diem (1982) searched the effectiveness of CAI in college algebra. Her study was designed to determine the extent to which microcomputer instruction affects the learning of mathematics in college algebra when used a substitute for traditional methods of instruction. The computer programmes involved in the study were designed to teach students how to find and graph the solution set of
linear inequalities with two variables.

The subjects involved in the study were enrolled in two sections of a college algebra course in a university class. The students were randomly assigned to four groups and each group was taught using varying methods of delivering instruction. One group received traditional classroom lectures followed by textbook homework. A second group was exposed to a computer tutorial program followed by textbook homework. A third group received a classroom lecture followed by a computer drill and practice programme. A fourth group completed both the computer drill and practice programs. Each group was administered a pre-test to determine the extent of their knowledge of the subject matter, establish the randomness assertion, and to determine whether or not the grasp were equivalent at the outset. After each group received instruction, a post test was administered to determine relative levels of achievement. Analysis of variance was used. The results indicated no significant differences between the four groups in the study.

In another study, Bamberger (1984) looked at the effect of LOGO on the problem solving strategies used by fourth grade children. The purpose of this study was to determine the effect of learning the programming language LOGO on the problem solving strategies used by fourth grade children while they solved mathematical word problems without a computer. A secondary purpose was to investigate whether children who had learned LOGO would regard mathematics more favourably. In the attitude measure significant differences were found only between the experimental and control group on their general attitude toward school.

The comparative effectiveness of microcomputers and flash cards in the drill and practice of basic mathematical facts was looked at by Fuson and Brinko (1985). A flash card procedure was designed with some of the features of microcomputers for the drill and practice of basic facts. Second, third and fourth graders followed the same daily routine for 6 weeks in either a flash card or a microcomputer condition, practising basic facts in
substraction or division. Weekly tests revealed learning in the first 2 weeks, little or no learning in the third and fourth weeks, and similar learning in the fifth weeks, when the groups changed practise conditions. The flash card and microcomputer conditions produced equivalent learning.

There was no difference between the microcomputer and flash card drill when the drill pretested a standard set of problems for practice primarily for speed (as with the substraction group) or when the drill was based on sets of problems individually tailored to the errors of a particular division. Results showed that microcomputers in schools remain a scarce resource; uses other than for retrieval drill are probably wiser. Such facts evidently can be effectively practised using a much cheaper alternative, that is, home-made flash cards, if these are used in a manner modelling computer presentation and feedback results.

In another study, Ernest (1988) looked at the use of microcomputers to teach mathematical problem solving skills to 13 year old students. Twenty-one children worked with six microcomputer programmes generated problem situations in two and half hours. While nine of the children worked 'hand on' with microcomputers, twelve of the children were class taught, with a single microcomputer used for demonstration purposes. Results of pre and post test scores showed that no significant gains in achievement were made by either group.

Much work is still to be done in the use of CAL in mathematics, including the preparation of new material. However, even use of effective software requires teachers; teachers can guide to ensure software being used effectively. Therefore, teachers' in-service education is very important. Mathematics Counts (Cockcroft, 1982) suggests that in-service work is most likely to be successful if that in-service training provides what the teachers themselves feel is relevant.

Teachers need to be given a course about how important it is to think about problem solving, critical thinking and how they can help to enhance students' problem solving, and critical thinking activities in mathematics. Even if the software helps and encourages problem solving,
creating, critical thinking, teachers have to know how to use this software effectively (Wishart, 1990).

"The use of computer as a tool will test the teacher's organisational skills" (Underwood, 1985, p. 34).

However, the majority of today's Turkish teachers have never received appropriate training in these skills. In-service training is very important for teachers to guide their students to use software in mathematics effectively. Of course, it is very important and necessary to use computers in mathematics, but what is more important is to use them at the right time and in the right place and in the right way; otherwise, computers will have little effect on teaching and learning mathematics.
CHAPTER 2

BACKGROUND TO THE USE OF COMPUTERS IN MATHEMATICS
IN LYCEES IN TURKEY

2.1 Introduction

The cradle of many civilisations, Turkey is a republic founded in 1923 after the collapse of the 600 year old Ottoman Empire. It lies partly in Asia and partly in Europe. Its location in two continents has been a central factor in its history, culture and politics. It has often been called a bridge between East and West, because of its location, its bordered by the Black Sea on the North; Iran and USSR on the East; Iraq, Syria, the Mediterranean Sea on the South; the Agean Sea on the West; and Greece and Bulgaria on the North-West. The total area of the country is 780,576 square kilometres and the population according to the 1985 census is 50,664,458. The official language is Turkish.

For administrative purposes, Turkey is divided into 71 provinces, Ankara is the capital of the country. On October 29, 1923, the National Assembly declared Turkey to be a republic and elected Gazi Mustafa Kemal (later known as Kemal Ataturk) president. A multi-party system was introduced in 1945, but 15 years later the government was overthrown by the Turkish Armed Forces and the country became ruled by a body of military officers. In July 1961 a new constitution was adopted, and in October after a general election, a civilian government was appointed. A new
constitution was approved by a referendum in November 1982. The new constitution provided for the separation of powers between the legislature, executive and judiciary and the holding of free election to the Grand National Assembly which has 400 members elected every five years. Following the General election on November 6, 1983 the military leadership handed over power a newly elected civilian government (Whitaker's Almanac, 1988).

2.2 The Turkish Educational System

In the eighteenth century, The Ottoman Empire was affected by the economic and political changes in European countries. In this century, industry and technology developed very quickly, but the Ottoman Empire did not adapt itself to these changes, gradually loosing its economic and military powers. Because of these reasons, administrators of the Ottoman Empire attempted to modernize in order to regain their old powers. In the Ottoman Empire, reformist movements were begun in the middle of the eighteenth century and continued until the establishment of the Republic of Turkey. In particular, the Educational System changed quickly due to the changes in the army and administration. In the First World War, The Ottoman Empire sustained a defeat, and at the end of the war, it lost a great deal of its lands. Inspite of these negative conditions in 1919, the Independence War was begun by Mustafa Kemal, and in 1923 the Republic of Turkey was established. In these years, Educational Institutions were lacking in both quality and quantity. By the establishment of the Republic of Turkey, Educational Institutions were widespread and modernized. The structure of the Ministry of Education was changed. The first important change in Educational Institutions was the ending of religious schools and the establishment of secularized education under the responsibility of the Ministry of Education. The Second important step, which affected the Turkish Educational System, was the acceptance of Latin Characters in 1928. These changes led to the launch of classes designed to develop a literate population. In 1929, the government made it compulsory for all people between
15-45 to attend these schools (Fidan and Erden, 1987).

Now, in Turkey, Educational Institutions are the responsibility of the Ministry of Education except for some preschool educational institutions and universities. Universities have been governed by the 1981 Higher Education Act.

In Turkey, the general purposes of the educational system have been determined by Basic Law of National Education. According to this law, The Turkish Educational System has 14 principles. These are briefly,

- Universality and equality,
- Requirements of individuals and society,
- Orientation towards an integrated society,
- Educational rights,
- Equality of educational opportunity for all,
- Continuity,
- Atatürk's reforms and principles,
- Education for Democracy,
- Secularism,
- The promotion of Science,
- Coeducation,
- Future organisation,
- Cooperation between school and family,
- Education everywhere (Akyuz, 1988, p. 8).

IT can be delivered for "equality of educational opportunity", "continuity", and "education everywhere".

Equality of Educational Opportunity

"All citizens, male and female are assured equal educational opportunity and educational institutions are open to every individual, regardless of language, race, sex and religion" (Basic Law of National Education, Article 24).

It is expected IT will increase the schooling ratios, improve the quality of education and level of
regional differences apparent in schooling (Fidan, 1988).

Continuity

"It is essential that general and vocational education of individuals should continue throughout life. In addition to the education of younger generations, necessary measures will be taken to provide adults continuing education to help them achieve constructive and productive adjustments to life and to their work environment" (Basic Law of National Education, Article 24).

The pace of technological change in society is increasingly sharply and no one can now expect the skill and knowledge which they posses at beginning of their working lives to be adequate until they retire. It aided learning can be provided more widely learn at an appropriate speed and convenient times (IT Cabinet Office, Advisory Panel, 1986). Adequate training for people in their work would be provided by IT. People need to embrace the opportunity to update their skills.

Education Everywhere

"National education objectives will be pursued not only at educational institutions, but also at home, in the environment, on the job, and everywhere and at every opportunity" (Basic Law of National Education, Article 24).

Video-tape, computers, networks and videodiscs can be used in education. They are important support tools. Through distance education and open university, IT would be delivered for those principles, and the aims of those principles would be provided.

An ingredient of the education system which is growing in importance is distance education in Turkey. This is provided by three distinct organisational units:
Despite, their facilities and services are very limited, these facilities and services would be improved by IT. The Distance Teaching Unit of the Directorate-General for Apprenticeship and Adult Education operates the theoretical content of the apprenticeship in electrical trades. It comes 3 years and headmaster certificate in the subjects. If the experience with electricians' course proves successfully, distance education is expected to be extended to other subjects (The Turkish Government Report, 1988).

The Open University at Eskisehir is accessible to all high school graduates who cannot obtain places at a conventional university. Most of the work is done by correspondence, but there are also television courses. Video tapes are also made available (OECD, 1989b).

TRT has a Department of Educational Programmes which transmits 10 hours of a Radio Programs a week for primary and secondary schools from September to July.

The use of IT can help to establish a nationwide standard of course delivery. Job-related training could be carried out using IT in the form of computer programs, films, video tapes, and interactive video disks developed centrally by acknowledged experts in their fields. Thus, IT could be firmly established as an important support tool.

2.2.1 The Administrative Structure of the System

During the independence War, the first Ministry of Education was established under the responsibility of the Government of Ankara. The Ministry consisted of the Departments of Primary Education, Secondary Education, Culture and Statistics, and only 21 people worked there. There were 2345 schools and 2861 teachers in Turkey (Basgoz
and Wilson; 1968, p. 39). The structure of the Ministry of Education proved inadequate to meet the pace of reform and expansion of the educational system. In 1926, the Ministry of Education was changed and improved, and the new Departments of Teaching and Training and Student Health Service were established by this law.

From 1926 to the present day, changes within education paralleled economic, political and social changes within Turkey. As was mentioned before, all educational institutions are the responsibility of the Ministry of Education, except some preschool educational institutions and universities. Besides the Central Organization of the Ministry, in cities, the Head Office of Education is the responsibility of the Governor. In counties, the head office of education is the responsibility of the Governor of the District.

2.2.2 The Level of the Turkish Educational System

In this section, the levels of educational systems will be reviewed so that readers understand this system more clearly. Education according to age in Turkey is shown in Table 2.1.

. Primary Education In Turkey

Primary education is an educational stage which guides and prepares the students' basic skills. We see that some pupils carry on their schooling, others go to work. In Turkey, Primary Educational Institutions cover infant, primary and middle school. The aim of this stage is to provide children with the abilities and skills required for integrating into society.

. Pre-School Education In Turkey

Preschool education is an educational stage which should provide physical, mental and social development for children between 0-6 years, and prepare them for primary school. This stage is very important, because at these ages, children's physical, social and mental development is very quick. Research about this subject has shown that,
### Table 2.1

The Structure of the Turkish Educational System

<table>
<thead>
<tr>
<th>Education Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary</strong></td>
<td>Kindergarten (0-3), Nursery Schools (3-6)</td>
</tr>
<tr>
<td></td>
<td>Primary Schools (7-11), Compulsory</td>
</tr>
<tr>
<td></td>
<td>Middle Schools (12-14)</td>
</tr>
<tr>
<td><strong>Secondary</strong></td>
<td>General Lycees (15-17)</td>
</tr>
<tr>
<td></td>
<td>or Technical Lycees (15-18)</td>
</tr>
<tr>
<td></td>
<td>or Occupational Lycees (15-18)</td>
</tr>
<tr>
<td><strong>Higher</strong></td>
<td>Universities 18 or 19</td>
</tr>
<tr>
<td></td>
<td>Technical Occupation High Schools and</td>
</tr>
<tr>
<td></td>
<td>Occupational High Schools upwards</td>
</tr>
<tr>
<td><strong>Further</strong></td>
<td>Writing and Reading Courses</td>
</tr>
<tr>
<td></td>
<td>Technical Occupation Courses 19 and upwards</td>
</tr>
<tr>
<td></td>
<td>Commerce, Woodwork, Needlework,</td>
</tr>
<tr>
<td></td>
<td>Art, Craft etc...</td>
</tr>
</tbody>
</table>

Improvement at these ages affect the children's future lives to a great extent (Bloom, 1964, p.72).

The preschool educational level is the least developed stage in Turkey. After the establishment of the Republic of Turkey, the government encouraged primary education but because the public sources have limited funds, the preschool educational level has not been improved. While part of the preschool educational system is under the Ministry of Health and Social Help, part is also under the...
Ministry of Education. Therefore, it is very difficult to control and organize this sector. These Institutions serving these age group are established in big cities, and children who come from rich and educated families can attend these schools.

. Primary Schools in Turkey

Primary schools are the first stage of primary education: writing and reading, solving basic problems, using their language correctly are achieved there. In the primary stage (7 - 12 years), schooling is compulsory. Over 95 percentage of children attend primary schools.

The children are prepared to go on to higher education or to leave and so live by their achievement. In particular, in developing countries, which have limited educational possibilities like Turkey, primary schools are very important for individuals to achieve basic knowledge and abilities.

. Middle Schools in Turkey

Middle Schools are the second stage of primary education which continues for 3 years. The students are prepared for General, Technical or Occupational Lycées. In the beginning years of the Republic, middle schools only educated students for General Lycées. Between 1930-63, Occupational Lycées were built and middle schools started to prepare students for these. Until 1970, there were not enough Middle Schools, but after 1973 the number of middle schools increased quickly. However, the number of students who attended these middle schools did not increase very quickly. Although some pupils carry on their schooling, others leave schools to take up employment. 54% of students who graduated from the primary school did not attend a middle school (SPO, The Fifth Five Year Development Plans, 1984-88).

. Secondary Education in Turkey

Secondary education is an educational stage which covers students between 15-17. This guides and prepares students for universities, and also trains the required
manpower to enter working life in the shortest possible time. Secondary Education is provided by General, Occupational and Technical Lycees. Whilst the training in General Lycees lasts only 3 years, that in Occupational and Technical Lycees lasts 4 years.

Secondary education is very important in order to train the intermediate manpower in the numbers and quality required for development. In other words, the aim is to train skilled workers, foreman and technicians and also to prepare some young people for higher education. While the Occupational and Technical Lycees train the intermediate manpower, General Lycees prepare students for Universities. Occupational and Technical Lycees are vocational and prepare students directly for the work place in the shortest possible time.

Industry and technology is developing in Turkey and occupational and technical education is very important. The Government has encouraged widespread development of this kind of Lycees in Turkey. While there were only 52 Lycees in Turkey in 1927, there were 1345 in 1988 (The Ministry of Education Document, Document of Department of Planning and Coordination, 1988). At the same time, the number of the students in Lycees has increased. However, general Lycees prepare students for Universities. When these students graduate from the Lycees, if they cannot enter the universities, they cannot find jobs easily. Thus, the number of unemployed people is increasing in Turkey and it is necessary to make more place available in Occupational and Technical Lycees in order to train intermediate manpower.

. Higher Education in Turkey

Higher Education is an educational stage which depends on secondary education. Different types of university organisation have been observed in Turkey since the first modern western style university. The university of Istanbul was established by re-organizing the Ottoman university (Darulfunun-u Osmani) in 1933.

28 universities (27 state and 1 private) are governed by a common law, namely the Higher Education Act. All Turkish Universities, except The University of Bilkent,
are state-financed.

A system of university education has developed which includes both traditional universities (i.e. those based on chair system) such as the University of Istanbul, Istanbul Technical, Cukurova and Tigris and relatively new universities (i.e. centralised universities) such as the Middle East Technical University (METU), Hacettepe and Bosphorus.

In 1981, the introduction of the new Higher Education Act put largely autonomous universities under the strict control of the Higher Educational Council (HEC), which consisted of representatives from universities and outside interests. The HEC is the policy-making body in the area of Higher Education. One of the considerable changes that was brought about by the Higher Education Act concerning the overall structure of higher education system was that the academic teacher training colleges, two or three year high schools were no longer to be established. Those already in existence including state conservatories and higher institutions of Islamic studies have had their status changed and they are now attached to the universities.

The idea behind this change was to remove differences between the traditional universities in favour of the latter and in order to centralize the administration of all universities. This is because the traditional universities had scattered and diversified higher education institutions. There was little co-ordination among them even though they used to receive their financial resources through the same channel—i.e. the administration of the university. They were entirely independent in the use of their resources and in the organisation of their curricula. Each similar faculty or chair may have had different administrative structures. The affect of centralisation has been to modify the degree of autonomy enjoyed by the universities (Basgoz and Wilson, 1968). The existing 28 universities are located in only 18 provinces. There are 3 degrees; B.A., M.A and Ph.D. The B.A. degrees continue for at least four years, the M.A degrees for two, and Ph.D degrees for four years. In addition, some universities have
'Technical Occupation High Schools' which aim to train intermediate manpower in different areas and these courses are of 2 years duration.

Since the establishment of the Republic of Turkey, the number of students and academic staff in universities has increased. In spite of this, the schooling rate in Higher Education is only 8%, whereas, the equivalent figures in the USA is 58%, in England 20%, in Syria 18%, in Greece 17% (SPO, The Fifth Five Years Development Plan, 1984-88, UNESCO 1981).

2.3 Computers In Education

The pressure on any one educational system can differ in quality and intensity from one society to another. In Turkey, factors such as the population explosion, the increase in the birth rate, and the proportion of young people to older people differ from western countries. In Figure 2.1 the increase in the population rate since 1935 and the prediction of it until 1995 are shown.

Figure 2.1

Increases in Population Rate Since 1935 and Its Prediction Until 1995

population (as million)

30 40 50 60 70 80 90 (years)

Source: (State Statistical Institution Report, 1988).

In particular, in western countries, while the rate
of growth comes to 0, and sometimes it shows (-) value, this proportion is 2.3% per year in Turkey. On the other hand, in industrialized countries the older population is higher than that of Turkey; half of the population in Turkey is younger than 20 years old, the proportion of over 65 is 4.2%.

In Figure 2.2 the distribution of population according to age groups as percentages in Turkey is shown.

Figure 2.2
The Distribution of Population according to Age Groups in Turkey

The population of Turkey is very young and the growth of population is very high and this leads to high pressure and demands on the educational system.
The population of Turkey is increasing. Approximately 12 million pupils, and 400,000 teachers are in full-time education and approximately 1 million pupils also join the educational process every year. Schools are often crowded and a class size of 40 to 50 is common. Teachers are usually expected to teach from 20 to 40 hours a week. 53% of this young population live in cities, but for the 47% of them who live in rural areas, there are major problems in providing them with an efficient education. There are many deficiencies which affect the educational system, including lack of staff, lack of buildings, and lack of instruments.

The last decades have seen introduction of a range of reform in Turkish Educational System. Besides, solving of the educational problems have been looked in new technologies. That is why, studies of computer education have been started in order to increase sufficiencies and productivity in education using technological innovations and improvements.

The study of and use of computers in the Turkish Educational System were limited until the 1980s to the universities and a few technical schools which offered computer science programs and computer programming courses for management and research purposes. With the advent of cheap micro-computers, a considerable amount of computer hardware has started appearing in public and private schools in Turkey at a rapid rate (Fidan, 1988).

There are now approximately 4,000 computers in educational institutions. At first, priority was given to hardware more than software and to the teaching of "BASIC" programming but changes are now taking place and these will be discussed in detail later.

Let us turn to review developments in the use of computers in Turkey. Computers have been used in the Ministry of Education's Department of Testing and Researching, in The Central Bank, in some public services for more than 25 years, and by the end of the 1960s some universities had started to use computers. It is now very common to use computers for administration in Higher Education Institutions as well as in public services and,
since 1975, after educational institutions started to use computers the most computers (78%) have been used in the private sector, others (22%) have been used in the public sector. Distribution of computer software according to programming language are BASIC 39%, COBOL 31%, FORTRAN 16%, RPG 9%, PL/I 3% (Bircan, 1987, p. 16). BASIC and COBOL are the dominant programming languages.

Computers have been particularly used for commercial applications and also industrial and scientific applications. But the Educational System was affected very late by computers in Turkey. Some universities and a few technical schools had a computer science programme, and computer programming courses, but as a result of technological developments in information technology, computer sciences and engineering programmes have been established leading to bachelor, MA and PhD degrees. There are also some departments which have trained software and hardware engineers. At the same time Technical High Schools have some programming departments to train intermediate manpower in this subject.

Most of the universities have computers and in particular, METU and Bosphorous universities are the leaders in this field. Universities show big differences between each other in intensity and quality of the use of computers. Computers in universities have been used for academic and commercial purposes. Generally, the aims of using computers in education in universities are to teach students how to use computers and how to programme. Almost all universities which have computers and computer departments, have provided computer courses to private or civil institutions. In recent years, other sectors such as banks, press, and public institutions have given big attention to the use of computers in their own area. Generally, university computer usage focuses on the machine itself rather than on the use of the machine to support other subject areas.

Reasons for adopting computers in schools vary from country to country. The Turkish Ministry of Education's policy is to serve the national needs for modernisation and reconstruction. In general, our policy on computers in
schools is based on the greatest benefit going to the greatest possible number of students, but in the service of society as a whole, The Ministry of Education declared a policy of widespread introduction of computers in schools. The Minister of Education is quoted as saying "Training the children to use computer at an early stage through the schools systems makes it easier for them to grasp concepts of advanced computers technology at a later stage (The Government Report, 1988).

Short term political gains from adopting computers in education lie chiefly in the public's awareness which brings favourable publicity to the government. Short term gains have also come from in the approval of local manufacturers, assemblers, importers retailers and repairers of computers and supplies of software. The Ministry has also gained support from the industrial and commercial sectors who anticipate being able to employ students who have learned about computers at schools.

Recently, the Turkish Government, through the Ministry of Education, has placed a special emphasis on the utilization of computers in schools and on Computer Assisted Learning (CAL). As the prime Minister Stated, "Turkey is going to provide the schools of the nation with one million microcomputers in the next decade." It is the most expensive and largest project in the history of the Turkish Republic's Education. This means approximately 600 million US dollars of additional investment in education (Fidan, 1988). In order to initiate the computer assisted learning (CAL) with this target in view, a project was started under the responsibility of the Ministry of State for Scientific and Technological Affairs and the Ministry of Education.

"Computer Assisted Learning Project 1 (CAL1)" was prepared and an administrative unit was established immediately in 1984. A committee, which included representatives from the universities, and companies or institutions in the electronic industry, was constituted by the Ministry of Education in order to determine the framework of that project, the principles underlying the use of Computer Assisted Learning, and the hardware and software which could appropriately be used in the project.
Through realization of the project, the Turkish Government aimed to prepare the children and youth of the nation for a world of computers and of new information systems and technologies. It was also expected that CAL would increase the schooling ratios of the Elementary and Secondary levels and improve the quality of education and level of regional differences apparent in schooling. Thus the project was conceived as one of the strategic investments of scientific and technological advancement of the Nation.

In 1985-86 school year, a pilot study was begun by the Ministry of Education, a total of 1100 computers were given to 121 secondary schools at a ratio of one computer to one teacher or one computer to ten students. In this study, some of the teachers involved were trained in order to give computer appreciation training, however, this study did not succeed.

Computer companies saw that educational institutions would be a good market for them. As a result of technological developments in the world, the Turkish Government tried to adapt to these developments and computers suddenly came into our lives in Turkey.

The Government's enthusiasm for the use of computer in education gives little time for the structure of the project to be developed. It is obvious that such applications in education need to be carefully planned for development. That is why development of a comprehensive plan for CAL is very important.

In this project, first of all, in-service training was started, teachers were trained in a short time. It was not enough for them, and a very small percentage of teachers (484 teachers) were introduced to CAL as a part of their teacher training program and they were trained very generally. Four teachers were randomly chosen from each pilot school randomly for in-service training for 5 weeks (The Ministry of Education Conference, 1987).

After in-service training, CAL was started in 121 secondary schools with 1100 computers. During this project, CAL was undertaken for 3 hours per week, but these courses were planned to be given as one of the elective courses.
since 1987/88 school year. In this project (CALL), software was imported without paying much attention to what the curriculum required. The Curriculum needed to be analysed, and the software was not convenient to the available curriculum. While the universities and Turkish companies did prepare some software, it was not enough and consequently, this affected the educational uptake of CAL.

In Turkey, evaluation of CALL project could not be made, because the project was not carried out for a long enough time. Also curriculum was not changed and the project was implemented to integrate into the existing curriculum.

In the second week of October 1987, in cooperation with the two responsible Ministries, an International Conference was held in Istanbul. At that Conference, the main features of the Turkish CALL project was introduced to representatives of the universities, computer industry, institutions which have vested interest in the project, and to the experts in computer science and Computer Assisted Learning. During the conference, the project was discussed (Fidan, 1988). As a result, it was seen that, Turkish Universities with accumulated skills and research centres in computer sciences and computer assisted learning could play an important role in the realization of the project.

In 1989, a second new project, CAL2 project, was started. A new committee was established under the responsibility of the Ministry of Education. The committee scrutinized and evaluated the studies of the first project to understand why the project was not succeeding. This committee asked the universities and the computer companies to help them in order to realize the CAL2 project.

There were 28 companies which wanted to be involved in CAL2 project in Turkey: ELECTRONIC VENETA (Italy), DANSIC DATA & UNICS (Denmark), HOFBAUER & SIEMENS AG (Germany), SOPHA DEVELOPMENT & LEONARD (France), WICATT, LJ TECHNICAL SYSTEMS & TANDY (USA), and the remaining companies were from Turkey.

In the early stages of development, there has been strong competition from vested interests who want to control the training. Whoever controls training and training objectives at the pilot stage has a good chance of strongly
influencing major decisions at the development stage of the programme: including choice of hardware, location and character of further training, and method of development software.

In this context, close cooperation among departments of computer sciences, teachers and curriculum specialists needs to be established. The universities have new responsibilities for preparing teaching staff, courseware and conducting research at various phases of computer assisted learning (Fidan, 1988).

With the cooperation of companies, in-service training was started in the CAL2 project. Forty-six schools were defined from three big cities (Istanbul, Ankara and Izmir) for the pilot study which started in September 1989/90 school year in Mathematics, Chemistry, Physics and Language Courses. However, just before starting the pilot study, the Ministry of Education narrowed the project to mathematics only, but no school subject has clear responsibility for teaching information technology. Computer studies have been running for a few years. This has proved popular with educationalists but less popular with students, because educationalists saw computers as a solution of every kind of learning and teaching problems. Therefore, they were willing to use computers in their teaching. But despite this, students were offered no computer based teaching. Students did not like using computers in their learning, because of the badly written software, lack of suitable support material. It is now apparent that computers are not a cure all for educational ills. Courses in computer studies are well established on the timetable but the use of the computer to support other curricula areas has been slow to develop. Equally, although the teaching profession has been enthusiastic about the use of computers in education, students have shown greater reluctance to become involved in machine mediated learning.

In this project, computers were purchased by the Ministry of Education and Parents/Teachers Association. In the pilot study, computer companies, chosen by the Ministry of Education, put forty computers into selected school and they prepared the software. This software was on loan to the
Ministry of Education until the end of April 90. The Ministry of Education selected software which was suitable for CAL for 1990/91, and this was distributed to schools for use by teachers and students.

The committee overseeing the CAL2 project has aimed to increase the quality of education and the efficiency of the national education system through the use of new educational technology. To realize this aim, firstly, they decided to prepare new curricula. Secondly, they decided to provide software and hardware for CAL, and lastly they decided to train qualified manpower/staff. With these aims, the committee started a pilot study in selected schools with an efficient organization and enough finance in September 1990.

They planned evaluation studies to monitor the spread of CAL to all levels of education according to a MASTER PLAN which will be prepared using the results of this pilot study. In this project, the pilot study has been planned to last 1 year and the Master Plan for 10 years. The administration and evaluation of this project is to be implemented by an executive council as shown in Figure 3.

In Figure 2.3, the Administrative Organization of Committee of Turkish CAL2 Project is shown. The Ministry planned to establish this administrative organization but the structure was never set up.
Figure 2.3
Administrative Organization of Committee of Turkish CAL2 Project

Ministry of Education

- Advisory Council of the Project
- Orientation Council of the Project

Executive Council of the Project

- Group of Curriculum Specialists
- Group of Software Specialist
- Group of Hardware Specialists
- Group of Evaluators

UNIVERSITIES & FIRMS

SCHOOLS

Source: Report2 of Committee of Turkish CAL2 Project
2.3.1 Universities' Policies on Computer Based Education in Turkey

There are seven Turkish universities with well established departments of computer science and electronics. They are the universities of Bosphorous, METU, Hacettepe, Istanbul Technical, Yildiz, Agean and Bilkent. In these institutions, skills in all aspects of computer technology are highly developed and research activities are increasing. On the other hand, subsections of educational technology in departments of education are few in number and have been only recently established.

Contingents of Computer Sciences of engineering of these universities are shown in Table 2.2.

Table 2.2
Number Students of Computer Sciences and of Engineering at University Level

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<td>METU</td>
<td>50</td>
<td>50</td>
<td>60</td>
<td>60</td>
<td>60</td>
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<tr>
<td>BOSPHORUS</td>
<td>50</td>
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<td>50</td>
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<td>50</td>
</tr>
<tr>
<td>ITU</td>
<td>50</td>
<td>40</td>
<td>56</td>
<td>56</td>
<td>60</td>
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<tr>
<td>HACETTEPE</td>
<td>40</td>
<td>40</td>
<td>41</td>
<td>41</td>
<td>41</td>
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<tr>
<td>YILDIZ</td>
<td>40</td>
<td>40</td>
<td>50</td>
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<tr>
<td>AGEAN</td>
<td>40</td>
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<tr>
<td>BILKENT</td>
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SOURCE: Guides of Students Selecting and Settlement Centre (SSSC)

In addition, there are university departments of computer programming training technicians and programmes.
In conclusion, the use of computers in Turkey has a long history, but the use of computers in education (except higher education) has started only recently. In higher education, although there are lots of computers in lots of faculties, they have been used for administration, keeping personal records, accountancy etc., rather than teaching purposes except in departments of computers science and engineering. Briefly, computer science is now being taught in Turkey, and all engineering students, as well as some from other disciplines, receive obligatory training in computer science.

Initially, the use of computers in education started in universities and then entered secondary schools through occupational and public schools. Nowadays, universities which train engineers on software and hardware have started pilot studies on the use of computers in education as well as in primary and secondary schools.

The country's inability to supply system designers, programmers and hardware technicians needed by industry, commerce, government has generated the political will to establish computer education in schools. It follows that technical support for the schools is likely to be extremely difficult to find and even harder to hold on to.

2.3.2 Hardware and Software Distribution in Turkey

There are many different computer companies working within Turkey. It is common to import different hardware and software from a number of different countries and combine them in Turkey. On the other side, some of the companies have only imported and marketed computers. There are companies which want to produce computers, but they want the government to support them and find a market for them. Turkey builds assembles computers from imported parts and purchases full system from abroad.

The Turkish Scientific and Research Council has started a study related to hardware and software. The study can be divided into two separate phases. The first phase which is completed, is to design and implement on IBM PC/XT Compatible Computer. The second phase is to produce a local
network over these PC/XT's and its upgrades for schools.

The project aims to design and implement a local area network (LAN) including necessary hardware and software. The LAN will be composed of a file server with a hard disc and a printer and there are 15-20 computers. The main target is to achieve a system as cheap and as high performance as possible. Numbers of computers and their make in schools in Turkey are shown in Appendix A.

There are approximately 400 computer hardware companies in Turkey and 70 of them produce software as well, but the income of these firms from preparing software is only 2.7% of the total income. Most of the software in Turkey is commercial such as accountancy, current accounts and invoices. Banking, tourism and reservation programs are also common.

According to the report of committee of the CAL2 project, software has been imported and adopted in the short run, and will be prepared by ourselves in the long run. The Ministry of Education wants universities to help them to prepare software. A list of characteristics of software which is wanted are as follows: flexible, alterable, relevant, valid, motivating, portable (Report of Committee of Turkish CAL2 Project).

2.4 Use of Computers in Mathematics in Turkey

Developments in computers in education have great implications for the teaching of many subjects in schools. Mathematics is one such subject. While computers provide a new tool for mathematical research, they are, at the same time, themselves the source of new areas of research.

Computers are an indispensable tool for the applied mathematician, scientists, engineers and laymen to get numerical answers to practical questions. It is a very useful educational aid in mathematics education for mathematics teachers and students. When the teacher uses educational aids together with his/her presentations, he/she facilitates learning, motivates the students, and captures their interest. Blackboards, overhead projectors, television and video recorders, calculators, books, microcomputers and
software are all educational aids. Teachers need to consider how instructional aids can help students to attain the desired objectives and whether their use can offer an important on what the teacher might ordinarily do without the aids.

An optional computer course was introduced into some of Turkey’s secondary schools in 1987. It is run largely by teachers of mathematics. It seems that it will continue to run by mathematics teachers in the future, but to teach such a course, mathematics teachers who graduated before 1980s need in-service training on computers and educational software. The training programme for mathematics teachers before 1980s did not include any computer related courses. Therefore, most of mathematics teachers who graduated before 1980 have insufficient knowledge to teach computer studies adequately. Now, most mathematics teachers’ programmes include one or two computer related courses.

The syllabus of some Departments of Mathematics Education in Turkey are detailed in Appendix B. Until 1984, mathematics student teachers were taught in the department of mathematics at the Faculty of Science, but they had to take some pedagogical courses from the Faculty of Education. Since 1984, such student teachers have been enrolled in main course mathematics in the Department of Science at the Faculty of Education. Students from the Department of Mathematics can still be teachers but they have to take pedagogical courses from the Faculty of Education. Actually, there is no big differences from previous one.

Usually, mathematical techniques which are taught in schools by using pencil and paper or apparatus means mathematics teaching has been done with the traditional tools in Turkey. The present curriculum is convenient for traditional teaching methods. Our current curriculum may well be best developed by traditional teaching methods.

To develop a well trained cadre of teachers knowledgeable about computers is not easy. At present, it seems there is no plan to realize this goal.

The secondary school mathematics curriculum has many opportunities to use technology, but it is better for such major curriculum changes to be gradual and supplemental.
to the present curriculum in Turkey. Any new curriculum changes imported from outside would generate resistance in the Turkish mathematics educational environment and in the public, as happened in the early 70's when Turkey's schools adopted a "Modern Mathematics Curriculum".

The Turkish educational system needs reform and even radical changes in order to educate the new generation. Turkey has to find some solutions in a short time, and struggle to open its doors to the world. There are already enough pushing factors to build a bridge between the Turkish educational system and new technologies but the possibilities have still been limited.

Two fundamental issues must be addressed. The first is the different ways in which microcomputers can be used to support and improve mathematics teaching at any level. The second is the extent to which the availability of microcomputers should change the content of what is taught or the relative stress which is placed on different topics within the mathematics syllabus.

Today's explosive growth of knowledge has emphasised the importance of teaching students "How to learn" and "How to retrieve information" rather than facts and even skills which may become out of date in the near future. It is a common demand that the schools should give students not only knowledge in mathematics but the skills of thinking independently, creatively, purposely and productively. These goals, in turn, require some methodological changes in the teachers' way of teaching i.e. "teaching to think". It means that mathematics teacher should not merely give information, but should try also to develop the ability of using that information and give importance to problem solving - know-how information and mathematical modelling. That is why the software of mathematical activities which will encourage problem solving and logical thinking are urgently needed today.

The capacity of microcomputers to deliver the new curriculum will also force a major change of the goals and teaching methods in the mathematics curriculum. Of course, it will take some decades for Turkey as it took some decades for all other countries.
Turkey generally has not produced technology; rather, it has imported technology whenever it has been needed. New technologies have entered our daily lives very rapidly. But adapting systems, we must recognize, however, that the purchase of hardware and software is not sufficient for effective use of new technologies. These technologies need to be fully integrated into our administrative or educational system. This means that we must not only recognize that new technologies have impacts on our organizational structures but be prepared to change them. They also require an extensive training programme if they are to be effectively used. Technology does not include only implements but also a certain way of production and methods. The first phase of any developments of technology has required investment of research studies. Developed countries have invested lots of money in these research studies, whereas Turkey has a very limited budget, and there have been a very limited number of research projects in Turkey. However, general technological potential and situations of Turkey, and research activities into new technologies should be examined. Also, we should check how to apply and use these technologies in Turkey's conditions.
CHAPTER 3

RESEARCH METHODOLOGY

This chapter is an account of the research methodology employed in this study. This approach is set out by Checkland in his original paper (1972) and in his comprehensive book (1981). Naughton (1977) has also written a helpful practical guide. Adaptation of Checkland's 'soft' systems methodology to the research is also explained in this chapter.

3.1 System Approach

There are a number of different definitions and usages of the term system and the related terminology, e.g. system approach, system thinking, system methodology have been made in the literature (Hoos 1975; Krajewski and Thompson, 1981).

Churchman (1968) defines a system, in a very broad and general sense, as a set of parts co-ordinated to accomplish a set of goals. He lists the five main aspects of a system as follows:

1. The objectives of the system and performance measures which surrogate the objectives,

2. The environment of the system - set of fixed constraints which limit the behaviour of the system and are not under the direct control of the system's manager,
3. The resources of the system - the money, personnel and equipment available to the system,

4. The components of the system - the operations and functions performed in each of its subsystem,

5. The management of the system.

A very good adaptation and summary of the system terminology is made by Brember (1981). A system approach views the world as a complex of interacting sub-systems and uses systems thinking to help in understanding the world and its behaviour. System, a model of a whole entity; when applied to human activity, the model is characterized fundamentally in terms of hierarchal structure, emergent properties, communication and control. An observer may choose to relate this model to real world activity. When applied to natural or man made entities, the crucial characteristics are the emergent properties of the whole (Checkland, 1981). Systems thinking involves the use of systems concepts (ideas) and systems methodologies (frameworks for learning) and leads to the construction of models of the system, i.e. system modelling.

The systems approach is a way of thinking about a topic or problem that concentrates on interrelationships. It is characterised by the holistic view that the whole is more than the sum of the parts, as opposed to the elementarist view that the total is sum of the parts (Kast and Rosenzweig, 1979; Ackoff, 1971).

The systems approach is not an attempt to understand everything about a system, rather it tries to include all factors relevant to the topic or problem under consideration (Naughton, 1977). The major characteristics of systems approach are summarized by Olaydin (1988):

- The systems approach emphasizes the importance of the interrelationships which tie the system elements into a recognizable entity,
The systems approach utilizes the methodology of systems engineering to plan and design a system.

The systems approach is objective oriented. It does not start from a detailed analysis of the workings of particular parts of the system. The systems approach concentrates first of all, on defining the correct objectives before contemplating how they are to be achieved.

In summary, the systems approach recognizes the interrelationships which tie a system together. Interrelationships are essentially important to the solution of the problem. Applying a systems approach to solve a problem, requires that the system should be planned and acquired as an entity so as to satisfy the needs of its user. Each system's element has to be planned and acquired by explicitly considering its interrelationships with other elements of the system.

A systems approach uses system thinking and system concepts in order to help in understanding of the system. In spite of its widespread use no generally agreed definition seems to exist for the system concept. Boulding (1956) classified systems according to a hierarchy of increasing complexity which may be summarised as:

1. static structures, e.g. frameworks,

2. simple dynamic systems, e.g. clockworks,

3. self-regulating control mechanism, e.g. thermostats,

4. self-maintaining or open systems, e.g. cell,

5. plant level systems,

6. animal level systems characterised by self-awareness,
7. human level systems characterised by self-awareness, language and symbolism,

8. social systems characterised by communication and values (the present study is concerned with this level),

9. transcendental systems, e.g. unknowables.

Jenkins (1969) states that a system can be broken down into subsystems and is part of a hierarchy of systems. The subsystems contain transformation processes which convert inputs to outputs and subsystems are interconnected since the output of one subsystem forms the input for another.

As Checkland (1972) states, the systems approach by itself is not a methodology, but involves the use of systems methodologies. A methodology is an explicit, ordered, non-random way of carrying out an enquiry. Jenkins (1969) states that systems methodology comprises stages of system analysis, systems design, implementation and operation; formulation of the problem or objective is the starting point. These kind of problems and methodologies in which their objectives are understood, and can be defined as a starting point are termed "hard". They can be viewed as a search for an efficient means of achieving a known end. Checkland (1972) argues that there is a fundamental difference between these hard problems and soft problems because in the latter the end or what should be achieved is part of the problem. This the case in the present study. Checkland (1972) devised a methodology specifically geared to soft problem solving which is called Checkland's 'soft' system methodology. It explicitly includes human beings in the concept of human activity systems and allows for different points of view.

Systems modelling is a subjective process because no two people will look at any particular aspect of the world in exactly the same way. A systems model; is a set of organised assumptions about a particular aspects of the world and the way it works which have been identified as a
system (Naughton, 1977). As is indicated by many authors; (Beishon and Peters, 1976; Ackoff, 1971; Checkland, 1972) identifying systems is not a purely objective process since the purposes and interests of the researcher will be involved.

Consequently, the systems approach was used throughout the research, because it helps to explore various aspects of the topic under consideration from different points of view such as the socio-economical, the technological and the administrative requirements of a model for the use of computers in mathematics in lycees.

Checkland’s ‘soft’ systems Methodology which uses systems approaches has been chosen for this study. The choice is based on four main reasons:

1. It is a system approach,

2. It is useful in terms of building conceptual models - which is part of the characteristics of systems approach and one of the objective of the present research,

3. It is of practical use in real- world problems,

4. It is based on the concept of a human activity system.

3.2 The Checkland Methodology

This section describes the methodology and its associated ideas developed by Checkland. These are set out by Checkland (1972) in his original paper and his comprehensive book (1981). The related terminology is listed in Appendix C.

The Checkland ‘soft’ systems methodology presents an approach to solving problems by using system ideas to find a structure in apparently unstructured soft problems. The approach is based on building a conceptual model following certain guidelines. The conceptual model (and guidelines) can then be compared with the real-world or the
The differences between the two, the conceptual model(s) and the real world, may then highlight problem areas, for which solutions can be discussed or debated by the model builder with the problem owner(s). The human activity system is the central concept of the methodology. It is a system in which human beings carry out some activities and can attribute to the process. Human activity systems are not descriptions of reality but are intellectual constructs used in a debate about possible changes which may be incorporated into the real-world. Checkland stated that these systems are different from the order-processing systems, because such systems contain humans who are able to attribute meaning to human activities.

Consequently, there is no single testable account of such a system. Instead there is a set of possible accounts, any of which may be valid according to a particular point of view. The choice of view is subjective and can not be judged as inherently right or wrong. However, it can be evaluated according to its bearing on the problem situation, a case must be made in defence of the solution choices. A description of a human activity system must be accompanied by an account of the observer and the point of view from which his observation were made.
3.2.1 Specific Stages of the Methodology

Figure 3.1 The Checkland's "Soft" Systems Principles in Summary (1975)
The application of Checkland's 'soft' systems methodology involves seven stages. For brevity the methodology is expressed in the form of a diagram by Checkland. Figure 3.1 represents a chronological sequence and is to be read from 1 to 7, a logical sequence which is most suitable for describing it but which does not have to be followed in using it, as Checkland (1981) stated

"...in principle a start can be made anywhere. Backtracking and iteration are also essential. In an actual study the most effective systems thinker will be working simultaneously, at different levels of details, on several stages. This has to be so because the methodology is itself a system and a change in any one stage effects all the others" (p. 163).

The methodology contains two kinds of activities. Stages 1, 2, 5, 6 and 7 are real-world activities necessarily involving people in the problem situation; stages 3, 4, 4a and 4b are systems thinking activities which may or may not involve those in the problem situation, depending upon the individual circumstances of the study.

Stage 1: This directs attention away from defining 'the problem' to examining the situation in which the perceived problem lies (Brember, 1985). This stage is primarily an 'expression' phase. The intention at this stage is to find out the problem situation. While trying not to impose a particular structure on it. It is a stage where problems are examined and one avoids defining the problem (Olayidn, 1988).

Stage 2: This is the analysis phase where the richest possible picture of the problem situation is built up. The picture enables the selection of a particular viewpoint(s) and identification of a relevant system(s) for
The relevant systems are those human activity systems which the investigator, as the problem solver, has selected as likely to provide insight. Although such relevant systems are based on the 'real-world' of actual occurrences, they are regarded as inputs to the 'conceptual world' that is, a world of intellectual constructs or ideals which only exist in thought or imagination. It is also helpful to think in terms of the 'problem solving system' and 'problem content system' which contain the roles of 'problem solver' and 'problem owner' respectively when doing analysis at this stage. It is also necessary at this stage to look for any record of a slow-to-change 'structure' within the situation and elements of continuously-changing 'process' so as to enable the problem solver to form a view of how structure and process relate to each other (i.e. 'climate') within the situation being investigated. In attempting to achieve as neutral a display as possible, the concepts of 'structure' and 'process' and the relationships between them, that is, 'climate' are introduced at this stage. 'Structure' may be examined in terms of physical layout that is 'slow to change', power hierarchy, reporting structures, and the pattern of communications both formal and informal in an organization. 'Process' may be considered in terms of the basic activities of deciding to do something, doing it and then monitoring both how well it is done and external effects. The relationships between 'structure' and 'process' that is, 'climate' of the situation, is regarded as the core characteristics of situation in which problems are perceived. Generally, the function of stages 1 and 2 is to display the situation so that a range of possible and relevant choices can be articulated.

The identification of the relevant systems is the key to understanding of the situation. The relevant system is one which analysis feels may be relevant to solving the problem. However, selecting relevant systems is not an easy task, Naughton (1977) stated that

"The paradox here is that a Relevant System..."
need not necessarily be one which needs to be engineered to solve the problem. But it should contain the problem, or operate on it some way. Thus, in a company trying to reduce a "materials-flow system" or a "temporary storage-of-components systems"—neither of which is likely to be institutionalised within the existing situation. This is why Checkland recommends avoiding the use of systems concepts in the analysis phase—unless the problem situation is already a highly-structured one (which effectively means that it is a "hard" system). This recommendation sometimes causes confusion, especially since many people regard structure, process and environment as systems terms. In practice, this needn't pose too many difficulties. The confusion has arisen from the fact that when Checkland says the Analysis should not be conducted in terms of systems in the problem situation. What should happen is that one begins by examining the problem situation in a relatively unstructured, informal way and winds up choosing a particular viewpoint and identifying a relevant system. Obviously some systems thinking must enter into the later stages of the Analysis phase "(p. 40).

It is not perverseness on Checkland's part which leads him to caution people against the search for system in the problem situation. There is a great temptation, for example, to attribute systemic order to what already exists, and to identify existing organisational boundaries as system boundaries. The problem, however, may actually be the absence of any coherent systemic interconnectedness despite organisational appearances and assurances to the contrary, and this will become apparent if a system model in placed over the problem in this early stage of analysis.

The Analysis phase is genuinely difficult to carry
out because it requires a blend of open-ended and rather discursive thinking together with an element of purposefulness (after all, one has to come up with a relevant system in the end). The following methods of helping the process along have been recommended and tried with some success.

1. Searching for elements of structure and process in the situation. ‘Structure’ is taken to include the slow-to-slow change elements, ‘process’ the constantly changing ones ... The relationships between the two is an important core of the situation (Checkland, 1975; p. 280).

2. Posing (and answering) the questions:

(a) What resources are deployed in what planning procedures within what structure, in what environments and wider systems, by whom?

(b) How this resource deployment monitored and controlled?

3. Looking for general ‘themes’ in the problem situation. Examples might be things like ‘deprivation’, ‘over capacity’ etc.

Finally, it must be emphasised that the choice of relevant system is entirely subjective. But this does not mean that is an arbitrary choice. It is impossible to judge whether a given relevant system is right or wrong. But it is perfectly possible to judge whether it bears on the problem situation, whether it is coherent, etc. A relevant system must be thus be defensible within two conventions of ordinary logical argument (Naughton, 1977).

Stage 3: This involves naming some relevant systems and formulation of ‘root definitions’ of what these relevant systems are as opposed to what they do. The essence is to
get a carefully paraphrased explicit statement of the nature 
of some system which will subsequently be seen to be 
relevant to improving the problem situation. Such ‘root 
definitions’ are short verbal statement of relevant systems 
(Olayidn, 1988). It makes explicit the point of view 
embodied in the relevant system and tries to capture the 
essence of the relevant system. Using the checklist 
technique called the CATWOE criteria, the root definition is 
created. There are six elements of the CATWOE criteria and 
all must be included. Put into plain English, these six 
elements are who is doing what for whom and to whom are they 
answerable, what assumptions are being made, and in what 
environment is it happening? If these questions are answered 
carefully, they should tell the analysts all that is needed 
(Wilson, 1990; Checkland and Scholes, 1990). A 
well-formulated root definition will contain the following 
elements for which the mnemonic CATWOE is used. These 
elements should not be omitted without good reason:

. Customers, victims or beneficiaries affected 
  by the system’s activities.

. Actors or the people who carry out 
  transformational process.

. Transformational process or activities.

. Weltanschaung i.e. the world image which makes 
  this root definition meaningful.

. Owner, the person or organization who has the 
  power to cause the system to cease to exist.

. Environmental constraints which must be taken 
  as given (Brember).

Here, Client is the ‘whom’, Actor is the ‘who’, 
Transformation is the ‘what’, World view (Weltanschaung) is 
the ‘assumptions’, Owner is the person ‘answerable’ (the 
sponsor, the controller), Environment is kept as the
'environment' (the wider system of which the problem situation is a part).

Thus 'root definitions' have the status of hypotheses concerning the eventual improvement of the problem situation by means of implemented changes which seem to both the 'problem solver' and 'problem owner' to be likely to be both 'feasible and desirable'. Checkland is of the opinion that 'relevant' should not be taken to imply that the system selected is necessarily desirable, or that it is the system which ought to be designed and implemented in the real world. He suggest that we should try to avoid such utopian connotations.

Here the conflict is between the need to be 'pithy' and 'insightful' on the one hand, and to provide a reasonable base for conceptual modelling on the other. There is no such things as a right or a wrong root definition. Naughton (1977) explains how to evaluate root definitions:

1. 'Commonsense' methods. These simply involve subjecting the Root Definition to the kind of scrutiny to which any significant statement should be subjected - e.g. Is it internally consistent? Is it clear? Comprehensible to outsiders? Are there ambiguities concealed in its phraseology? Could it be phrased more succinctly? and so on.

2. Secondly a Root Definition can be evaluated by using the CATWOE criteria devised by Smyth and Checkland (1977).

Naughton (1977) indicates that the CATWOE criteria should be treated with caution. If applied mechanistically, they will tend to exclude short, insightful Root Definitions to the advantage of rag-bag -like definitions which try to include everything.

Stage 4: This consists of conceptual model building. These models are structured sets of activities (expressed as verbs) which are the minimum necessary
activities for the system to be the one named in the root
definition. It is a process model of human activity and it
is not a description of the real world. A conceptual model
is best built at a low level of detail initially, comprising
about seven activities, and then each activity can be
expanded in turn. Sometimes it is helpful to produce written
root definitions when resolving conceptual models, but this
may be unnecessary if there is little danger of introducing
hidden assumptions. A conceptual model should be checked
against its parent root definition and Checkland's formal
system model. The properties of a formal system are
summarised as:

. an objective or goal,
. a measure of performance,
. a decision taking process,
. sub-components which are themselves systems,
. sub-components which exhibit connectivity so that
  flows of information, materials and influences
  can be traced,
. an existence within wider systems or environments
  with which it inter-acts,
. a boundary delimiting the area over which the
  decision taking process has control,
. resources,
. some guarantee of continuity.

Given the adaptation of a relevant system and its
encapsulation in an root definition, two kinds of extended
description of it are possible:

1. A state description -i.e. enumeration of system
   elements and environment, plus description of
   their inter-relationships and properties.

2. A transformational description -i.e enumeration
   and description of the process which the system
   must do if it is to be the system described in
   the root definition. This essentially means
   viewing the system in input/output terms.
Given Checkland's concentration on human activity systems, it is not surprising that he selects (2) at this point in the methodology. Thus a conceptual model is a process model of a human activity system rather than a state description of one. A conceptual model is, therefore, a model of the activity system needed to achieve the transformation described in the root definition. A conceptual model is not a description of any existing system. It is no sense a description of any part of the real world. It is simple 'the structured set of activities which logic requires in a notional system which is to be that defined in the root definition.'

After a private communication with Checkland, Naughton (1977) has pointed out that:

"Once conceptual model building starts there is a noticeable tendency for it to slide into a description of actual activity systems known to exist in the real world. This needs to be resisted because it negates the whole purpose of the approach, which is to generate radical thought by selecting some views of a problem situation as possibly relevant to improving it, working out the implications of those views in conceptual models, and comparing the models with what exist in the real world situation. If description of the real world slip into the model then in the comparison stage we shall be comparing like with like, and novel possibilities are unlikely to emerge. If the conceptual model derives properly from the root definition but still leads to an unexisting comparison then of course the root definition itself was not sufficiently radical, and another version should be tried" (p. 46).

As before, there is no way of knowing whether a given conceptual model is correct or not. Checkland recommends that each conceptual model should be checked against (1) its root definition and (2) the requirements of 'his formal system model'.
(1). implies for example checking to see if the conceptual model includes all the activities implied by the root definition, and ensuring that it does not include activities not specified in the root definition.

(2). implies, for example, checking that the conceptual model embodies some system for monitoring its performance and that its environment has been specified.

Stage 5: This is the stage where the conceptual model and the rich picture are compared. It is achieved by listing elements of the conceptual model and writing down the real world mechanism. This activity often reveals gaps in the analysis and so stages 2 to 5 must be repeated. The final list of differences forms the basis for debate in the next stage (Brember, 1985).

The purpose of this comparison is to generate a debate with problem owners, which in stage 6, will define possible changes that simultaneously meet two criteria, namely:

. that they are arguably desirable; and

. they are also feasible given prevailing attitudes and power structure, and having regard to the history of the situation under examination.

Naughton (1977) states that:

"It is difficult to know when to stop conceptual model building. The temptation is always to refine the model 'just a little bit more'. All in all, it is probably better to use the strategic rule: iterate. Stop conceptualisation before you really want to, go into the comparison phase, and use your experience to modify the conceptual model again" (p. 47).
Checkland insists that the comparison stage be conducted with participants involved in the problem situation with the object and generating a debate about possible changes which might be introduced. If the conceptual model is a good one (which of course implies that the choices of relevant system and root definition were also good) then there will be considerable differences between it and what exists in the problem situation. In practice, the comparison stage can be regarded in different ways, depending on the needs of the situation.

For example:

1. As a device for forcing actors to think critically about their present methods/procedures/systems.

2. As a method of opening up debate about what has gone wrong in the past and why?

3. As a method of opening up debate about general strategic issues - e.g. why do this at all? Why are we in this business? etc.

4. In design problems where the reality does not yet exist (because the new system has not yet been built), the conceptual model can be compared with the expectations of concerned actors in order to highlight potential future problems.

Stage 6: The debate must involve participants from the problem content system. The exact nature of the debate will vary with the aim of the study. Possible changes or future plans are discussed in terms of feasibility and desirability. Again gaps in the analysis may appear as unrecognised constraints come to light.

Stage 7: Once the changes have been agreed they can
be implemented and may give rise to a new set of problems.

3.3 Adaption of Checkland's Soft Systems Methodology to the Research

The overall objective of the research is to study the use of computers in Lycees in Turkey and create a model for the implementation of IT to The Turkish Educational System is firmly based on three goals, namely;

1. that the model will help create models for the other phases of education,
2. it might be help improve new models for other subjects in Turkish schools,
3. to provide easy access to the latest developments in the use of computers in mathematics in Lycees in Turkey.

It is in the context of these three approaches that the research objectives of planning a model for the use of computers in mathematics in Lycees in Turkey can best be understood. The research therefore aims to achieve the following objectives:

a. to develop a theoretical (conceptual) framework for the study by planning a model for the use of computers in mathematics in Lycees in Turkey,

b. to evaluate the effectiveness of the use of present use of computers in mathematics in Lycees in The Turkish Educational System,

c. to relate the conceptual model(s) of the use of computers in mathematics in Lycees to the reality of the Turkish Educational System,

d. to examine the expectations and opinions of computer users and computer owners in Secondary
Education about such a model,

e. to highlight potential future problems related to adopting the model in the special case of Turkey,

f. to evaluate the appropriateness of Checkland’s ‘soft’ system methodology in developing a theoretical framework of use computers.

In the light of these objectives, creating a model using computers in mathematics should take into consideration the people’s needs and then a solution to their problems. Therefore, the problem solver (researcher) should talk to the problem owner (users -teachers and students-, decision makers) and try first to understand the situation, and second to work accordingly, solving the problems and improving the situation. This methodology deals with human activities and system approach.

In order to fully grasp the impact and direction of the findings and recommendations that emerged at the end of this research, it is important to recognise clearly certain aspects of the proposed study. The examination of the current situation of the use of computers in mathematics in Turkish Lycees helped the researcher to determine what was feasible, and the research was limited to the use of computers in mathematics in Lycees and recommendations that were offered in that light probably are only appropriate for The Turkish Educational System.

As it is stated in Chapter 2, there is no existing model for informing the use of computers in mathematics in Lycees (in Turkey).

Data about opinions and views of the computer users, computer owners, and potential users were collected through a survey. This survey contains two questionnaires which were applied to users (the users were divided into groups; students and teachers). In addition interviews were undertaken with the educational decision makers.

The result of the surveys and interviews provided the detail for the rich picture or descriptive model (Stage
2) of the real world.

After the collection and analysis of data, step by step application of the methodology was continued. At the first stage of the methodology the main aim was to learn about the relationships between users and computer units and decision makers and information on the current situation, in Checkland's Methodology this stage is called the unexpressed problem situation. The survey supplied the necessary information for this stage.

At the second stage which is called the Analysis Phase (or expressed problem situation). Expressing the problem situation is based on the knowledge gained through doing the survey. The starting point is thinking about the problem content and problem solving systems. The role of the problem solver was occupied by the researcher who has experience using computers in mathematics in Turkey, and has knowledge of the Turkish Educational System. The role of the problem owner was played by computer users, which includes teachers and students, and also decision makers, which includes the Ministry of Education. The richest possible picture was built at this stage based on the results of the survey. Relevant systems were decided by the problem solver according to her knowledge on the subject. The analysis phase led to the selection of relevant systems. The strategy then continues with root definition formulation, conceptual model building and comparison.

In the comparison stage the conceptual model(s) was compared with the opinions.

Another important point in the present study was the identity of the client. In previous studies the client organisation who commissioned the work clearly owned the problem and was responsible for taking action to solve it. There are also problems which can not be owned in this sense.

Cornock (1980) extended the methodology into this area of 'supra-institutional' problems when he used it to interpret the state of the art world in Britain. In supra-institutional problems no single person or organisation can gain ownership of the problem.

According to Checkland the 'client' is someone who
wants to know or do something and commissions the study. The implication is that he can cause something to happen as a result of the study. The client does not exist in this sense in the present study. Instead there are several partial clients each displaying some of the above characteristics which, when taken together, constitute 'the client'. In other words the client exists but in a diffuse form, not as a single person or organisation. These partial clients are: the researcher and the real world decision makers. The researcher commissioned the study by selecting the problematic, but is not in a position to take action as a result of it. The school and computer professions could be said to have commissioned it. The profession may take action when it becomes aware of the study but is not required to do so. The managers do not commission the study but they could do. Again they may take action as a result if they wish and they are most likely to derive benefit from it. However, these benefits has arisen incidentally, whereas they could have been central if they had actually commissioned the study.

In the present systems study the client was neither a person nor a organisation and no one was intended to benefit directly from the study or to take action as a result of it. It is true that the Turkish Ministry of Education may take action as a result of it. The present problem in neither client-owned nor impossible to own but seems to be somewhere in between. The expected effect of lack of a true client is that stage 6 is difficult but 7 (debate about change and action to improve the problem) would be impossible. On the other hand, debate with the real world managers, who act as a partial client, and with users, hopefully allowed some progress to be achieved 7.
CHAPTER 4

DESIGN AND CONDUCT OF THE SURVEY

In this chapter, the method and techniques which were used to collect the necessary information concerning the current situation of CAL in mathematics at Lycee level in the Turkish Educational System are discussed.

4.1 Introduction

One of the main steps in the methodology applied to this study is to build a rich picture about the real world. It is not possible to give enough information about the real world without good background knowledge. This knowledge can be obtained through a combination of documentary and literary sources as well as survey techniques like observations, interviews and questionnaires, or from experience working in the field.

In the present study, the development of an effective model of using computers in mathematics in lycees in Turkey requires us to have an understanding of the current situation of computer use, and background knowledge mostly obtained from documentary sources. With this purpose in mind, a brief history about using computers in mathematics and general information on the subject were given in Chapter 2. This chapter presents the essentials of this background to certain problems or phenomena on using computers in mathematics in Turkey. Furthermore, research literature gave guidance on what relations to look for in forming the picture. It was decided that a survey of attitudes, opinions, and ideas should be conducted. The
survey with a combination of interview and questionnaire techniques then the researcher faced the problem of the choice between qualitative and quantitative methods.

4.2 Qualitative and Quantitative Methods Choices

Epistemological questions about quantitative and qualitative methods have been the subject of much discussion (see Philips, 1973; Glaser, 1978 and Patton, 1980). However, two works were found to be very useful for this research. Patton’s book led the researcher to the consideration of the relative strengths and weaknesses of qualitative and quantitative data and gave a through guidance to qualitative interviewing. A second book, on systems thinking, of great help in reviewing the research methodology and its qualitative character, the research strategy, and than analysing the research results (Checkland, 1981).

As was stated above qualitative and quantitative methods involve differing strengths and weaknesses. Patton (1980) summarises these differences as follows:

"The advantage of a qualitative approach is that it is possible to measure the reactions of a great many people to a limited set of questions, thus facilitating comparison and statistical aggregation of the data. This gives a broad generalizable set of findings presented succinctly and parsimoniously. By contrast, qualitative methods typically produce a wealth of detailed information about a much smaller number of people and cases. This increases understanding of the cases and situations studied but reduces generalization" (p. 28).

Moreover as Patton (1980) indicates both qualitative and quantitative data can be collected in the same study. For the on-going study it was decided to use an integration of both methods, because of the different characteristics of various parts of the survey. The main aim of the survey was to collect information to reflect the richest possible
picture of the real world. In order to carry out the stages of Checkland's 'soft' systems methodology, the survey was designed to enter into other peoples' perspectives. The only way to achieve this was using qualitative interviewing (using mostly open-ended questions). This is not readily achievable by the other survey techniques.

One of the aims of the questionnaire was to collect some general information to have an idea about users' opinions and feelings on using computers in mathematics in order to identify their role as an input to the system. Users, here in this research, were defined as inputs and outputs of the system. In other words users and their needs were the input while users and their satisfactions were the output according to need satisfying type relevant system which was taken as a focus point for the study.

As a result different types of methods were used within the study. The qualitative method was used for the main part in order to apply Checkland's methodology's stages. The quantitative method was used to collect supportive data about the user populations to improve the knowledge of the real world and improve the conceptual models by thinking in terms of the users' needs in detail and to avoid creating an utopic model.

In the present case the purpose of the enquiry was to collect information about how the existing system works and what are the decision makers' opinions on a model of the use of computers in mathematics in Lycees. The existing situation in the Turkish Educational System on CAL was examined and a model was created for Turkey.

Principally, the researcher adopted Checkland's (1984) 'soft' systems approach. This involves building conceptual model(s) which need(s) to be compared to a real-world mechanism. To do this effectively therefore, the researcher decided to use a semi-structured interview schedule for decision makers, and structured and open-ended questionnaires for teachers and students. They provide a method for obtaining a meaningful comparison of the conceptual model(s) and the real world situation so as to enunciate areas of differences.

Research into using computers in mathematics in
Turkey in terms of effectiveness and efficiency requires the employment of a particular social research method. This may be either a quantitative or a qualitative enquiry approach based on observation, interviews and questionnaires as the primary means of data collection. In this study, the conceptual models derived from 'root definitions' using Checkland's 'soft' systems methodology, which itself is a qualitative approach. The researcher chose the qualitative approach in order to test the 'real world' setting of the conceptual models derived from the various root definitions.

The choice of qualitative approach was not chosen because of an aversion to quantitative approach but on some sets of purposeful principles:

(a) Checkland's 'soft' systems methodology is itself a qualitative methodology which is geared to highlighting and solving 'soft' problems in an organization and it is an approach that takes cognisance of human beings in the concept of 'human activity system' and allows for different points of view.

(b) The research being conducted is at three Lycees which have CAL in mathematics, and such a sample of respondents for the survey, of 180 students and 12 teachers, is small for a quantitative research methodology.

(c) The choice of qualitative methodology based chiefly on interview and questionnaire schedules deigned within the researcher's framework of reference, is necessary so as to conform with the researcher's conceptual models derived from a 'root definition' using Checkland's 'soft' systems methodology.

The Sample of the Study
The sample consisted of all available schools -

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Therefore, the teacher questionnaire was a single questionnaire, and distributed to 12 teachers, the student questionnaire was distributed to 180 students. In addition, five decision makers were interviewed.

The chosen methodology does not aim at statistical validity or quantitative measures; nor was the selection of subjects to approach or interview based on a representative sample for the whole of Turkey. This is something to bear in mind when considering the issue and results of the research.

In this study, results were not generalized. The answers to the question are descriptive, and the results produce impression of computer use in mathematics in Ankara. Qualitative data consist of detailed description of situations, events, people, interactions and observed behaviours, direct quotations from people about their experiences, attitudes, beliefs and thoughts (Patton, 1980).

There is an essential difference between a study which seeks to generalize and one which seeks to look for diversity and nuances in perceptions, opinions, knowledge and attitudes. In the last instance all questions are equally valuable and interesting for a closer analysis, while a generalizing study primarily treats the response according to some statistical distributions (Vedi, 1986, p. 60).

Briefly, the main aim of the survey was to collect information to reflect the richest possible picture of (the real world). This was done in three phases:

The first phase was a preliminary study of Lycees selected for research in order to gain some understanding of the nature of appropriate work as well as opinions, attitudes and ideas about the existing situation on using computers in mathematics.

The second phase was to test the core questions for the questionnaires. The test started with teachers and students outside the selected population. The result of this is reported below under the heading "pilot survey and development of research instruments".

The last and most important phase of the study was the semi-structured interview with decision makers and the distribution of the questionnaire to teachers and students.
As Cohen and Manion (1989) state there are three prerequisites to the design of any survey. These are the specification of

1. the exact of purpose of the enquiry,
2. the population on which it is to focus,
3. the resources that are available.

In the present study, the exact purpose of the enquiry is to collect information about the real world in order to provide the richest possible picture of the existing situation. In other words, to learn about how the existing system works and what are the people opinions on computers, and attitudes to using computer.

Population and available resources are discussed in further sections of this chapter.

4.3 The Size of the Whole Population

The first step was to identify the subjects (members of the population) to be surveyed.

The development of an effective model on using computers in mathematics requires a sound understanding of the current situation in Turkey. It should be emphasized that it was not possible to take more than three schools within the actual field work of this study. Because the use of computers in mathematics was limited to three Ankaran Lycees, involved in the CAL2 project. However there could be a question mark about representability of these three Lycees in readers' mind. Since the present study seeks diversity and nuances in perceptions, opinions and attitudes rather than generalizations. There is no need to be representative on the selection of sample, since the chosen methodology does not aim at statistical validity or quantitative measures.

It should be made clear here that conducting this survey on three Lycees in mathematics which do not have a representative power does not mean that results and findings of this research has no validity for any other subjects and levels apart from the chosen ones.
In order to understand this situation and compare it with the conceptual model(s) derived from 'root definition' of Checkland's 'soft' systems methodology, the researcher involved all students and teachers from three schools to gather evidence from respondents.

To do this effectively, the researcher went to each of these schools to ask for a list of names of students and teachers who were involved in this project (CAL2).

The Ministry of Education chose three first level classes from each school. Thus there were nine classes which carried out CAL in mathematics in the whole of Turkey.

The potential sample consisted of 255 students, 18 teachers and 5 decision makers in this project. Each of three schools had six mathematics teachers who were involved in this project. The second task after identifying the population was the selection of the samples for interviews and questionnaires. The survey population comprises computer users and decision makers.

. **Users:** Users would be anyone who is actively working with computers in schools. Users here include mathematics teachers and students.

. **Owners:** Decision makers would be owners. Decision Makers include administrators who effect the service in the schools.

The decision makers who are in charge of this project were also interviewed. Five decision makers belonged to different institutions. Two of them were employed by the Ministry of Education, three of them were employed by the Universities. They have a very important role in this project. This committee decided everything on this subject such as budgeting, selection of hardware and software, in-service training etc. They have been authorized by the Minister of Education. They are autocratic. Once their decisions are taken, they are passed on to the Lycees to

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1 Owners are the people who have the power to cause the system to cease to exist (Checkland, 1981).
apply, and there is nobody from the schools such as school administrators or teachers, on this committee for decision making.

In the case of users, the researcher intended to obtain a general idea about their attitudes, opinions and ideas on using computers in mathematics in order to identify their roles in the system.

As the sample is not representative, more research is needed before more general conclusion can be drawn. This will be discussed further.

4.4 Gathering of the Data

The field work for the pilot and final investigation was carried out between March and June 1990. Permission had to be obtained in order to conduct questionnaires in schools, and to interview decision makers from the Ministry of Education in Turkey.

All three schools were used. All principals and mathematics teachers of the schools involved were supportive and allowed their students time off from their lessons to answer the questionnaire.

The selection of the interview and questionnaire methods is governed by the methodology itself, the researcher’s experience, the subject and the time available for this research.

4.4.1 Questionnaires

Questionnaires may be used as the principal means of gathering information having direct bearing on the research objectives. As Tuckman (1972) describes it, by providing access to what is inside a person’s head, (it) makes it possible to measure what a person knows (knowledge or information), what a person likes or dislikes (values and preferences), and what a person think (attitudes and beliefs).

In this study, the main aim of the questionnaires was to gather evidence about users; their attitudes, opinions and ideas on using computers in mathematics
Therefore, questions which were directed to the users concentrated on their opinion, attitudes in general.

4.4.2 The Interview

One essential of the qualitative research method is that it allows a flexible approach to interviewing. The research method allows the widest possible exploration of views and behaviour patterns of the respondents. The approach uses less formally structured interviewing procedures. The semi-structured interview schedule does ask questions in precise terms and in a specified order, most of the questions are open-ended.

The choice of a semi-structured interview was felt to be the most appropriate interview for this study. Unstructured interviews could be more revealing and useful for an experienced researcher, but on the other hand semi-structured interviews are easier to carry out and also easy to analyse.

In this study, the main aim of the interviews was to gather evidence about decision makers' opinions, feelings and knowledge on using computers in mathematics. Qualitative interviewing, with semi-structured, open-ended questions, is especially suited when we want to enter to someone else's perspective (Patton, 1980).

4.5 The Pilot Survey

A pilot study was conducted in order to improve the quality of the information-gathering instrument and to gain insights into the problems that might be encountered in the actual conduct of the needs identification, and to check if the questionnaire was reliable and valid enough to apply to the respondents of the study.

The pilot study included consideration of the content sequence, wording, question format and the frame of questioning. When the pilot survey for the purpose of testing the questions was finished, it became clear that some questions ought to be changed, a few ought to be
omitted while others ought to be left open-ended. Generally speaking, after realizing this, it became possible to ask simpler and more direct and concrete questions related to people's opinions and knowledge in the actual area.

4.5.1 Students

The sample for the pilot study consisted of 75 students, aged 15-16 years, in the first year of Anatolia Lycees. In this pilot study, one class was randomly chosen from each of three schools, to give a good representation of students. The three classes in each school were of equivalent ability. They were homogenous groups. Because, after the primary school, at the age of 12, they had to take a natural entrance exam under auspices of the Ministry of Education.

The total student sample was as follows:

<table>
<thead>
<tr>
<th></th>
<th>Students</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>In Lycee I</td>
<td>27</td>
<td>36</td>
</tr>
<tr>
<td>In Lycee II</td>
<td>23</td>
<td>31</td>
</tr>
<tr>
<td>In Lycee III</td>
<td>25</td>
<td>33</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>100</td>
</tr>
</tbody>
</table>

None of these students were in the actual study when the final questionnaire was conducted.

In the pilot study, the same questionnaire was given to students a second time fifteen days later and

---

2Anatolia Lycees comprehend the middle as well as the upper secondary level. Access is only possible through a nation-wide entrance examination after five years primary schools, and is highly competitive. Therefore, these schools receive students of above - average academic ability who come mainly from socially privileged families. Their main mission is to intensify the learning of foreign languages. 70 per cent of teaching, particularly science and mathematics, is conducted in a foreign language, mostly in English but there are also Anatolia Lycees that teach in German or French. Anatolia Lycees follow the same curricula as normal Lycees but they operate under better conditions, particularly with lower students-teachers ratios (OECD, 1989b).
answers to every question were checked for consistency for every student. Where the re-test agreement was less than 85 percentage, the question was changed. The responses are analysed in Appendix G. For instance, the percentage of Question 1 was %100, percentage of Question 5 was %85, percentage of Question 16 was %90 etc. It was the nature of the question which had to be calculated.

Another idea behind giving the questionnaire twice was to make sure of sincerity and accuracy of respondents.

4.5.2 The Teachers

A pilot study on the teachers' questionnaire was also carried out. Mathematics teachers were taken from the same classes which were randomly chosen for the students' questionnaire for the pilot study. There were six mathematics teachers. In the pilot study, the researcher showed the questionnaire to each teacher, and interviewed them individually to test that the questions were understood, which questions to ask, the sequence of questions wording alternative question formats, and the time frame of questioning, and the current state of using computers in their teaching in general. The teachers explained some theoretical and practical issues in the field. To understand the teachers' attitudes towards the computer it was important to get them to talk to the researcher about their experience. Almost all of the teachers had lots of questions and views of their own to share and it was time well spent. These teachers were not involved in the main investigation.

The interviews were structured to cover some of the same questions each time, but focusing on new issues as they arose. The teachers were invited to reflect and speculate on their experiences.

A lot of useful feedback and constructive criticism were obtained from the interviews and these were taken into account when revising the questionnaire for the main study. The pilot study also gave very useful insights which were invaluable to the actual data gathering process, and subsequent analysis of data. In sum, it rendered the final
investigation more efficient and reliable.

4.6 Development of Research Instruments

In the present study, there was one questionnaire for the students, one questionnaire for the teachers, and one interview schedule for the decision makers.

When developing the research instruments, the experience gained during the pilot study was taken into consideration. Thus it was decided to use it in the construction of questionnaires in this study: fixed-alternative items; open-ended items; and scaled-items.

The fixed-alternative items allowed a respondent to choose from two or more alternatives. Open-ended items supplied a frame of reference for respondent's answers, but put a minimum of restraint on the answers and their expression. Other than the subject of the question, which was determined by the nature of the problem under investigation, there were no other restrictions, either the content or the manner of the respondent's answer. Scale items comprised a set of verbal items to which respondents indicated degrees of agreement or disagreement. A number of statements are written to indicate attitudes towards the chosen topic, and the statements should follow all the rules of clarity, simplicity, specificity and so on previously spoken of in connection with item writing generally. They should cover a range of positive or favourable attitudes through to negative or unfavourable attitudes, including a few neutral or innocuous statements (Burroughs, 1975, p. 119). Statements which show positive or favourable attitudes and negative and unfavourable attitudes and a few neutral statements were put altogether in this study. The response was located on a scale of fixed alternatives.

Fixed alternative items, open-ended questions and scale items were used in both the teachers' and students' questionnaires. Open-ended questions plus a few fixed alternative items were used for the interviews' schedule. The data are collected as open-ended narrative without attempting to fit program activities or people's experiences into predetermined standardized categories, such as response.

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choices that comprise, typical questionnaires on tests. The data are open-ended in order to find out what people's lives, experiences and interaction mean to them in their own terms and their own natural settings. On the other hand, open-ended responses permit one to understand the world as seen by the respondents.

The open-ended questions were used in the interviews schedule to give flexibility. They allowed the interviewer to probe so that any misunderstandings were cleared up and they allowed the interviewer to go into more depth whenever it was necessary.

The final questionnaires for teachers and students consist of three parts. The complete questionnaires are represented in Appendixes D, E, F.

However a brief description of the format is given below.

In both questionnaires PART I is to gather personal data about the students and teachers.

PART II assess both students and teachers attitudes to computer usage.

In PART III of both questionnaires, respondents were asked to indicate their agreement to definite statements which were directly related to the subject using a five point Likert scale. They were asked to mark one of the five scaled answers, on a scale 1 to 5 as follows:

. 1: strongly agree
. 2: moderately agree
. 3: neutral (neither agree nor disagree)
. 4: moderately disagree
. 5: strongly disagree

according to their feelings towards these statements.

The main idea behind the use of this mechanism was to make sure of reliability of responses. If there were obvious and strong differences between the answers given to certain questions in PART II and the reactions given to the related statements in PART III, it meant that reliability was questionable in that particular case (Young, 1972), (Cronbach, 1984).
Briefly, the scale scores checked data obtained by the open-ended questions.

4.6.1 The Teachers' Questionnaire

As mentioned before the pilot study showed that some questions needed to be expanded, adding some details, and other deleted because they did not yield relevant information. Besides it was found that the questionnaire lasted in some case more than one hour. Respondents then became tired, showed signs of restlessness and loss of interest. To prevent this, after the pilot study the teachers' questionnaire was made shorter and easier to complete. Although, the teachers' questionnaire remained more detailed and longer than the students' questionnaire.

The teachers' questionnaire consisted of three parts in both the pilot and final studies. PART I was on teachers' background information. Although in the pilot study, PART II consisted of 53 questions, in the final study it consisted of 43 questions. PART III consisted of 44 in the pilot study, and it was 38 in the final study.

Examples of Changes Made In The Teachers' Questionnaire

In the pilot study, Question 10 asked "Do you also have a separate computer room available for mathematics?" There was no need to ask this question in the final study, because in this project CAL was carried out just for mathematics lessons.

The second part of Question 16 stated "If yes, Are you still participating in in-service training course?" This became a separate question (Question 17) in the final study, because all the teachers participated in in-service training course.

Question 23 asked "Was attendance at your in-service training course recognised by the award of a certificate or diploma?" During the interview, it became apparent that teachers like to get a certificate at the end of courses. The perceived need for certification was investigated through the addition of Question 24 "If Not,
Would you like to get a certificate at the end of the courses? Why?"

Question 27 asked "Are you involved in preparing software?" and a second part was added as "If not, Do you want to be involved in preparing software?" Question 28 was deleted, it asked "The software, which you have, is most appropriate for?" and Question 29 was also omitted. It asked "Do you think the available software encourages your students to work by themselves?" During the pilot study, it was seen that there was not enough software, and teachers did not have enough ideas about software.

Question 31 asked "Have you got a group of software evaluators?" This established that there was no software panel in three lycees. The question was redundant and removed for the final questionnaire.

Question 37 "Does software allow you to teach better?", Question 41 "Do you think students can learn mathematics better through computers?", Question 45 "Has using computers in mathematics encouraged you in your teaching?" and Question 46 "Do you think using computer in mathematics has affected learning positively?" went to PART III as definite statements.

Question 47 was omitted. It asked "Do you use computers to create a competitive atmosphere among the students?", but teachers did not like this question, because in the Turkish Educational System, the idea of a "competitive atmosphere" is disapproved of.

In the pilot study, some open-ended questions were changed into structured ones e.g. Question 11 asked "How many computers are there in your classroom organization?" on the basis of answers like "one computer for two students", "one computer per student" and open ended question was changed into a structured ones (Question 10) in the final study.

Question 16 asked "How long did you participate in the in-service training course?" On the basis answers like "6 months", "1 year", and "more than one year" it became a structured answer (Question 16).

The second part of Question 18 looked at "If not, in your opinion how often would it be better provided?"
became structured one as "Do you think would it be best provided as:"  

PART III consisted of 38 statements in the pilot study, 44 in the final study. A few of them were deleted and a few of them added e.g. Statement 2 said "Computers motivate pupils to develop a positive attitude to mathematics.", Statement 3 said "Computers motivate and support the learning of mathematics." They were almost the same for which reason, Statement 3 was deleted in the final study.  

Statement 5 "Computers also motivate teachers on their teaching of mathematics." was added, it was also controlled statement of Statement 1 and Statement 2. In the pilot study, Statement 6 was "Computers greatly affect the role of the teachers." and it was changed to "Computers positively affect the role of the teachers." in the final study (Statement 6). Statement 12 was "Computers are expensive and highly over acted pieces of equipment." and it was divided into two sections as: "Computers are expensive machines." (Statements 13), and "Computers are exaggerated pieces of equipment." (Statement 14) in the final study.  

Statement 28 was deleted in the final study, it said "Computers lead to independence." the idea of independence was also disapproved of by the teachers.  

Statement 31 was also deleted in the final study. It was "It is stimulating to teach mathematics through computers." and it was almost the same like Statements 2 and 5.  

4.6.2 The Students' Questionnaire  

After the pilot study, some questions needed to be expanded, adding some details, while others deleted.  

To prevent students becoming tired with a subsequent loss of interest and signs of reluctance, the students' questionnaire was shortened. The researcher avoided asking lots of questions of the students. In the students' questionnaire, students' opinions and general ideas on using computers were researched. This project was in its first year, therefore students were not very informed
The students' questionnaire consisted of three parts in both the pilot and final studies. PART I was on students' background information, PART II consisted of 18 in the pilot study, this consisted of 15 questions in the final study. In the pilot study some questions were open-ended, they became fixed alternative items in the final studies. PART III consisted of 18 statements in pilot and final study.

Examples of Changes Made in The Students Questionnaire

PART I was on students' background information. In the pilot study more detailed information was asked of the students such as their parents' occupation and which year they came from. After the pilot study these questions were deleted, because we did not need their parents' occupations, as there were not any hypothesis to look at their socioeconomic levels or compare them with anything.

There was no need to specify their classes either, because this project was carried out for first year students in all three schools.

In PART II, the second part of Question 2 asked "If yes, Why do you like using computers?" This was changed into "If not, Why do you not like using computers?", because pilot study showed that most of the students did not like using computers, this part was changed.

The second part of Question 9 was "If Yes, Why?" and "If not, Why?" This was shortened to "Do computers make mathematics classes easier? Why?" it was seen that sometimes to ask questions in two parts was more difficult for students.

In the pilot study, two open-ended questions were changed into fixed-alternative items e.g. Question 13 asked "What do you prefer learning by computers?" On the basis of answers like 'problem solving', 'drill and practice', 'educational games', and 'learning how to program' open-ended question was changed into fixed-alternative item (Question 13) in the final study.

Question 14 asked "How do computers affect your
On the basis of answers like 'it makes mathematics easier', 'it makes mathematics boring', 'it makes mathematics more difficult', 'it makes mathematics more interesting' these became fixed-alternative items.

Questions 16, 17 and 18 were omitted, because Question 15 asked "Do you like your software packages, which are available, in mathematics? why?" according to answers in the pilot study, it was seen that there was little software available in these schools. In the first year of the project, a very limited amount of software was prepared by companies. There was a large award of contracts for software which was given to Computer Companies and Universities wanting to prepare software, by the Ministry of Education. They were to submit by the end of June 1990 (this study was conducted in March and June 1990). This software would be selected for the 1990/91 school year.

During the teachers' pilot study and decision makers' interview, teachers and decision makers also expressed that there was not enough quality software available. Therefore, all questions on software were omitted in the students' questionnaire.

4.6.3 Interview Schedule

Interviews can take several forms, ranging from very informal exchanges to very structured, ordered sets of questions. Selection of the form depends upon the research, the subject, the kind of information needed, and the characteristics of the people to be interviewed (Kane, 1985). It is possible to list the interview focus in very general groups as follows:

1. Unstructured (nonstandardizing interview): Here, there is no set order of wording of questions, no schedule, and the researcher is not looking for the same information from each person. It is difficult to analyse the data.

2. Structured (standardized interview): This is the most formally structured type of interview. The same information is required for each person, and each is asked
It is relatively easy to analyse data. The standardized interview schedule is best used: when a large member of people are being interviewed, when many of the answers may fall into clear cut categories which can be coded and processed by confronted; when the people being interviewed are homogeneous and tend to share the same characteristics and outlooks; when the researcher already knows enough about the subject and he/she knows what is important to ask and how to ask it.

In this kind of interview, people have little opportunity to introduce serious variations on researcher choice of answers, and no opportunity at all to introduce completely different orientation.

3. Semi-structured interview: Similar to structured interview with more flexibility. More freedom is given to the interviewer to explain the questions and the same freedom to the respondent to answer. The same information is required of each person but it is not necessary to ask exactly the same question in exactly the same order. Analysing the data is easier than an unstructured interview.

No pilot study was conducted for the interview schedule because the population sample of 5 was too small to be divided up.

Although the interview schedule is shown in Appendix F, a brief description is made here. The interview schedule consisted of 38 questions and most of them were open-ended questions, a few of them were fixed-alternative items.

The interview sessions were tape recorded and transcribed for analysis. Qualitative analysis was preferred as the material. The transcripts were read several times in order to develop a system for categorizing.

The interview covered the following subjects: their opinions on using computers in mathematics, what the existing situation was on the project, on software and hardware, on in-service training.

Content and analysis of the questionnaire and interview schedule is shown in detail in Chapter 5.
4.7 Conduct of the Main Survey

Care was taken to keep the questionnaires and interviews short, unambiguous and easy for the respondents to complete. Great attention was also paid to the order of the questions so that the whole structure of the questionnaire and interview appeared logical while fitting the available space. It was shortened to encourage users to respond.

4.7.1 Students

The sample was 180 students for the full study. The total students' sample is made up as follows:

<table>
<thead>
<tr>
<th>Number of Students</th>
<th>Percentage %</th>
</tr>
</thead>
<tbody>
<tr>
<td>In Lycee I</td>
<td>65</td>
</tr>
<tr>
<td>In Lycee II</td>
<td>58</td>
</tr>
<tr>
<td>In Lycee III</td>
<td>57</td>
</tr>
<tr>
<td>Total</td>
<td>180</td>
</tr>
</tbody>
</table>

It was necessary to conduct the questionnaire, question by question to ensure that the students attempted every question and they spent the right amount of time on each. It took approximately 35-40 minutes for the main investigation. The students were generally cooperative and took these questionnaires seriously.

4.7.2 Teachers

The giving of the questionnaire to the mathematics teachers was carried out in much the same way as with students. All of the teachers were from Lycees which had carried out the CAL project. The sample consisted of 12 teachers. The teachers were also very cooperative. Their awareness of their importance of using computers in mathematics in promoting their own excellence lent the extra
incentive and interest to the investigation, especially when the aims of research were made known to them. The actual questionnaire lasted 45-60 minutes.

4.7.3 Decision Makers

The entire process of gathering data from the decision makers was much more time consuming and tiring.

The decision makers were initially contacted by phone to inform them of the survey and requesting cooperation. In spite of their busy personal schedules, they willingly gave up their time and without this the investigation could not possibly have been successfully carried out.

On the phone, the respondent was told the nature of the interview. All the interviews took place in the respondents' own offices. This gave the opportunity to observe some of his/her immediate surroundings which might be relevant to the investigation. Telephone calls interrupted the interviews several times. After every interruption the interviewer repeated the last question and reminded the interviewee of the conversation from the point it was interrupted.

As the interviews were designed to build the richest possible picture of the decision makers' point of view, the interviews were started with a brief standard explanation of the survey. The researcher endeavoured to ask each person the same question in the same way. The interviews lasted for more than 40 minutes.

After each interview, the interviewer spent sometime making notes about her observations. A tape recorder was used to record the responses and they were transcribed. Interviewees did not object to the presence of a tape recorder for recording the interviews. On the other hand, using a tape recorder gave the interviewer great freedom and the chance to listen and formulate follow up questions.

Comments were noted wherever they were made and where confusion, certain points were clarified by further discussion. The interview is reported in Chapter 5.
The decision makers all have formal educational training. All of them have a doctoral degree in the field and three of them are Associate Professors.

Some general impressions were confirmed. It had been revealed that care had to be taken to assure the respondent that his/her anonymity and integrity would be protected. It had to be emphasized that the researcher was independent of the authorities, and that there were no links between her and the mass-media. The last proved to be very important for establishing rapport because most interviewees seemed to be antipathetic to the Press, Radio and TV.

All the respondents were willing to be interviewed and interested in the research.

4.8 Method of Analysis

The questionnaire and schedules were analysed by hand. For fixed alternative items quantitative data on the absolute number of respondents that answered by choice to the question were pretested. In the case of open-ended questions it was difficult to analyse, but since the importance of qualitative open-ended questions came from the intention of entering into other person's perspectives, the findings will be used for illustration in Chapter 5.
CHAPTER 5

CONTENT AND ANALYSIS OF THE QUESTIONNAIRE AND INTERVIEW

This chapter describes the responses to the questionnaires and interviews.
Summary statistics are presented in tables in the text.

5.1 Teachers' Questionnaires

5.1.1 Content of Teachers' Questionnaire

The teachers' questionnaire covered the following areas: personal and background information on teachers, general questions on using computers in mathematics such as; their opinions, feelings and attitudes, in-service training course on this subject and software etc. (See Appendix D)

Answers from the teachers as a whole are given under these topics. Questions 1 to 4 in PART I dealt with information about teachers background, their age, sex, teaching experience and the universities from which they graduated.

General questions on using computers in mathematics were asked in Questions 1 to 43 in PART II. The purpose of using computers in their teaching and decisions to use computers in their teaching were examined in Questions 1 and 2. The frequency of using computers was examined in Question 3. In Questions 4, 5, and 37, respondents were asked to give their feelings about using computers. In Question 6, 8, 11

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and 12 respondents were asked to explain their opinions on computers and the use of computers in mathematics. The conditions in which computers were used in their schools were also asked in Questions 9 and 10.

Questions 14 to 35 were about pre and in-service training, using software, and syllabuses. In Questions 41 and 42 respondents were asked to assess their students' achievements in mathematics. Sometimes, a structured question was followed by an open-ended question on the same subject in which respondents were asked to give relative judgements about computer use.

PART III was prepared to assess the reliability of respondents' previous responses. In PART III some statements were presented to establish teachers' attitudes to computers and their feelings about computers. Below are some examples of questions, which were asked to test reliability of respondents' previous responses.

Question 8 "Do you think computers are wonderful machines that could do tremendous things for education?" in PART II was checked by the responses Statement 4 "Computers are wonderful machines that could do tremendous things for education?" in Part III. While 75% of respondents' answers were "No" in PART II, they did not agree that "Computers are wonderful machines that could do tremendous things for education." Question 18 in PART II was checked by Statement 9 in PART III. 75% of teachers did not agree that "In-service training course on this subject for teachers is waste of time", and 67% of them said "Yes" for Question 18 "Do you think in-service training is a good approach to solve problems?" so there is substantial consistency of answers.

The second part of Question 26 was "Would you prefer to select software by yourself?" to which 50% of them said "Yes" Statement 11 said "I believe that teachers should choose their own software." and 59% of them agreed with it. Question 28 asked "Do you think it is more difficult to teach some topics without this software?" and 65% answered "No". Statement 15 said "The software usually enables me to teach mathematics better" and 67% of them did not agree with this. In Question 35 teachers were asked "To what degree is
the Ministry of Education helpful on this issue?" and 67% of them answered as "very helpful" and "helpful" and Statement 22 said "The Ministry of Education is very helpful on this issue." and 67% of them did agree with it.

In fact all twelve teachers were totally consistent in their answers, and there was a positive relation between teachers' answers.

Finally, an open-ended request for criticism was included and this provided an opportunity for airing problems and making further comments.

Statistical Presentation

Frequencies and percentage are used to present the results of the questionnaires. Where frequencies and percentages are given, the ratings on the point scale items which appear in the questionnaire were reduced to three parts: high, mid and low to simplify the interpretation of results. The high rating was simply created by combining 4 and 5, and the low rating by combining scales 1 and 2, the mid rate represents 3: neutral. Ratings of negatively worded statement were recorded so that 5=1, 4=2, 2=4, and 1=5.

Qualitative data is also classified as frequencies and percentages (Tate, 1965). Results derived from percentage and frequencies are descriptive and they show the descriptive situation on using computers in mathematics. Descriptive statistics are used to organise, summarize and describe measures of a sample. No predictions or inferences are made regarding population parameters, and at the descriptive level no attempt would be made to predict population (Cohen and Holiday, 1975). Furthermore, there were no hypotheses or assumptions in this study. Hypotheses require problem(s) to be put at the beginning of the study. Whereas in this study, the methodology requires us to reach the problem at the end of the study.

It is assumed that the all data obtained from the questionnaire is equally valuable and interesting. A generalizing study primarily treats the responses according to some statistical distributions.
5.1.2 Analysis of Teachers' Questionnaire

The respondents and their backgrounds

Answers to Questions 1 to 4 are presented here. The questions asked are about age, sex, teaching experience and the universities they graduated from. The responses are given in Table 5.1.

Table 5.1
Personal Information About Teachers

<table>
<thead>
<tr>
<th>AGE</th>
<th>25-30</th>
<th>31-35</th>
<th>36-40</th>
<th>40-+</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>-</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SEX</th>
<th>MALE</th>
<th>FEMALE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>5</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TEACHING EXPERIENCE</th>
<th>0-5 YEARS</th>
<th>6-9 YEARS</th>
<th>10 - +</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>8</td>
<td>7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UNIVERSITY GRADUATED FROM</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>42</td>
<td>2</td>
<td>16</td>
<td>5</td>
<td>42</td>
<td>12</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

There were twelve teachers from three schools. They had varied backgrounds. They were between 25 and 40 years old, four of them between 25 and 30 years old, four of them were between 31 and 35 years old and four of them were between 36 and 40 years old, seven of them were male, five of them were female.

They had from three to more than ten years of teaching experience. 42% of them graduated from two year educational institutions, 16% of them graduated from three year educational institutions and 42% of them graduated from Universities.

All of them were regular classroom teachers. This data helped to show computer users and their background in mathematics teaching and learning in Turkey.
General Questions on Using Computers in Mathematics

Use of Computers

Here the researcher discusses the questions which seem to her to have been most useful in providing a rich picture. The purpose of each question is given, together with the responses of the twelve teachers and researcher's comments.

Answers to Questions from 1 to 14 are presented here. In these questions the teachers were asked how computers were used, the frequency of use, decisions of using computers in teaching, feelings towards computers and knowledge about computers.

Question 1 asked "What do you use computers for in your teaching?" (See Table 5.2)

Table 5.2
The Use of Computers in Mathematics Teaching

<table>
<thead>
<tr>
<th>(a) Drill and Practice</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>58</td>
</tr>
<tr>
<td>(b) Simulation</td>
<td>%</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(c) Educational Games</td>
<td>%</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(d) Tutorials</td>
<td>%</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(e) Demonstration</td>
<td>%</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>a &amp; d &amp; e</td>
<td>%</td>
</tr>
<tr>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>a &amp; c &amp; e</td>
<td>%</td>
</tr>
<tr>
<td>4</td>
<td>33</td>
</tr>
</tbody>
</table>

116
This indicates that the computer was used for a very limited range of purposes with no teacher using the computer for simulation. Fuson and Brinko (1985) compared the use of drill and practice programs with well prepared traditional materials and concluded that microcomputers may be too precious a resource to use for drill and practice. The authors designed a set of flash cards, with some of the characteristics of computer programs, for drill and practice of basic facts in subtraction and division. The group using the computer showed no difference at any stage of learning from the matched group using the flash cards. The results of Wishart's (1990) study however shows that the use of simulations can increase learning and involvement and that children enjoy using simulations. She suggests that the educational program should concentrate on providing illustrated simulations with varying challenges where the emphasis is on controlled exploration of a topic. It can be concluded that educational software would be much improved by allowing user control and providing a greater variety of challenge and complexity with less emphasis on reinforcement. Software where the user is in control is readily available and its use in education is beneficial. Users prefer to discover the complexity of software when control is given to them by choices. This is most important in creating involvement and effective learning (Wishart, 1990). When users have choices they pay more attention to the subject.

Decision about Using Computers in Mathematics Teaching

Answers to Question 2 are presented here. This question asked "How did you decide to use computers in your teaching?"

i. Sixty-eight percent thought that involvement with computers would be very interesting and it would aid their future career development.

ii. Thirty-two percent of teachers stated that the Ministry of Education pushed them to use computers in their teaching.
Indeed, the Ministry of Education did want teachers to use computers in their teaching but in general most teachers wanted to use computers in their classroom. They had a personal desire to develop professionally, to learn the newest tool of the trade and to do their jobs better. Other reasons centred on perceived benefits for their students and preparation for the world of technology outside school. Others quoted new job opportunities and pressure from the Ministry of Education as reasons for using computers.

Educational settings are particularly resistant to change, and the classroom teacher has proven to be the key factor in the success of any innovation. This is particularly true for the innovation of microcomputers in education.

Frequency of Computer Usage
In Question 3 respondents were asked about the frequency of use (See Table 5.3).

Table 5.3

<table>
<thead>
<tr>
<th>Frequency of Using Computers in Mathematics Teaching</th>
<th>Neptune</th>
<th>Rarely</th>
<th>Frequently</th>
<th>Always</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>4</td>
<td>33</td>
<td>8</td>
<td>67</td>
<td>12</td>
</tr>
</tbody>
</table>

Most of the teachers (67%) were using computers frequently and the remainder (33%) were using computers rarely. While 33% of teachers took the whole class to the computer room once a week, the majority (67%) took their class to the computer room three times a week.

Feelings Towards Using Computers in Mathematics Teaching
Teachers were asked in Question 4 if they liked using computers or not. The majority of teachers (68%) said they liked using computers, though 32% of teachers did not. When asked "why they did not like using computers," their
answers were based on "It was impossible to teach mathematics through computers", "The syllabus and their conditions were not suitable for computers", "There was lots of inefficiency such as in-service training courses, software and manpower".

Because of the varied positions taken in the educational literature about computers in the schools, teachers in the survey did not have a clear understanding of the theory or the practice of using computers in their classroom. Computers were viewed as a highly technical and complex innovation by teachers, because the computer is a multi-purpose device and can be put to many uses, and they are easily overwhelmed by the computer.

There were combined feelings of enjoyment, fear, interest, boredom, meaningfulness about using computers, but Question 5 "Which alternative word best describes your feelings about using computers?" showed that 68% of those feelings concerning computers were enjoyable and interesting, but for 32% of teachers they were boring and frightening. (See Table 5.4)

Table 5.4

Feelings Towards Using Computers in Mathematics Teaching

<table>
<thead>
<tr>
<th></th>
<th>% a</th>
<th>% b</th>
<th>% c</th>
<th>% d</th>
<th>% e</th>
<th>% f</th>
<th>% a&amp;e</th>
<th>% b&amp;d</th>
<th>% b&amp;f</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. enjoyable  b. boring  
c. exciting  d. frightening  
e. interesting  f. meaningless

Some teachers were inspired by the new technology and their enthusiasm was rekindled. Other teachers, not understanding the computer and often knowing little about how the computer works compared to their students, were frightened of not being the experts in their classroom.

Those teachers who were enthusiastic about computers had to face much scepticism from other colleagues, not just at the start. Many of them were worried by the resistance to change among their colleagues who were afraid
of the innovation, and refused to accept the justification offered for spending so much money on computers.

In question 7 "Did you take any course about computers when you were student at the University?", we can see that only 42% of teachers had taken formal computer courses, when they were students at the University.

In Question 10 teachers were asked how many computers they had in their classroom organization. In one school, they had one computer for every two students, but in the other two schools they had one computer per student.

A variety of kinds of hardware were purchased for the three schools within the system.

Ability of Using Any Computer Programming Language

Only 42% of teachers indicated the ability to use a programming language, and 17% indicated the ability to write in more than one language. The most common language used by this group was BASIC with 33% indicating the ability to use this language. The other computer languages used by this group of teachers were COBOL and FORTRAN (Question 13). (See Table 5.5)

<table>
<thead>
<tr>
<th>BASIC</th>
<th>BASIC &amp; COBOL</th>
<th>FORTRAN &amp; COBOL</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>26</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

Pre and In-Service Training Courses

Questions from 14 to 24 were about pre and in-service training courses. The teachers had had only the briefest of pre-service courses relating to computers. Pre-service courses lasted 3 months (Question 14) and in this course teachers were only taught details of hardware and software. (Question 15). (See Table 5.6).
Table 5.6

The Courses in Pre-service Training

<table>
<thead>
<tr>
<th></th>
<th>a %</th>
<th>b %</th>
<th>c %</th>
<th>d %</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12 100 12 100</td>
</tr>
</tbody>
</table>

- a. IT and its usefulness to arouse interest
- b. Changing attitudes towards the application of computers in the classroom
- c. Obtaining clear information about the use of computers in as many ways as is feasible
- d. Learning details on hardware and software

Their in-service training courses lasted from 6 months to more than one year, and 67% of the teachers are still participating in in-service training programs.

All of this group of teachers said that this period was not long enough for them to make progress. The course was three hours in a week. Most of them (75%) wanted to continue their training for a year such as "a year full time", "one day per week in a year". Question 20 asked "In which areas do you need training?" The majority of teachers thought (58%) they needed training in computer usages in mathematics and new styles of mathematics teaching. In Question 21 teachers were asked "What kind of course did you take in in-service training?" 50% of teachers took courses introducing them to computers, programming courses, and courses on using hardware and software in the classroom. A few of them took programming or introduction to hardware and software systems during their in-service training courses. (Table 5.7).
Table 5.7
The Courses in In-service Training

<table>
<thead>
<tr>
<th>a</th>
<th>% b</th>
<th>% c</th>
<th>% d</th>
<th>%</th>
<th>a&amp;b&amp;c %</th>
<th>a&amp;d %</th>
<th>c&amp;d %</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6 50</td>
<td>3 25</td>
<td>3 25</td>
<td>12 100</td>
</tr>
</tbody>
</table>

a. Introduction to computers
b. Computers in mathematics
c. Programming
d. Using hardware and software

These courses were given at their schools and by the companies from which the hardware was purchased. (Question 22).

Question 23 asked "Was attendance at in-service training courses recognised by a certificate or diploma?"
For 75% of the teachers, attendance at in-service training courses was not formally recognised by the award of a certificate or diploma, and most of them (78%) would have liked to receive a certificate. In their opinion "Teachers, who were involved in the in-service training courses, ought to be rewarded. There could be a difference between teachers who were involved and who attended courses and those who did not. They also felt that "Certificates could be motivating, and they would encourage them". In Question 24, When teachers were asked if they had been given any examples of good practice in computer use in their schools, they answered "No".

All of the teachers involved in this project were given at least 6 months' in-service training courses by the computer companies. Yearly on-going support was offered to all teachers by trainers from the companies. This support was given to teachers by cooperation of university staff and staff from computer companies on generally technical side of computers.

The teachers who were involved in a computer course only during the first year of the project tend to be the most negative about computer usage.

The teachers in the study were, in fact, using the
computers, turning them on and off, inserting diskettes, assisting children in the use of computers and programming. They had a rough idea about use of computers in mathematics.

The absence of quality software supported the idea advanced by those with some training in computer science that teachers would have to learn programming, and computer programming was taught to 75% of the teachers in in-service training courses.

The in-service training courses were not sufficient for the teachers' needs and as a consequence, they developed self-help in their spare time. Teachers said that they left their courses feeling quite enthusiastic but very under-prepared. Some of them thought they had not received enough training to do their jobs properly.

The conclusion is very clear. Many teachers are willing, eager and enthusiastic to use the new information technology but they are unable to do so without training and support. As the AAMT Action Group Report (1986.3) points out "computers will not be used well unless teachers have time to learn how to use them to enhance students learning". This has clear implications for teacher education both at the pre and in-service levels. Encouraging teachers to develop IT skills is the necessary starting point for changing attitudes towards the application of computer technology in lessons. Recent funding cutbacks in Turkish Education, however should have a major impact on in-service education and have highlighted the need for innovative methods for supporting teachers in the incorporation of computers in the mathematics classroom.

Software

Questions from 25 to 32 were about software and the uses of software. Most teachers (67%) did not have a variety of software in their schools (from two Lycees). The amount of software was very limited although they could use whenever they wanted (Question 25).

Question 26 asked "Are you involved in the selection of software packages?" None of the sample teachers were involved in the selection of software packages. Half of the teachers (50%) said they would prefer to select software
themselves. While only 17% were involved in preparing software, 60% of the teachers did not want to be involved in preparing software (Question 27).

They thought the available software was not particularly helpful to their teaching. In Question 28, Teachers were asked "Do you think it is more difficult to teach some topics without this software?" The majority of teachers (67%) answered "No", and Question 29 asked "Does it allow you to teach better?" and 75% of the teachers' answers were "No". Teachers criticised heavily the quality of educational software.

Only one school had a software purchasing committee which included teachers (Question 30). In Question 31, teachers were asked "Is using software part of your syllabus?" Only 17% of teachers thought using software was part of their syllabus. The others thought it was necessary to change the syllabus to take account of computers. They also felt that there was not enough software and they did not plan to use more software.

Good software was in short supply, and given the feeling of inadequacy felt by many teachers, they either did nothing or they chose to use the more simple and limited drill and practice programs.

Much of the software was badly written, difficult to use, and lacked suitable support material. Pages of books were copied onto the screen like an electronic workbook. In this case, it would be better for students to use books instead of computers, because it is tiring for them to fix their eyes on a screen rather than a printed page.

As one of the developing countries, Turkey has invested a lot of money from her budget for computer studies in Education. This is a big sacrifice for the Turkish budget, and it needs to be spent very carefully. The money should be spent to gain economic and social advantage. Information Technology is essential to Turkey, because the Turkish government aims to be in electronic communication with developed countries and train people to become aware of the new technology and its implications for their lives.

Selecting good software is also very important in preparing students to be problem solvers and to encourage
the developments of technical skills. Software and hardware should be put together. We should not forget that software and hardware go hand in hand. Decisions to buy hardware determine and limit the software available to run a that machines, or vice versa.

The Turkish Ministry sponsored an "ideal" computer for the Turkish Educational System, but existing software did not run on this ideal machine. Computer companies instead of universities were asked to prepare software, but we do not forget that Turkey has spent lots of money and effort on preparing software. However the way which this was chosen was not planned carefully. If we cannot take consideration those things, there is no point in using computers in education.

We have to pay more attention to the preparation of quality software, because quality software encourages the development of higher order skills which are very important and necessary in a developed country. It also encourages the use of exploration and discovery.

In Question 32 teachers were asked "Which of the following functions of computers should be learned by your students?" (See Table 5.8)

<table>
<thead>
<tr>
<th>Functions of Computers</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. word processing</td>
</tr>
<tr>
<td>b. statistical analysis</td>
</tr>
<tr>
<td>c. spreadsheet</td>
</tr>
<tr>
<td>d. database</td>
</tr>
</tbody>
</table>

Table 5.8

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>b&amp;c</th>
<th>ab&amp;c</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>17</td>
<td>1</td>
<td>8</td>
<td>1 17</td>
<td></td>
<td>43</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
<td>4</td>
<td>33</td>
<td>2 33</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

A minority of the teachers (33%) thought that statistical analysis and spreadsheets should be learned by students.

Teaching Methods
Teachers were asked in Question 34, if they usually identified their mathematical goals in their teaching and their answers were "No", because "The goals were identified by the Ministry of Education".

In the questionnaire, these teachers were asked if computers had affected their teaching methods (Question 37). Thirty-three percent thought that computers affected their teaching negatively, and obstructed them. The remainder said that computers did not affect their teaching negatively and their teaching styles were compatible with computers. In Question 38, teachers were asked "Do you use computers as an electronic blackboard?" None of them used computers as an electronic blackboard in their teaching.

A minority of the teachers (33%) thought using computers did not encourage them in their teaching. All of the teachers provided coaching and assistance to their students (Questions 39 and 40).

Encouragement of The Ministry of Education

Question 35 asked "To what degree is the Ministry of Education helpful on this issue?" Teachers usually answered this question as "very helpful" or "helpful". (See Table 5.9) Whereas, when the researcher asked decision makers "Are you helpful on this issue?" Decision makers answered that although they tried to be helpful, but this was not always possible.

<table>
<thead>
<tr>
<th>very helpful</th>
<th>%</th>
<th>helpful</th>
<th>%</th>
<th>not helpful</th>
<th>%</th>
<th>not at all</th>
<th>%</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>25</td>
<td>5</td>
<td>42</td>
<td>4</td>
<td>33</td>
<td>12</td>
<td>100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A major concern of the teachers when answering the questionnaire that they might answer in such a way as to offend higher authorities (i.e. the Ministry of Education and thus damage their future careers)

Assessment

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Question 41 queried teacher assessment of students. Most of the teachers (67%) assessed students' performance, but this process did not benefit students because they were rarely provided with feedback for the assessment. It was just a final score. These assessments had been used by the organisation to determine students' progress, and to provide a report which included these results and teachers' observation on students who used computers in their learning.

These reports were part of the Ministry of Education's evaluation of the project. None of them used computers for keeping students records such as students' numbers, pass rates (Question 42).

Feelings and Opinions on Using Computers

Users' (teachers') opinions and feelings about using computers in mathematics were explored.

In Question 6, teachers were asked if computers helped students to understand mathematics better. While 58% of teachers said "Yes", 42% of teachers said "No". Question 12 supported this opinion. Teachers (58%) thought that the value of the microcomputer as a teaching aid was indisputable. Some of the reasons given by the teachers in response to Question 6 were "It raises pupils interest", "It clarifies difficult subject", "It puts more demand on pupils", "It obstructs pupils' communication", "It is difficult to use computers in mathematics". By contrast, the remainders did not think the value of microcomputers as a teaching aid was indisputable. Because "It makes mathematics teaching more difficult", "It obstructs students' communication", "It is difficult to use computers in mathematics."

In contrast, in Question 8, the majority of the teachers (75%) thought that computers were not wonderful machines that would do tremendous things for education.

Question 11 asked if computers would effect the role of the teacher or not. Teachers (67%) did not think they would be replaced by a computer, but they expected that their role with students would change as they each learn to communicate with these machines. Teachers were considered
themselves as liaisons between computers and students. 

Research has shown us that when they begin using computers in education teachers are reluctant. Combined feelings of fear, mistrust of what computers would do to the role of teachers, uncertainty about what computers could do, curiosity and attraction generate this ambivalence. Computers have proven to be an extremely anxiety producing innovation for teachers due to their complex demanding and non-obvious nature. By contrast, in Turkey, teachers were willing to use computers in their teaching because involvement in the CAL2 project was a privilege, and indicated that they could use computers in the future. The most important thing is that the number of teachers in this study is very limited, and a further picture would require research with a larger number.

Most of the teachers (58%) agreed that 'the student learned mathematics better by using computers', and 'computers motivated students to develop positive attitudes to mathematics' (Statements 1 and 2). (See Table 5.10 and 5.11)

Table 5.10
"Students Learn Mathematics Better by Using Computers"
Survey Results According to Likert Scale

<table>
<thead>
<tr>
<th>5&amp;4</th>
<th>%</th>
<th>3</th>
<th>%</th>
<th>2&amp;1</th>
<th>%</th>
<th>TOTAL</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>58</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>33</td>
<td>12</td>
<td>100</td>
</tr>
</tbody>
</table>

5&4 : high rating  
3 : mid rating  
2&1 : low rating

Table 5.11
"Computers Motivate Students to Develop Positive Attitudes to Mathematics"
Survey Results According to Likert Scale

<table>
<thead>
<tr>
<th>5&amp;4</th>
<th>%</th>
<th>3</th>
<th>%</th>
<th>2&amp;1</th>
<th>%</th>
<th>TOTAL</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>58</td>
<td>1</td>
<td>8</td>
<td>4</td>
<td>33</td>
<td>12</td>
<td>100</td>
</tr>
</tbody>
</table>

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Teachers (75%) did not agree that 'computers were wonderful machines that could do tremendous things for education', they (75%) agreed that 'computers were exaggerated pieces of equipments' (Statements 4 and 14). (See Tables 5.12 and 5.13).

Table 5.12

"Computers Are Wonderful Machines That Could Do Tremendous Things for Education"
Survey Results According to Likert Scale

<table>
<thead>
<tr>
<th>5&amp;4</th>
<th>%</th>
<th>3</th>
<th>%</th>
<th>2&amp;1</th>
<th>%</th>
<th>TOTAL</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>25</td>
<td>-</td>
<td>-</td>
<td>9</td>
<td>75</td>
<td>12</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 5.13

"Computers Are Exaggerated Pieces of Equipments"
Survey Results According to Likert Scale

<table>
<thead>
<tr>
<th>5&amp;4</th>
<th>%</th>
<th>3</th>
<th>%</th>
<th>2&amp;1</th>
<th>%</th>
<th>TOTAL</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>75</td>
<td>1</td>
<td>8</td>
<td>2</td>
<td>17</td>
<td>12</td>
<td>100</td>
</tr>
</tbody>
</table>

Half the teachers did not agree that 'teachers do not know anything about computers, and 'the pupils probably know more than teachers do about computers' (Statements 18 and 21) (Table 5.14 and 5.15), and rest of them did agree that 'there is nothing wrong with their teaching method' (Statement 25).

Table 5.14

"I Do Not Know Anything About Computers"
Survey Results According to Likert Scale

<table>
<thead>
<tr>
<th>5&amp;4</th>
<th>%</th>
<th>3</th>
<th>%</th>
<th>2&amp;1</th>
<th>%</th>
<th>TOTAL</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>25</td>
<td>3</td>
<td>25</td>
<td>6</td>
<td>50</td>
<td>12</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 5.15
"The Students Probably Knows More Than I Do About"
Survey Results According to Likert Scale

<table>
<thead>
<tr>
<th>5&amp;4 %</th>
<th>3 %</th>
<th>2&amp;1 %</th>
<th>TOTAL %</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>58</td>
<td>1</td>
<td>33</td>
</tr>
<tr>
<td>8</td>
<td>33</td>
<td>12</td>
<td>100</td>
</tr>
</tbody>
</table>

While 25% of teachers agreed that 'they feel a sense of insecurity when they use computers in their teaching, half of teachers did not agree with them, and 25% of teachers were neutral (Statements 29 and 30). (See Table 5.16 and 5.17)

Table 5.16
"I Feel A Sense of Insecurity When I use Computers In My Teaching"
Survey Results According to Likert Scale

<table>
<thead>
<tr>
<th>5&amp;4 %</th>
<th>3 %</th>
<th>2&amp;1 %</th>
<th>TOTAL %</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>25</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>6</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>12</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 5.17
"I Feel A Strain When I Use Computers in My Teaching"
Survey Results According to Likert Scale

<table>
<thead>
<tr>
<th>5&amp;4 %</th>
<th>3 %</th>
<th>2&amp;1 %</th>
<th>TOTAL %</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>25</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>6</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>12</td>
<td>100</td>
</tr>
</tbody>
</table>

While statement 32 was "I do not like computer", Statement 33 was "I am happy with computers." They were also checking statements. Fifty-eight percent did not agree with statement 32, fifty-eight percentage of teachers did agree with statement 33. (Tables 5.18 and 5.19)
Table 5.18
"I Do Not Like Computers"
Survey Results According to Likert Scale

<table>
<thead>
<tr>
<th>5-4</th>
<th>%</th>
<th>3</th>
<th>%</th>
<th>2-1</th>
<th>%</th>
<th>TOTAL</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>42</td>
<td>-</td>
<td>-</td>
<td>7</td>
<td>58</td>
<td>12</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 5.19
"I Am Happy With Computers"
Survey Results According to Likert Scale

<table>
<thead>
<tr>
<th>5-4</th>
<th>%</th>
<th>3</th>
<th>%</th>
<th>2-1</th>
<th>%</th>
<th>TOTAL</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>58</td>
<td>1</td>
<td>9</td>
<td>4</td>
<td>33</td>
<td>12</td>
<td>100</td>
</tr>
</tbody>
</table>

Some of the problems mentioned by one or more participants were: too much time to set up the computers, extra preparation time required, lack of equipment, malfunctions and children became more reluctant to study.

It may seem somewhat perverse to dwell upon teachers' reluctance to adopt new teaching methods and resources and to explore their unwillingness to develop and improve their skills. There is a wealth of goodwill and enthusiasm in the teaching profession, and a broad interest in the idea of Information Technology, but usually, a characteristic of teacher behaviour is a reluctance to venture into new areas where there might be some risk of things going wrong. There are of course perfectly legitimate reasons for this stance. Teachers are under increasing pressure to produce results and therefore reluctant to give up or modify tried and tested methods. The reasons for teacher indifference towards the new technology fall into three areas: the individual, the organisation, and the innovation itself. Using recent developments in attribution theory (Kelly, 1984) the introduction of computers into the classroom by eliciting the teachers' own explanation of their belief and behaviour. The major cause of reluctance

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and concern is to do with lack of confidence and competence, and the perceived increase in workload is not the prime problem.

Teachers perceived that it was important to provide computer literacy courses for all students. They stated that CAL should be used more, but wanted more training and improved software. The teachers emphasized that the pressure on teachers to 'finish the syllabus' was immense. Students rejected any attempt by teachers to spend time on what is perceived as being outside the syllabus. Success or failure in the examination was strongly linked in students' minds to knowing what was in the syllabus. This idea prevented teachers from using computers willingly in their teaching.

In summary, the lack of adequate hardware facilities in schools, the lack of quality software which meets the curriculum needs of teachers, the lack of adequate support facilities for teachers to find out about software and assess its relevance to meet their needs, the lack of appropriate training for teachers and the more general problem of how education systems can be made more responsive to education have affected the CAL2 project in Turkey.

5.2 Students' Questionnaire

5.2.1 Content of Students' Questionnaire

The students' questionnaire also covered personal and background information on students, and general information on using computers in mathematics such as their opinions, feelings and attitudes (Appendix E).

Questions 1 to 4 in PART I dealt with information about students' background, their age, sex, and their mathematics grade before and after using computers.

General questions on using computers in mathematics were asked in Questions 1 to 15 in PART II. Questions 2, 5 and 14 were controlled by statement 1. Most of the students (64%) did not like using computers (Question 20), and 65% of students' feelings on computers were a combination of boredom, fear and meaninglessness (Question 5), and for 64% of students computers make mathematics boring and more difficult (Question 14). In statement 1, 64% of students did
not agree that 'using computers make mathematics more interesting for them'.

Questions 7 and 8 were controlled by statement 10. A few of them (36%) wanted to go to the computer room more often (Question 7), a few of them (39%) wanted to go to the computer room everyday, 25% of them wanted to go to the computer room three times a week.

Question 15 was controlled by Statement 11. 66% of the students did not think that software makes mathematics easier and more interesting, and in statement 11, students did not agree that 'software usually enables them to learn something they could not otherwise learn'.

Generally, all their answers were consistent. Thus, there is a positive relation between students' answers.

5.2.2 Analysis of Students' Questionnaire

The Respondents' and Their Backgrounds

There were one hundred and eighty students from the three schools. They were between 15 and 17 years old and 95 of the students were male, 85 of the students were female. Roughly a third of students obtained low mathematics grades (1-4); a third were average (5-7); a third were high achievers (8-10) (See table 5.20). This ratio did not improve, indeed they were slightly but non-significantly worse, following the computer experiences. It was between 1 and 4 for 39%, it was between 5 and 7 for 36% and it was between for 25%, after using computers. \( t^1 \)

Test was chosen as an appropriate statistical test in other words, it helped to distinguish differences between mathematics' grades before and after using computers. Our values of \( t \) are smaller than that shown at the 0.05 level (\( t = 1.980 \)) and there is no significance difference between mathematics grades after and before using computers. (See Table 20).

\[ t / Sd \] was used in this calculation. Here, \( d = \) differences between two percentages, \( Sd = \) standard deviation of differences between two percentages (Kutsal & Muluk, 1978).
Table 5.20

Personal Information About Students

<table>
<thead>
<tr>
<th>AGE</th>
<th>15</th>
<th>16</th>
<th>17</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100</td>
<td>70</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>55%</td>
<td>39%</td>
<td>6%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SEX</th>
<th>MALE</th>
<th>FEMALE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>95</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>53%</td>
<td>47%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MATHEMATICS GRADE BEFORE COMPUTERS</th>
<th>1-4</th>
<th>5-7</th>
<th>8-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEFORE COMPUTERS</td>
<td>60</td>
<td>70</td>
<td>50</td>
</tr>
<tr>
<td>AFTER COMPUTERS</td>
<td>70</td>
<td>65</td>
<td>45</td>
</tr>
<tr>
<td>t VALUE</td>
<td>0.71</td>
<td>0.36</td>
<td>0.33</td>
</tr>
<tr>
<td>df: 0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>t table: 1.980</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

It seems that computers did not affect students' grades.

General Questions on Using Computers in Mathematics

Only 22% of the students had computers at home (Question 1), and they used computers for games (52%), scientific applications (8%) or for both (40%). (See Table 5.21)

Table 5.21

The Uses of Computers at Home

<table>
<thead>
<tr>
<th>a %</th>
<th>b %</th>
<th>c %</th>
<th>d %</th>
<th>e %</th>
<th>b&amp;c %</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>52</td>
<td>5</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>40</td>
<td>40</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. word processor  b. games  c. scientific applications
d. database  e. simulation

The uses of computers at home were very limited.
The students did not like using computers in
mathematics. The reasons for this negative attitude were 'it makes mathematics more difficult', 'it makes mathematics boring', 'there was no good and varied software'. Students' and teachers' questionnaires showed us computers usually were used for drill and practice. This could make mathematics classes boring after a while, we know from the teachers' analysis there was not enough software, and this can cause students to lose their interest in software.

The use of carefully and appropriately designed learning packages would improve students understanding of the mathematical concepts and encourage them towards using computers in mathematics. If suitable software were used, students would gain confidence more quickly. If they can be in control of the program, they can become involved with it. With suitable software students would have seen how computers could be useful for mathematics, how they could add some value to mathematics. Being in control of the program is most important in creating involvement with it (Wishart, 1990).

While 72% of students' parents did not encourage them to use computers, 28% of their parents encouraged them to use computers in their learning (Question 3). The students thought that 'their parents were not aware of using computers', 'they did not know anything about computers', 'they wanted them to use computers for their future'. There is only a narrow segment of parents who are particularly ambitious for themselves and for their children, and are convinced that personal computers are destined to play a very important role in the work place, and are willing provide a machine at home.

Purpose of Using Computers

When asked about the purposes of using computers in mathematics teaching. (Question 4). The students confirmed the findings of the Teachers' Questionnaire. Most of them (64%) were only using them for drill and practice, the rest of them were using them for drill and practice and educational games. (Table 5.22)
Table 5.22
The Uses of Computers in Mathematics Learning

<table>
<thead>
<tr>
<th>(a) Drill and Practice</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>58</td>
</tr>
<tr>
<td>(b) Simulation</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) Educational Games</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>(d) Tutorials</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>(e) Demonstration</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>a &amp; c</td>
<td>%</td>
</tr>
<tr>
<td>70</td>
<td>39</td>
</tr>
</tbody>
</table>

Feelings Towards Using Computers

Students' feelings were in contrast to the teachers' feelings on using computers. Students usually thought that computers were boring, frightening and meaningless (65%), they were enjoyable, interesting and exciting for the minority.

(Table 5.23)

Table 5.23
Feelings Towards Using Computers in Mathematics Learning

<table>
<thead>
<tr>
<th>a&amp;e %</th>
<th>c&amp;e %</th>
<th>a&amp;c %</th>
<th>b&amp;f %</th>
<th>b&amp;d %</th>
<th>d&amp;f %</th>
<th>a&amp;e&amp;c %</th>
<th>b&amp;d&amp;f %</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>8</td>
<td>10</td>
<td>8</td>
<td>6</td>
<td>8</td>
<td>4</td>
<td>25</td>
</tr>
</tbody>
</table>

a. enjoyable  b. boring  
c. exciting     d. frightening 
e. interesting f. meaningless
Frequency of Using Computers

Question 6 asked how often the computers were used (i.e. regularity, frequency). Most of them (64%) were using computers frequently, and Question 7 asked if they wanted to go to computer room more often, and why? 36% of their answers were 'Yes'. Their reasons usually were 'They wanted to learn more about computers for their future', 'They wanted to use computers in mathematics'. (Table 5.24)

Table 5.24

| Frequency of Using Computers in Mathematics Teaching |
|-----------------|---------|--------|---------|--------|
| Nevertotal | %      | %      | %      | %      |
| Never          | 65      | 36     | 115     | 64     | 180 100 |

In one school students had one computer per two students, in two schools students had one computer per student (Question 10), and they were using them with teachers in the computer room. Their answers were consistent with their teachers’ answers. Question 13 showed that students preferred learning problem solving and learning how to program (13%), problem solving and drill and practice and playing games (11%).

Opinions About Using Computers

The majority of students thought that computers made mathematics boring and more difficult (64%), and the rest of them thought it made mathematics easier and more interesting (Question 14). (See Table 5.25). While the majority thought that computers made mathematics boring and more difficult, they wanted to go to the computer room more often, because they saw computers as game playing and in their opinion anything was better than mathematics.

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The students did not like the software, which was available, and they did not think software made mathematics easier and more interesting (66%), (Question 15).

Questions 9, 11, and 12 showed the antagonism to computer use. Computers were not seen as wonderful machines that could do tremendous things for education (68%) nor did they think computers encouraged them to talk about mathematics (67%).

Students have different reasons for wanting to learn about computers. Some of them are keen on computers because they see computers as important and power-giving in the modern world, as a means to getting a well paid job. Some of them said that the course would help them at the university.

As mentioned before, scaled items in PART III also showed students’ opinions and feelings on using computers in mathematics. Below some examples are given to show students’ opinions and feelings on this subject.

They did not agree that 'Using computers make mathematics more interesting for them' (64%), and 'They learn mathematics better through computers' (60%). Statements 1 and 2). (Table 5.26 and 5.27)

Table 5.25
Opinions About Using Computers

<table>
<thead>
<tr>
<th></th>
<th>a %</th>
<th>b %</th>
<th>c %</th>
<th>d %</th>
<th>a&amp;c %</th>
<th>b&amp;d %</th>
<th>TOTAL %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td>6</td>
<td>20</td>
<td>11</td>
<td>20</td>
<td>11</td>
<td>25</td>
</tr>
</tbody>
</table>

a. It makes mathematics easier
b. It makes mathematics boring
c. It makes mathematics interesting
d. It makes mathematics more difficult
Some of them agree with 'They feel a strain when they use computers in mathematics' (Statement 4), and they did not agree that 'Using computers in mathematics is frightening' (Statement 9). (Table 5.28)

While they did not agree 'They know probably more than teachers do about computers' a small of them agreed with it, and rest of them (39%) were neutral. (Statement 5) (Table 5.29)
Table 5.29
"I Know Probably More Than Teachers Do About Computers"
Survey Results According to Likert Scale

<table>
<thead>
<tr>
<th>5&amp;4</th>
<th>%</th>
<th>3 %</th>
<th>2&amp;1</th>
<th>%</th>
<th>TOTAL</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>19</td>
<td>70</td>
<td>39</td>
<td>75</td>
<td>42</td>
<td>180</td>
</tr>
</tbody>
</table>

Students (59%) believed that computers are not useful in mathematics. (Statement 7) For 44% of students 'Computers cause to develop negative attitudes to mathematics', 17% were neutral (Statement 12). (Table 5.30) They did not agree (72%) that 'They do not know anything about computers' (Statement 13).

Table 5.30
"I Do not Know Anything About Computers"
Survey Results According to Likert Scale

<table>
<thead>
<tr>
<th>5&amp;4</th>
<th>%</th>
<th>3 %</th>
<th>2&amp;1</th>
<th>%</th>
<th>TOTAL</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>30</td>
<td></td>
<td>130</td>
<td>72</td>
<td>180</td>
<td>100</td>
</tr>
</tbody>
</table>

Generally, research findings indicate that at the beginning of CAL, students have been more enthusiastic than teachers and usually one of the greatest benefits derived from the use of computers in instruction results from its capacity to motivate students. However, this study showed that students did not like using computers very much in mathematics in Turkey.

In particular, because much of the software is badly written, unreliable and difficult to use, given with a lack of suitable support material, the students' use is often limited and unimaginative. In this situation students became frustrated, resorted to the more familiar pencil and paper. They were not actively involved and they became uninterested.

The use of carefully and appropriately designed
Learning packages would promote better student understanding of the underlying mathematical concept, and encourage them towards using computers in mathematics. If suitable software were used, the student could quickly gain confidence when using them. Software has proved useful in a wide variety of applications.

5.3 Interview

Investigation into using computers in schools in terms of effectiveness and efficiency requires the employment of a particular social research method. This may be either a quantitative or qualitative enquiry approach based on observation and interview as the primary means of data collection. In this study, the conceptual models derived from 'root definitions' using Checkland's soft system methodology which itself is a qualitative approach, to be compared with the 'real-world' situation in the ongoing research. The researcher chose a qualitative approach, so as to be able to test the 'real-world' setting of the conceptual models derived from the various 'root definitions'. The choice of a qualitative approach aimed the study at using computers activities in education in this research. The main idea of interviewing was to supply relatively rich information about the existing situation which could not be gathered by questionnaire.

The research method allows the widest possible exploration of views and behaviour patterns of the respondents. The approach uses less formally structured interviewing procedures. Although a semi-structured interview schedule has questions asked in precise terms and in a specific order, most of the questions are open-ended rather than pre-coded. The data to be provided by this semi-structured interview schedule is to some extent quantifiable since all respondents are asked the same questions in the same order. This also allows the researcher to read through a selection of the interviews so as to get broad ideas about the interrelationships of evidence. It is the belief of the researcher that the choice of semi-structured interview schedule will provide the
opportunity to study the issues raised in conceptual models in greater depth.

This schedule therefore essentially provides the means of comparing the built conceptual models derived from 'root definition' of soft system methodology with the real world situation.

Generally, the interview schedule can best be understood in terms of using computers in schools which the conceptual models represent. Therefore, the questions of interview schedule are made to be issues derives since the conceptual models depict that scenario.

While the researcher admits that the 'semi-structured' interview by its very nature is not totally susceptible to detailed quantitative analysis, it is possible to use quantitative analysis for the structured questions and qualitative analysis for the unstructured questions. This enables the researcher to present a comprehensive analysis of their opinions of using computers in mathematics in lycees. It is considered adequate since it is unnecessary to impose a particular pattern of interpretation or to analyse the semi-structured interview from a particular standpoint.

The approach adopted in the case of unstructured functions' differs. The information obtained is difficult to analyse. Thus, the researcher relies heavily on narrative descriptions, since there is a need to compare the findings from the responses with the conceptual models.

It would be unwieldy to present all the decision makers with each of the unstructured questions. Instead a representative selection of quotations from the responses to the questions is used to illustrate an idea of the attitudes of the respondents to a particular issue. It is also provides the type of raw data or 'primary information' that the researcher has had to content with it.

5.3.1 Content of the Interview

The semi-structured interview consisted of 38 questions directed to decision makers (See Appendix F). The interview covered the following: general questions on using
computers in mathematics such as their opinions and feelings on computers, hardware, software, in-service training courses, carrying out projects etc.

The interview began with "Do you think the computer is useful for Lycees in mathematics?" In all cases the answer was "Yes", so the interview was carried on. If not, there were some questions to be asked and the interview would be stopped.

Questions 1, 2 and 3 were about the subject’s field of interest and the reason for beginning the interview with these was an innocuous beginning which people would be happy to talk about.

Question 5 asked about reasons for using computers in mathematics.

Questions 6, 7, 8 and 10 asked about this project and participation in order projects related to this one. The idea of having a suggested model to guide developments in the use of computers in mathematics in Lycees was asked in Questions 12, 13, 14, 15.

Budget and expenses of this project were asked about in Questions 16, 17, 18, 19, 20, 21, 22. Hardware, software, pre- and in-service courses were asked about in Questions 23, 24, 25, 26 and 27. The remaining questions were about teachers and their teaching and curriculum.

5.3.2 Analysis of the Interview

The five decision makers belonged to different institutions, two of them were employed by the Ministry of Education, three of them were employed by universities. Two decision makers' (who came from the Ministry of Education) were different from the others. Three decision makers (who came from universities) were more open to innovations and new ideas. Some examples are given below.

None of the decision makers thought that computers were wonderful machines that could do tremendous things for education. Their answers were usually of the form "we have to be careful to use computers and we cannot rely on computers for everything", but all of them thought that computers would affect the educational system positively and
They were optimistic about computers and they said "they tried to do their best" such as purchasing the best computers, cooperating with companies, preparing teacher training courses, even if they were not enough (Questions 1 and 2).

They did not think that the value of computers as a teaching aid was indisputable and "computers should be used as a teaching aid like a video, or over-head projector" and they added "they had to use computers as a part of the new technology, we could not expect lots of things from computers". (Question 3).

While two decision makers from the Ministry of Education thought students could learn the existing curricula better through computers, the university representatives did concern. There was a difference of opinion at the top level of implementation (Question 4).

The reason for the CAL2 project was the recognition of problems in mathematics education. Research has shown that students usually do not like mathematics and are afraid of mathematics (Association of Turkish Education Conference, 1985). In the decision makers' opinion, computers could help solve this problem and they wanted to concentrate resources here (Question 5).

The decision makers were satisfied with the CAL2 project so far. They were sensitive to political overtones but all of them knew about what they needed, and what they had done so far. (Question 6 and 7).

Question 8 asked "Have you got any executive committee which works effectively to provide coordination?" Their committee work consisted of only five decision makers, not more. They got some help from computer companies and decision makers believed that the committee worked effectively to provide coordination. The Ministry of Education has not got a research centre, or software centre, or in-service training centre for carrying out CAL. They planned to establish one, but the plan was never carried out. However, they were planning to establish these centres in the future. (Questions 8 and 9). They would plan other projects for the future to spread CAL to several subjects such as Chemistry, Languages, Physics, Biology and at every
level such as Primary and Secondary (Question 10).

Question 11 asked "Are you cooperating with other institutions on the project?" They only cooperated with computer companies. Computer companies cooperated with universities. There was a major conflict between The Ministry of Education and Universities over CAL. The Ministry of Education and universities both thought that CAL was their responsibility.

Decision makers from the universities were receptive to a model provided by the researcher to guide developments in the use of computers in lycees. The decision makers from the Ministry of Education did not like the idea very much of having a suggested model to guide developments in the use of computers in lycees, because they said they could create their own model.

Question 14 asked "If a model is created for Turkey do you want to support it?" Decision makers from the universities said "Yes", all of them agreed to support such a model. While their expectations from this model were about how to arrange in-service courses, staff development, the preparation of software, textbooks, they did not want to use a model which could be offered by someone else. (Question 15).

Question 16 asked "What are your possible funds and indicating sources at the total budget for 1989?" The Ministry of Education spared 30% of its budget, and the Ministry of State spared 10% of its budget for this project, and they did not want to answer how much money they spent on hardware, software, staff development and curriculum, but they only mentioned that a large proportion of the budget was spent on preparation of software. (Question 17). In their project the preparation of software had the highest priority, and they saw the order of priority software, hardware, staff development and curriculum design. All of them knew that they had to pay more attention to staff development and curriculum design as well. (Question 18)

Question 19 asked "How did you choose your software and hardware?" They invited bids and the computer companies applied for that one, and the companies supplied hardware and software. For now, the decision makers do not have any
plans for preparing and using software. Computer companies have prepared software according to The Ministry of Education rules and conditions. (Questions 20 and 21).

Question 22 asked "Does your software fit the present curriculum?". They do not know yet whether it would fit or not, because they gave their mathematics syllabus to computer companies to prepare software according to this syllabus. They offered a brief pre-service courses before the beginning of the project and it lasted for 3 months.

The participation in in-service training courses was voluntary (Question 24) and they did not give any certificate or diplomas for attendance (Question 25). Courses were given at computer companies and schools. (Question 26).

Question 27 asked "Have universities been involved in in-service education? If yes, in which departments?" Their answers were, universities had not been involved directly, but computer companies asked help from university staff from computer sciences departments and education departments.

Question 28 asked "Do efforts for staff development come from the teachers or from the Ministry of Education?" At the beginning of the project, teachers were asked to join in pre and in-service training courses, but later teachers made big efforts for this. The decision makers admitted that they were not very helpful to the teacher on this issue, but they would try to do their best in a short time, and they did not do anything like promotion or award for teachers who used computers in their teaching. (Questions 29 and 30).

Question 31 asked "Do the schools' principals take an active role in using computers in their schools". The answer was no, they were only told their schools would get computers and with what level of support without negations. Most of them (3) did not think principals were also important in the project. The decision makers thought teachers were more important. And they did not have enough staff who could take responsibility on this project, they needed more qualified people in the project (Question 32).

In Question 33 the decision makers were asked "Have you got any community pressure or community support?" They
did not have any community support or any community pressure but parents were very keen for their children to use computers in their learning and in some schools parents donated some money for computers, software etc.

All the decision makers thought that computers made teaching easier, and more interesting for teachers and computers could never take their place. (Questions 34 and 35).

Question 36 and 37 were about the mathematics curriculum. In their opinion computers would cause some changes in the mathematics curriculum and the curriculum would need to be changed, but the decision makers did not have any plan for changing for now. The decision makers knew that they should make a plan as soon as possible.

The decision makers thought that as a beginning, students must learn how to use the computers' capabilities for functions such as spreadsheet, statistical analysis, and word processing. Gradually, they could learn how to write program as well. (Question 38).

Besides these answers, all decision makers were aware that the resources needed are physical, in the form of appropriate hardware, software (space and reliable electrical power) and human in the form of trained teachers and other staff. The physical resources were imported and manufactured but the human resources must be trained. The decision makers claimed that there is no escape from the fact that placing computers in schools, within a support framework which allowed them to be put to effective use, places a very heavy demand on the training system of the country through the innovation.
CHAPTER 6

APPLICATION OF THE CHECKLAND'S SOFT SYSTEMS METHODOLOGY TO THE PRESENT STUDY

This chapter describes the application of the Checkland methodology to and presents a logical account of the argument for the systems study.

6.1 Introduction

The Checkland's 'soft' systems methodology uses systems ideas to find a structure in apparently unstructured 'soft' problems and consequently acts to provide solutions to the problems. It is based on building a conceptual model to be compared with the 'real world'.

This chapter is a part of an on-going attempt to tackle what are perceived to be "problems in the real world" and to do so by the explicit use of systems concepts (Checkland, 1975, 79a, 79b, 84).

In some soft problems the need is for action, in others the need is for knowledge. The methodology has been used in lots of studies in action programmes. So far these studies have concentrated on organisations or industrial firms and were conducted in a client/consultant context where the client commissioned the study and expected to benefit from it; the emphasis being an action.

In essence the methodology can be described as a screen stage process of analysis which uses the concept of human activity system as a means of getting from 'finding out' about the situation to 'taking action' to improve the
situation. (Figure 3.1 in Chapter 3 illustrates this process).

The logical sequence illustrated by this figure is a useful way of describing the methodology but it does not necessarily represent the sequence in which it is used. In reality it represents a pattern of activities.

The methodology contains two kinds of activity. Stages 1, 2, 3, 5, 6 and 7 are real world activities necessarily involving people in the problem situation; stage 3, 4, 4a and 4b are systems thinking activities which may or may not involve those in the problem situation, depending upon the individual circumstances of the study.

In general, the language of description of stage 1, 2, 5, 6 and 7 will be the everyday language of the particular situation while the language of stages 3, 4, 4a and 4b will be the systems language.¹

The analysis may start with any activity, progress in any direction and use signification iteration at any stage. In the present study research worked simultaneously, at different levels of detail on several stages. Therefore, a change in any one stage affected all the others. The application of the methodology will be discussed on the following sections.

In this study, firstly, the problem situation was expressed, secondly, conceptual model(s) were built and lastly, comparison of models with the real world was made.

6.2 The Application of the Methodology

In order not to impose a particular structure on building the 'rich picture' at this analysis phase, an element of slow to change 'structure' within the situation (Turkish Educational System), and elements of continuously changing 'process' (using computer activities in mathematics in Lycees), and their relationships 'climate' were carefully investigated.

The 'structure' was analysed in terms of the

¹For the system terminology look at the Glossary (Appendix D)
The 'climate' of the situation which is the relationship between 'structure' and 'process' is considered to be the core characteristics of a situation in which problems are perceived.

6.2.1 The Problem Situation "Unexpressed" (Stage 1)

First of all, the methodology involves describing the situation in which the perceived problems lie. 'Problems in the real world' concern problems which can be found by ourselves facing, rather than be bounded problems, that is a situation can be perceived as a problem and it seems, something needs to be done.

The use of computers in education has became a popular means for schools to gain prestige. At the start of the work (Checkland's Stage 1) the main idea was to learn about computer use in mathematics in our Lycees. Research started with the question of 'What is the current situation on using computers in education in Turkey?'. No specific problems were identified at the beginning.

The researcher started with the computer users' and decision makers' opinions, and attitudes, then moved back towards the system. The question moved from rather unstructured problem situation to structured problems.

The aim was to learn about the relationship between users and using computer activities in mathematics in Turkey.

Research was concerned with problem situations in which there were felt to be unstructured (unexpressed) problems. No specific problems were identified, just a feeling that research studies (activities), using computer
activities could be improved.

There are three elements in this study:
The User Survey (See Chapter 4 and 5)
The Checkland's Methodology (See Chapter 3)
The Researcher

6.2.2 The Problem Situation "Expressed" (Stage 2)

The second stage of the methodology is to analyse the problem situation in a neutral way which does not distort the problem into any particular form.

During the research process, problem characterizing these situations became expressed (structured). The starting point was thinking about problem content and problem solving systems and identifying the elements in these systems which are relevant to the problem situations.

The relationships between the problem content and problem solving systems at this stage are shown in Figure 6.1.

Figure 6.1 Relationships Between the Problem Solving and the Problem Content System
Many facts were sifted in the analysis phase (stage 2 of the methodology) to achieve the position shown in later figures. Information was culled from many different sources including using computers in mathematics in Lycees, and in the Turkish Ministry of Education, and the rich picture from the Turkish Lycees.

Most systems study usually takes place in circumstances in which there is a perceived problem and readiness to take action to solve it. In such a situation, there is a 'problem content' system which contains the role of problem solver. The problem solver defines the problem content system and use Checkland's 'soft' systems methodology to recommend action to solve the problem owner.

Problem Solving System

This includes the role PROBLEM SOLVER (the researcher) who has experience of the Turkish educational System, and use of computers in mathematics in Turkey, other roles in the system are: SUPERVISOR occupied by Dr. J. Underwood who helped in research and using computers in mathematics (in education). Resources of the problem solving system are: the combined opinions of users, evidence from the user survey and studies of the problem solver.

The problem solving system of the research contributes to the Turkish Educational System in using computers, that is to say the point of view operating in the problem solving system.

The problem Content System

The working context of users has already been described in Chapter 4 and 5. The 'problem situation' is expressed briefly here in Figure 6.2. The relationships between the elements has been rationalised as: humans carry out activities in the Turkish Ministry of Education and surrounding Lycees, and their activities are regulated by constraining influences of the place of computers in learning and teaching, programme planning, pre and in-service training, selecting of hardware and software, preparing software, evaluation, and funding.
Figure 6.2 A Descriptive Model of the Problem Situation
STRUCTURE

Teachers
Students

The Turkish Educational System

Three Lycees

Decision Makers

MANIFESTATIONS

The Survey
Population

The Ministry of Education

Ankara Anatolia, Cankaya and Gazi Anatolia Lycees

from Universities from the Ministry of Education

ACTIVITIES

Using Computers in Mathematics
Deciding How Teaching Mathematics Learning Mathematics through Computers through Computers Evaluation
Software
Preventing Selecting Using

Preparing Selecting Using

Hardware
Selecting Using

Assessment

Staff Development (Pre and In-service training)
Deciding How Attending

CLIMATE

educational and professional

The Turkish Educational System in the context there are areas of expertise unique to Turkey

the educational pattern is teaching and learning mathematics through computers, and in-service training programs

physical surroundings of the Lycees

Three Turkish Lycees in Ankara
CONSTRAINTS

goals and objectives
and educational Acts.

The notion of Lycees is central to the 'problem situation and has been explored by answering the following questions.

. What are the elements of structure?

Users
Physical form (a place or places)
materials (software and hardware)
(textbooks)
(learning and teaching materials)

These elements are available in various proportions.

. What transformations occurs in Lycees.

i.e. inputs \[\rightarrow\] transformation \[\rightarrow\] outputs

some examples:
living needs \[\rightarrow\] satisfied, desirable and planned learning

unsatisfied information \[\rightarrow\] satisfied information
(learning) on using computers

. What do LYCEES provide

from the researcher perspective

. a purposeful environment for study on using computers in mathematics
. a source of using learning and teaching materials (software and hardware)
. means for using computers in mathematics
. a focus for using computer activities in mathematics

from the decision makers perspective

. services
. place to teach and learn using computers in mathematics
. guidance in using computers in mathematics
. materials for using computers in mathematics
. staff for using computers in mathematics
The role of Users

Users here include mathematics teachers and students. The role USER is then occupied by working with computers in the three Turkish Lycees survey (population). The user survey discovered relationships between using computer activities and the nature of the user’s work. [Thus, user can be modified into users (teacher), users (students)].

The relevant factors are summarised in Tables 6.1 and 6.2. The first part of each table shows structure, process and climate in the users world. The second part views using computer activities.

The Roles PROBLEM OWNER and DECISION TAKER

Who occupies the role of PROBLEM OWNER in the problem content system? Two likely candidates are - the DECISION MAKER and the USER. The former is a clear choice. The DECISION MAKER, who is involved in this project from the Turkish Ministry of Education and Turkish Universities, is also a DECISION TAKER, and as such could affect the services in schools. It is less obvious that the USER can also be assigned to this role. It is by this choice that the user’s view is incorporated into the study, although an actual user would probably not himself recognise that he owns the problem. The USER is not a decision taker in the problem content system.

Hence, the USER’s problem could be: "I have needs which should be satisfied by a source(s) organised to meet general demand instead of my individual needs." This is opposite with decision maker’s: "I am concerned with organising services to meet the needs of individuals but these are difficult to predict and so I actually organise service to meet general demand."
### Table 6.1
Rich Picture of the Teachers

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<tr>
<th>STRUCTURE</th>
<th>Teachers, Lycees, Computer Labs.</th>
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<td>PROCESS</td>
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<tr>
<td>Teaching</td>
<td>Teach mathematics</td>
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<td>in computer labs.</td>
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<td>Evaluate</td>
<td>Assess students performance by quiz, educational exam monthly purpose board</td>
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<td>Administrate</td>
<td>Organize students' exam results, it to keeping students' records paramount</td>
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<td>Report</td>
<td>Write papers on observations improvements on students benefit professional</td>
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<td>B. Attending pre and in service training programs .Generic computer training in how to turn machine on and off, loading software .How to care diskettes .Programming language .To be informed about types of software available</td>
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<td>C. Using Software .Load and use software .Care of diskettes</td>
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<td>D. Using Hardware .Turn the machine on and off</td>
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<td>E. Available Material Sources .Hardware .Software</td>
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Table 6.2
The Rich Picture of the Students

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<td>(Verbs) Learning mathematics through computers</td>
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<td>educational control through teachers and assessments</td>
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3. Using computers in mathematics is influenced by many factors some e.g. the nature of user's work or his motivation can not be controlled by the decision maker but may help him to assess potential needs. Other factors, e.g. budget are also outside the decision maker's control and the limit the use of computers in lycees. Yet other factors, such as user's opinions of the use of computers in classrooms and the value of this, can be influenced by the decision maker and so he can affect users.

Figure 6.3 presents the relationships between problem solving and problem content systems. In a nutshell, the diagram shows how the problem solver/the researcher user systems approach to define problem content and adopt the Checkland 'soft' systems methodology to recommend appropriate actions to solve the problems identified to the problem owner.

Expression of the "Problem Situation"

Figure 6.1 can now be detailed with the essential elements concerning the 'problem situation' in Figure 6.3.
**Figure 6.3 Elements in the Problem Solving and Problem Content System**

**PROBLEM SOLVING SYSTEM**

**PROBLEM SOLVER:** the author

Other Roles:
- **SUPERVISOR**
  Dr. J. Underwood

Resources:
- user survey evidence
- combined opinion of users
- studies of problem solver

Constraints on problem solver:
- satisfy requirements for a higher degree
- do work, write and submit thesis within the time limit

Point of view:
- Contribution to the Turkish Educational system in Using Computers in education (maths)

**PROBLEM CONTENT SYSTEM**

**PROBLEM OWNER:**
- i. Decision maker
- ii. User
  - Teacher
  - Student

Structure:
- Teachers
- Students
- Lycees
- Computer Labs

Activities:
- Using computers in mathematics (teaching and learning by computers)
- Using software and hardware
- Evaluation
- Pre and in-service training programs

Climate:
- educational and professional knowledge
- using computers in mathematics in lycees serves users
- individual needs are satisfied through a general service

**CHECKLAND METHODOLOGY**

defines problem content system and uses to recommend action, learn about or redefine
Choice of the Relevant System

The preceding analysis suggests a possible 'relevant system' a system which was relevant to the root definition. These examples are not intended to be mutually exclusive or form a complete list. Here "using computers in Lycees" a "need satisfying system" are subsystems of the 'real world systems' when in fact it is a part of such a system.

- a need satisfying (for students and teachers)
- a system for realizing purpose of educational computing
- a system for students and teachers in order to provide a service
- a system for demonstrating the benefit of a service to a wider system
- a system enabling students to learn mathematics through computers.

The 'relevant system' selected as having most bearing on the problem situation i.e. learning about computers/users relationships, is that of the provision of service/need satisfying type which serves by providing and facilitating the use of computers in mathematics in Lycees.

The Strategy of the System Study: The strategy is shown in Figure 6.4. The colours show part of the methodology in this strategy:

red: analysis phase
blue: conceptual world
green: the comparison of real and conceptual world

The analysis phase leads to the selection of a 'relevant system' for the provision of service need satisfying and the identification of two problem owners: Decision makers and users. Then it branches into decision makers and users which continue root definition formulation, conceptual model building and comparison. Further questions requiring additional analysis are likely to arise from the
comparison. The users strand differs from the decision maker strand in two ways: (i) it is specially based on the user survey data as opposed to assumed general knowledge; and (ii) the comparison of real worlds may reveal areas where the user rich picture could be improved, i.e. it tests that model whereas decision maker strand will generate recommendations for action.

Figure 6.4 Strategy of the System Study
6.3 Formulation of 'Root Definitions' of Relevant System and Conceptual Models

Formulation of the 'root definitions' of the relevant system is stage 3 of Checkland's 'soft' systems methodology.

Stage 3 is the crux of the methodology. It is the point at which it is necessary to choose a way of viewing the problem situation.

'Root definitions' have the status of hypotheses concerning the eventual improvements of the problem situation by means of implemented changes which seem to both the 'problem solver' and the 'problem owners' to be likely to be both desirable and feasible.

In order to build conceptual model in stage 4, a root definition should be a richly precise (and concise) expression of a particular view.

6.3.1 The User Strand: Root Definitions and Conceptual Models (Stage 3 and 4)

As mentioned before, the role of problem owner is occupied by both the decision makers and users (i.e. teachers and students). Having chosen or identified the relevant system, the researcher proceeds to define the first level 'root definition', which is stage 3 of Checkland's 'soft' systems methodology, and finally build a conceptual model, which is stage 4 of the 'soft' systems methodology.

The 'root definition' that is considered relevant is expressed below.

User Root Definition 1 (RDI) The Ministry of Education system, specialises in the acquisition, organisation, evaluation of using computers in mathematics in Lycees on the basis of cost effectiveness. This system serves users by providing computers and software.

According to Checkland the formulated 'root definitions' must contain the mnemonic "CATWOE" which are considered to be elements in well formulated 'root
Having formulated the 'root definition', the next step is building a conceptual model, which is stage 4 of Checkland 'soft' systems methodology.

Construction of Conceptual Model(s) (Stage 4)

This is the stage 4 of the adopted Checkland's 'soft' systems methodology. This stage, in which from root definition to conceptual model, the most rigorous stage in the adopted Checkland 'soft' systems principles. However, because the conceptual models of users and decision makers are models of 'human activity' systems and their elements are verbs in this research.

The 'elements' as verbs are ensured because they are models of human activity systems and also the elements are structured, with inputs/outputs as required of a system model.
The 'verbs' are structured in a logical sequence. The main 'verbs' in the model cover three cores of the transformation which are either 'transfer' or 'human activity' system.

It should be noted that any of the 'root definitions' may be looked at as a description of a set of purposeful human activities conceived as a transformation process. The conceptual models built for this on going research are models of the 'human activity system' needed to achieve the transformation described in the 'root definitions'. The 'root definitions' are an account of what the system is, while the conceptual model is an account of activities which the system must do in order to be the system mentioned in 'root definitions'. The models so built are simple but emerge as subtle and powerful.

**Conceptual Model(s) (CM1) of User Root Definition 1**

In essence, the construction of the conceptual model(s) of users is based on the 'root definition' formulated above.

The conceptual model derived from 'root definition' is depicted in Figure 6.3. The same principles are followed in building other subsequent conceptual models for this study.

This conceptual model (CM1) (Figure 6.5) cannot be extended into a more detailed level about how these activities may be carried out without more information. The analysis stage 2 explains that there are two types of users: teachers' and students' computer using activities which are summarised in Table 6.1 and 6.2. The modelling process was repeated for the problem owner.
Figure 6.5 Conceptual Model (CM1) of User Root Definition (RD1)
6.3.2 User Students

Root Definition 2 (RD2a) The Ministry of Education and the Lycees, run the system, specialising in the acquisition, organisation, and evaluation of using computers in mathematics.

This system serves students (whose activities are: learning mathematics through computers, using computers in mathematics, using software, taking exams) by providing computer facilities which they need and facilitating their use.

Their needs are: Learning mathematics through problem solving, critical thinking, investigation and research into computers in mathematics. To satisfy these needs, they use computers, software, textbooks and this is facilitated by computer labs which are easy to use.

Table 6.4
Root Definition of User Student

<table>
<thead>
<tr>
<th>C (Customer):</th>
<th>Students</th>
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<td>A (Actor):</td>
<td>Teachers</td>
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<td>T (Transformation):</td>
<td>serve through the provision of using computers in education and facilitating of use User - user with satisfied using computer need User - user helped by using computer provision</td>
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<td>W (Welthanschauung):</td>
<td>The exploitation of using computers is necessary and desirable A special system of providing it is necessary</td>
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<td>O (Owner):</td>
<td>The Ministry of Education</td>
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<td>E (Environment):</td>
<td>Existing structure, resources, technology</td>
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Conceptual Models (Cm2ai, and 2aii) The 'generate' activity of (CM1) has been expanded in CM2ai (see Figure 6.6) to include user student details. Similarly the 'serve' activity has been expanded in CM2aii (see Figure 6.7).

Figure 6.6 Conceptual Model (CM2ai) of Students with activity "generate" expanded
Figure 6.7 Conceptual Model of CM2aii with activity "serve" expanded.
6.3.3 User Teachers

Root Definition 2 (RD2b) The Ministry of Education and lycees are the system specialising in the acquisition, organisation of using computers in mathematics. This system serves teachers (who activities are: teaching mathematics through computers, using software and hardware, administration and assessment of students' performance) by providing computer facilities, in-service training courses which they need and their use. To satisfy these needs, they use computers, software, textbooks and their use is facilitated by computer labs which are easy to use, and they attend in-service training centre for discussing their problems, learning new developments on this subject, taking and giving advise.

Table 6.5
Root Definition of User Teacher

| . C (Customer): | Teachers |
| . A (Actor): | Decision makers |
| . T (Transformation): | serve through the provision of using computers and facilitating of use |
| . W (Welthanschauung): | the exploitation of using computers in teaching is necessary and desirable |
| . O (Owner): | The Ministry of Education |
| . E (Environment): | existing structure and resources, technology |

Conceptual Models (CM2bi, 2bii) Models were derived in the way described above. CM2bi (see Figure 6.8), CM2bii (see Figure 6.9).
Figure 6.8 Conceptual Model (CM2bi) of Teachers with activity "generate" expand

**Perceived need for**
- hardware
- software
- textbooks
- evaluated books
- documentation
text
- written reports

**Do work**
- identifying mathematical goals
- select software to meet mathematical goals
- load and run programs
- provide coaching and assisting
- ask appropriate question
- circulate among students
- check for on task behaviour and understand
- give feedback
- assess them by giving homework
classwork

**Generate**

**Need computer for**
- teaching mathematics
- administration
- solving problems
- investigation
- critical thinking
- skill and drill
- electronic blackboard
  (for teachers and students discussion)

**TEACHER** with satisfied need
Figure 6.9 Conceptual Model of (CM2bii) Teachers with activity "serve" expand
6.3.4 User Students and Teachers

Root Definition (RD2c) The Ministry of Education and lycees, run system specialising in the acquisition, and organisation of using computers in mathematics. This system serves students and teachers (whose activities are: learning and teaching mathematics through computers, using computers in mathematics, using software and hardware, taking exams, administration, assessment of students' performance) by providing computer facilities which they need and facilitating their use and providing pre and in-service course which teachers need. To satisfy these needs they use computers, software, textbooks and their use are facilitated by computer labs which are easy to use, and attend pre and in-service training courses (for teachers) for solving problems and finding answers on using computers in mathematics in their teaching.

Conceptual Models (CM2ci and CM2cii) Models derived in the way described above: CM2ci (Figure 6.10), and CM2cii (Figure 6.11).

6.4 Decision Makers

Root Definition 3 (RD3) The Turkish educational system and its two related sub-systems the Ministry of Education and sample Lycees, together for the over all system conducting the CAL for the purposes of producing effective and efficient outputs. The systems have to evaluate such outputs. The Ministry of Education, as a part of its service, provides computers for using mathematics and the means of facilitating its use with the aim of enabling students/teachers in a Lycee setting, to meet their own continuing needs for teaching and learning mathematics.

For this reason decision makers seek to adopt monitor and control the means of selecting the best allocation of resources amongst the enormous numbers of possibilities which are always present in the educational system. The Decision makers seek to fulfil their stipulated
functions and responsibilities in terms of providing adequate, accurate, timely current facilities and materials, and ensuring quality facilities for using computers in mathematics.

These activities are regarded as part of providing quality service.

Figure 6.10 Conceptual Model (CM2ci) of User Student and Teacher with activity "generate"
Figure 6.11 Conceptual Model of (CM2cii) Users Student and Teacher with activity "serve" expanded
Table 6.6
Root Definition of Decision Makers

<table>
<thead>
<tr>
<th>C (Customer):</th>
<th>Teachers and Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Actor):</td>
<td>Decision Makers</td>
</tr>
<tr>
<td>T (Transformation):</td>
<td></td>
</tr>
<tr>
<td>i. supplying and handling hardware and software</td>
<td></td>
</tr>
<tr>
<td>ii. knowledge of teachers and students and their needs for using computers in mathematics</td>
<td></td>
</tr>
<tr>
<td>iii. monitoring and controlling of using computers in mathematics in Lycees</td>
<td></td>
</tr>
<tr>
<td>iv. professional knowledge of using computers</td>
<td></td>
</tr>
</tbody>
</table>

Its generation action is to meet these needs and its outputs are users with satisfied needs. The action is to serve through the provision of computers and the means of facilitating its use.

<table>
<thead>
<tr>
<th>W (Welthanschauung):</th>
<th>The teachers and users are working in a world where its desirable that their needs for using computers in mathematics are met and that is achieved through a service.</th>
</tr>
</thead>
<tbody>
<tr>
<td>O (Owner):</td>
<td>The Ministry of Education, Lycees</td>
</tr>
<tr>
<td>E (Environment):</td>
<td>. Agreed function wider system, service continuing</td>
</tr>
<tr>
<td></td>
<td>. competition of other educational resources for expenses in the Ministry of Education, and government social services commitments</td>
</tr>
</tbody>
</table>
RD3 suggests a system CM3i and CM3ii which have resources and knowledge inputs. These models monitor the process by which the decision makers fulfil their role as provider of appropriate services and monitor the activities to ensure that its achieving its purpose (agreed function). For example, provide hardware and software, know criteria for achieving role. (See Figure 6.12 and 6.13)

In Figure 6.14 All of the Conceptual Models (CM5) are presented in order to show relationships between models.

**Figure 6.12 Conceptual Model (CM3i) of Decision Maker's Root Definition (RD3)**
Figure 6.13. Conceptual Model (CM3ii) of Decision Maker
CHAPTER 7

THE COMPARISON OF CONCEPTUAL MODELS
WITH THE REAL WORLD

In this chapter the conceptual models described in chapter 6 were compared with the real world as perceived by the teachers and decision makers in the survey population.

7.1 The Comparison of Conceptual Models and the Real World (Stage 5)

The purpose of the comparison stage is to enable the researcher to identify the problem areas of using computers in mathematics in Lycees in Turkey. In this way, the effectiveness of using computer activities in the Turkish Ministry of Education can be determined. It is also to create in the light of the problem situation, but in a mood of detachment from it, a model which can be compared, formally and specifically, with the picture built up in the analysis phase. The comparison stage is so called because in it parts of the problem situation earlier analysed in stage 2 are examined alongside the conceptual models. According to Checkland, this should be done together with the concerned participants in the problem situation with the object of generating a debate about possible changes which might be introduced so as to alleviate the problem situation.

In describing the rationale of the stage therefore, Checkland develops four different approaches to conducting the comparison which have emerged from the various
researches he has personally carried out (Wilson, 1990, pp. 77-86). These are

i. general discussion,
ii. question definition,
iii. (historical) reconstruction, and
iv. model overlay.

The first comparison is concerned with a general discussion about the nature of the models, and any organization implied by them, when related to the nature of what is believed to exist (Wilson, 1990, p. 79). The conceptualization stage often raises major strategic questions. Such questions take the form: "Why do this at all?" rather than "Is this done well?"

The second comparison, question generation, is the most commonly used. This approach is using the models as a source of questions which are written down and answered systematically and it is these answers which will provide illumination of the conceptual models. This method of using the conceptual models as a base for "ordered questioning" in the problem situation has subsequently been much used in naming of Checkland's studies.

The third way of comparison is by reconstructing a sequence of events in the past and comparing them with what might have happened if the relevant conceptual models had actually been implemented. He suggests that this method should be used delicately. This is because it can easily be interpreted by participants as offensive recrimination concerning their past performance. In this way, the whole content of the study would be history, and the analysis compared the story as remembered and recorded at the time by participants, with a system model of researcher/problem owner(s) interaction.

The final comparison uses the model overlay. It is a model whereby a second model of 'what exists' is drawn and given, as near as possible the same 'form' as the conceptual model. In this way, direct overlay of one model or the other will reveal the mismatch and forms the basis of discussion change.
The researcher decided to use the 'question definition' model for this project because the conceptualization stage of this research raised many strategic questions about the present effectiveness of using computers for mathematics teaching. The 'question definition' model enabled the researcher to highlight the problem areas when the conceptual models were compared with the real world. Activities were listed irrespective of whether they were perceived as effective change done well or not for changing on using computers in mathematics.

To do this effectively, each of the conceptual models built is considered separately. However, three basic facts need mentioning before proceeding to the comparison. These are:

(a) that the views expressed in the comparison are based on evidence obtained from the users of teachers in three Lycees which CAL carried out. In this study, the conceptual model of teachers as users was only compared with the real world: In this project (CAL2) in Turkey, teachers have had very important roles as a bridge between students and decision makers,

(b) that the decision makers interviewed are responsible for whole of the CAL2 project in the Turkish educational system,

(c) that great care is taken to base the comparison on the evidence collected and not on the personal impression of the researcher.

Teachers' and decision makers' roles were presented with a list of conceptual model activities and it was asked whether the model agreed or disagreed with their experience, what were the differences, and whether the model omitted the major elements of the real world,
7.2 User Strand

The first comparison was made with teachers' real world and teachers' conceptual models. Comparisons are illustrated in table 7.1 and 7.2. The conceptual world column correspond to the list presented to the teacher and the real world column notes his/her responses.

Table 7.1 Comparison of Conceptual Models CM2bi with the Real World

<table>
<thead>
<tr>
<th>CONCEPTUAL WORLD</th>
<th>REAL WORLD</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+ agree</td>
<td>- disagree</td>
</tr>
<tr>
<td>Your work activities include</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.the identification of mathematical goals</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>.the selection of software to meet goals</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>.loading and running of programs</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>.providing coaching and assisting</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>.asking appropriate questions</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>.circulating among students</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>.giving feedback</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>.the assessing students by giving homework, classwork</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Would you like to use computers for</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.teaching maths</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>.administration</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>.solving problems</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>.investigation</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>.critical thinking</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>.drill and practice</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>.electronic blackboard (for teacher and student discussion)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>.concept teaching</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>.educational games</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>.demonstration</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>.bringing class together during topics or project work</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>.simulation</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>.tutorials</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>CONCEPTUAL WORLD</td>
<td>REAL WORLD</td>
<td>COMMENTS</td>
</tr>
<tr>
<td>-----------------</td>
<td>------------</td>
<td>----------</td>
</tr>
<tr>
<td>You use (in your schools)</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>.computers</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>.software</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>.textbooks</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>.documentation text</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>.written reports</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

**ADDITIONAL COMMENTS**

When teachers do not have any experience on using computers in their teaching

It is ideal to have a handbook which can be helpful on use

It is ideal to have an advisor, who is always ready to answer questions, in their school.

Advisors can be available to consult but the teacher should be working independently.

Teachers can teach in the classroom and advisors review the lesson.

From time to time some meetings can occur during the school day when the teacher is released from responsibilities.
Table 7.2 Comparison of Conceptual Model CM2bii with the Real World

<table>
<thead>
<tr>
<th>CONCEPTUAL WORLD</th>
<th>REAL WORLD</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>You attend pre-service courses for</strong></td>
<td>+ agree - disagree</td>
<td></td>
</tr>
<tr>
<td>.obtaining enough information about IT, and its usefulness to arouse interest</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>.changing attitudes towards the application of computer technology in lessons</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>.obtaining clear information about the use of the computer in as vary ways as is feasible</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>.learning details on hardware and software</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td><strong>in-service courses for</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.solving problems which occur when using computers in your teaching</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>.setting goals for the software</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>.evaluation of software</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>.selection of software</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>.BASIC, LOGO</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>.evaluation of students' achievement in your classes</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>.attend examples of good practice</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>You assess students' performance for</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.attainment of mathematical objectives by</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.Formative Evaluation</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>.homework</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>.classwork, quiz, monthly</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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## coffeausual WORLD

<table>
<thead>
<tr>
<th>REAL WORLD + agree _ disagree</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>You report how students achieve mathematical goals, objectives in order to&lt;br&gt;. provide feedback to the system and improvements in the system and its implementations</td>
<td>+</td>
</tr>
<tr>
<td>Your sources of what are hardware software textbooks written reports</td>
<td>+</td>
</tr>
</tbody>
</table>

### ADDITIONAL COMMENTS

. In-service courses should be more detailed
. Attending in-service courses should be encouraged and promoted.
. They should ask for help from teachers who have experiences in CAL for future studies. It will be useful for other teachers.

Comparing the conceptual model with the real world in Turkey shows some differences (see Tables 7.1 and 7.2). The respondents said that Mathematical goals had been identified by the Ministry of Education and software had also been selected by the Ministry of Education, therefore they had to obey the rules, and added they would if they knew how to do so in their teaching. They had used computers only for teaching mathematics, administrators and used software only for drills and practice, educational games, demonstration and tutorials. They did not have textbooks, documentation text or written reports beside computers and software in their school. As can be seen in Table 7.2, teachers said they attended the pre-service courses only for learning details on hardware and software.
7.3 The Decision Makers’ Strand

The implications of Root Definition 3 were compared with the real world, there is no big differences and CM3i resolved into CM3ii. The conceptual model activities derived from CM3ii were compared with the real world mechanism (see Table 7.3). This led to further collection of data to supply the necessary details about the real world mechanism. The observed differences suggested an investigation of the monitoring and control system which ensured the system achieved its agreed function and examination of this function in detail.

The observed differences suggested an investigation of the monitoring and control system which ensured the system achieved its agreed function and examination of this function in detail.

The conclusion was now presented to a ‘real world’ decision maker. In the subsequent discussion the decision maker commented that

"(i) merely pointing out some areas to consider was worthwhile (from this point of view);
(ii) that help in achieving some rational control would be acceptable;
(iii) that this help should provide a framework to guide thinking perhaps a list of questions to be asked and how to obtain the answers."

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Table 7.3 Comparison of Conceptual Model CM3i and CM3ii with the Real World

<table>
<thead>
<tr>
<th>CONCEPTUAL WORLD ACTIVITIES</th>
<th>REAL WORLD MECHANISM</th>
<th>DIFFERENCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>.acquire and maintain knowledge of population (teachers and students)</td>
<td>experience, unconscious process assume needs are met by 'normal' services the Ministry of Education's and Secondary School Programme's Goal employ professional staff such teachers, specialists</td>
<td></td>
</tr>
<tr>
<td>.acquire and maintain knowledge of population for using computers in maths</td>
<td>maintain buying policy</td>
<td></td>
</tr>
<tr>
<td>.understand agreed broad goals</td>
<td>.organise hardware and software and means of facilitating use</td>
<td>.provide pre-and inservice courses for teachers</td>
</tr>
<tr>
<td>.acquire and maintain professional knowledge of using computers in maths</td>
<td>.maintain buying policy</td>
<td>.organise hardware and software and means of facilitating use</td>
</tr>
<tr>
<td>.maintain buying policy</td>
<td>.organise hardware and software and means of facilitating use</td>
<td>.provide pre-and inservice courses for teachers</td>
</tr>
<tr>
<td>.organise hardware and software and means of facilitating use</td>
<td>.organise hardware and software and means of facilitating use</td>
<td>.provide pre-and inservice courses for teachers</td>
</tr>
<tr>
<td>.provide pre-and inservice courses for teachers</td>
<td>.monitor these activities</td>
<td>.monitor these activities</td>
</tr>
<tr>
<td>.monitor these activities</td>
<td>.assess activities</td>
<td>.assess activities</td>
</tr>
<tr>
<td>.assess activities</td>
<td>.take control action</td>
<td>.take control action</td>
</tr>
</tbody>
</table>

The outcome of the previous section suggested an investigation of monitoring and control activities, so
attention was focused on this area for the second iteration of the methodology. The new root definition can be stated informally as 'a monitoring and control' system to support the system described in RD3 and illustrated in CM3ii (Figure 6.13). Since the monitoring and control sub-systems are subservient to the 'operate and acquire knowledge' subsystems these also need to be examined in more detail. CM5i and CM5ii (Figures 7.1 and 7.2) show how the monitoring and control sub-systems relates to these other subsystems at a more detailed level.

7.3.1 The 'Acquire Knowledge' and 'Monitoring and Control' Subsystems

1. In order to proceed further a formal statement of using computers in mathematics needs to be constructed. The procedure for this is explained with reference to model CM5i.

   (i) Knowledge of the population and of their needs for using computers in mathematics is combined into a description ((a) in CM5i).

   (ii) A list of various ways of meeting different needs using computers is derived from knowledge of using computers in mathematics ((b) in CM5i).

   (iii) These are combined into formal statements of the detailed function of the use of computers in mathematics in Lycees ((c) in CM5i).

   These statements describe the population needs of using computers in mathematics and how they will be met in practise.

2. The next step is to enquire how to support "using computers" activities. Table 7.4 lists each conceptual world activity and then identifies the computers uses required to carry it out. The third column of the Table

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suggests how this system might be arranged by a decision maker who serves teachers and students. The sort of information that might be obtained is illustrated by that gathered during the present study. Some of this information is so nebulous that specific sources cannot be suggested as it is usually gained through experience and awareness. Even in these cases, consideration of questions will draw the decision makers' attention to factors of which he may already be aware, but the significance of which is not recognised.
Table 7.4 Using computers in mathematics required for defining the detailed function

<table>
<thead>
<tr>
<th>Conceptual World Activities</th>
<th>Needs of Using Computers for Conceptual World Activity</th>
<th>Suggested Real World Mechanism for Obtaining Using Computers Needed for a System Serving Teachers and Students</th>
<th>Illustration of the Sort of Using Computers in Maths likely to be Obtained (based on data gained in present study)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understand broad goals</td>
<td>Authoritative statement of broad goals from the Ministry of Education</td>
<td>Seek in official documentation e.g goals of Ministry of Education and secondary schools' programme</td>
<td>e.g to serve requirements of students and teachers in Lycees</td>
</tr>
<tr>
<td>Know about population being served</td>
<td>What are the limits of population what groups are included and what are excluded?</td>
<td>Judgement (basis is indefinable) on who users of computers are likely to be</td>
<td>e.g. All students and teachers from three Lycees which was involved in pilot study for CAL2</td>
</tr>
<tr>
<td></td>
<td>Who actually constitutes population?</td>
<td>Seek lycees lists obtained from the Ministry of Education</td>
<td>e.g. user population</td>
</tr>
<tr>
<td></td>
<td>How are they described?</td>
<td>Count people in Lycees' lists</td>
<td>e.g. survey population numbered about 225 students and 18 teachers</td>
</tr>
<tr>
<td></td>
<td>What is the size of the population and its consistent groups? Does it they vary much?</td>
<td></td>
<td>three Lycees in Ankara</td>
</tr>
<tr>
<td></td>
<td>Where are users located?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. Monitoring and Control of Detailed Function

Monitoring and control of the activities see CM5i involved in writing the statement of the detailed function ensures that it is kept up to date and still applicable to the population being served. Monitoring is a continuous process of being aware of charges which way affect the details of using computers function and is easier if key areas have already been identified. Each piece of knowledge should be consciously reviewed at intervals. The criteria for deciding when to do this will be based on past experience and knowledge about the likely frequency of change. Where the population remains static for many years the role may only need revising as new ways of needs of using computers develop. On the other hand, if the population is constantly changing in character the using computers function would have to be reviewed more often. Initial control action will be to check the original knowledge or gather new information on using computers in mathematics. The details in the
formal statement can then be modified accordingly.

7.3.2 The 'Operate' and 'Monitor and Control' Subsystems

The purpose of this monitoring and control system (See Figure 6.9) is to ensure that computer operations do what they are supposed to do, and there must be a link between the computers function and monitoring process. This is achieved by deriving the criteria for judging performance from the formal statement of the use of the computer. Each operational activity needs its own set of criteria and must be monitored in ways which enable performance.

7.3.3 Conclusions of the Decision Makers' Strand

The main differences between the conceptual world and the real world are in

(i) the monitoring and control process for ensuring effectiveness,
(ii) the lack of a model or a picture of the population served.

These formal process which are predicted by the conceptual world, do not appear in anything like so identifiable a focus in the real world, these should be more examined in more detail, and possibly, new systems implemented.

7.4 The School System as a Part of a Wider System

The monitoring and controlling system acts as a link with different parts of the wider system which in turn facilitates using computers in mathematics in Lycees in Turkey. However, by selecting the decision maker as the 'problem-owner', "the system" is limited to the schools under his sphere of control. This system is only part of a wider system, and the school's agreed function within that wider system has to be taken as given. The study as presented, therefore has centred on 'task-based' root
definitions (Checkland and Wilson, 1980, pp. 51-54). A look at the wider system indicates 'issue-based' root definitions where there will be several views about the aims of different parts of the system. However, this approach might lead to a study of the Ministry of Education's administrative structure rather than specifically schools issues.

7.5 Improving the Rich Picture of the Users

The user strand finished with a debate about the user survey model. Comments were made during that discussion prompted further questions which showed the demand for data collection. To this effect, the questions of what/how people use computers in schools; the reason why they need computers in schools were clarified. Another area of exploration was the motive of the users working on computers in a way to give the decision maker a clear idea for further consideration. If the users' reasons were discovered, then the Checkland's methodology could be used to infer what needs should be met. Comparison of users' reasons and decision makers' intentions would reveal differences that could lead to new ways of using computers in mathematics in Lycees in Turkey.
Figure 7.1 Conceptual Model (CM5i) of Decision Maker Relationship Between The Knowledge Acquisition Subsystem And Monitoring Subsystem: The Users
Figure 7.2 Conceptual Model (CM5ii) of Decision Maker Relationship Between The Knowledge Acquisition Subsystem And Monitoring Subsystem: Environmental Factors
CHAPTER 8

THE PATHWAY OF THE SYSTEMS STUDY

The aim of this chapter is to give an account of how the work described in chapters 6 and 7 came about, to try give some flavour of how it progressed from the first initial thoughts to the final outcomes.

The main points of these chapters are described briefly, together with the problems encountered and how they were overcome; some significant problems are discussed in more detail. The pathway presented is a superficial account illustrating the threads that were followed through the project. It is emphasized that understanding of the ideas deepened gradually and continuously.

A critical discussion of the appropriateness of Checkland's 'soft' systems methodology as an evaluative research tool in an educational context follows. This critique draws on the researcher's practical experience in the use of the methodology to build a conceptual framework of the use of computers in the mathematics classroom. The appropriateness of Checkland's 'soft' systems methodology in developing conceptual framework for the use of computers in mathematics is also discussed.

8.1 Review of the Study

The development of a theoretical framework of educational computer activities in the Turkish context is central to this research. Education itself is a system, of which the school is a sub-system. However, Education is a
complex system with ill defined boundaries. The system approach is a concept rather than a methodology. To capture this system the researcher had to seek a methodology which took cognisance of the difficulties in defining the component parts of the Educational System. It is for this reason that the researcher chose the Checkland methodology to aid in the development of a theoretical framework of using computers in schools.

The impetus for this study was the researcher's concern that the CAL project she had been involved in did not appear to be meeting the desired objectives. The researcher felt there was a lack of communication between participants in the study. The needs of each of the participants had not been clearly defined.

Consideration of classroom computer use has played a significant role in the generation of ideas through this research in terms of choice of systems approach concept and the adaptation of Checkland's 'soft' systems methodology.

The 'systems approach' has been used throughout the research because it helps to explore aspects of the topic under consideration from different points of view and as a whole problem. In other words, the 'systems approach' looks at the system as a whole.

The development of an effective model for using computers in education requires an understanding of the current situation in Turkey. The use of computer activities in mathematics was limited to three Ankaran Lycees. Data about the real world mechanism were collected by survey which included interviews and questionnaires. Results of the surveys helped to provide a rich picture or descriptive model of the current situation. The aim of the survey was to collect data and combine it into 'rich picture' itself a descriptive model of the real world.

Two distinct problems were identified.

i. the 'problem situation' itself; and
ii. methodological problems

These are the 'problem content' and 'problem solving' systems respectively in the systems' terminology.
The expression of the 'problem situation' was based on knowledge gained from the field surveys. Although many differently worded root definitions were produced from which conceptual models were derived, the majority took the form of a sub-system doing something for (i.e. serving) another sub-system. An alternative type of root definition was 'need satisfying' that is one sub-system which had to justify its existence by demonstrating its contribution to another sub-system.

I remind the reader that in this methodology the following roles are of key significance: the decision makers, the users and the clients.

According to Checkland the 'client' is someone who wants to know or do something and commissions the study. The implication is that he can cause something to happen as a result of the study (Checkland, 1981).

Users were presented as inputs and outputs to the system. The problem situation was expressed from the user's and the decision makers' points of view. The notion of user and decision maker as 'problem owners' grew from an acknowledgment of these multiple view points. The assumptions and facts about Turkish schools derived in the analysis phase were based on the researcher's own knowledge. In order to reduce the possibility of bias, assumptions and facts were checked against several sources with a literature review and reconfirmed by several educators in Turkey.

One problem was that the study faced was a lack of a true 'client'. There were several partial 'clients' each displaying some 'client' characteristics which - taken together - constituted 'the client'. In other words, the clients existed but in a diffuse form, not as a single person or organisation. This issue led the researcher to supra-institutional problems. The effect of this diffuse form of client was that it was impossible to process Stages 6 & 7 of the methodology that is the debate about change and action to improve the problems. This forced the researcher to take on the role of 'client' at stages 6 & 7 and to make recommendation for the improvement of the system. This was not an ideal situation and the ensuing problems caused by this forced uptake of 'client' role which will be discussed.
in greater detail in section 8.2 of this Chapter.

There were a number of deficiencies in the process by which CAL was introduced into the study schools. At the beginning of the study the researcher had no preconceived idea about findings of the research on the management problems regarding the 'monitor & control' and the 'acquire & maintain' activities. It was impossible for her to define those issues as problems at the beginning of the study. Since they were not known it was impossible to test them at all. The methodology enabled the researcher to find out these management problems and the necessity and importance of the 'monitor & control' and the 'acquire & maintain' activities which are generally either unconsciously performed or neglected. Neglecting these activities results in an opaque system and this can lead to serious failure of the system. There was no authoritative or responsible body which was required to undertake management activities such as the 'monitor & control', the 'acquire & maintain' activities in the system. The management of the innovation process is not simply desirable but necessary. Though computer activities existed, in general these activities were uncoordinated, and this had an immense impact on the overall effectiveness of the system. As a consequence:

- a detailed 'monitor & control' mechanism was designed. This work for a profession could not go beyond the design stage, but it could be taken further for the real world decision maker if he desired it;

- the researcher was able to occupy several roles; problem solver and a partial client. She was also involved in all kind of problems in the area as an academician. However survey evidence was necessary to get beyond a general level and to avoid bias;

- a strategy was obtained which used the 'need satisfying' type of relevant systems and root definitions for first the decision maker and then
the users as 'problem owner';

- initial trials of the decision maker strand were satisfactory. All details of the project were asked;

- the user strand was less successful because in particular, in students' strand results could not get beyond a general level;

- once the problem owners had been identified their corresponding root definitions and conceptual models could be built;

- the school system is a sub-system of the educational system and it was necessary that this sub-system should hold some image of the total system it was serving i.e. that definition of the function in detail was essential;

- the comparison between the conceptual models and the real world revealed differences on different levels; and

- user strand root definitions and conceptual models were made in general, since it was not possible to go into detail for all different types of users.

The development and construction of the conceptual models of computer use in mathematics was achieved in Chapter 6 using Checkland's 'soft' systems methodology. Checkland's 'soft' systems methodology does not only played a significant role in the construction of the conceptual models but also in the comparison with the real world mechanisms in Turkey.
8.2 A Critique of Checkland's Soft Systems Methodology And An Evaluation Research As Tool In An Educational Context

A perceived insufficient use of computer activities in schools was the starting point of this research. The main aim was to identify and understand why CAL was not being used effectively in Turkish schools. In order to do this the researcher monitored and evaluated a prestigious government project. This project was designed to improve mathematics teaching in Ankaran schools through the use of new technology.

In order to maintain a degree of objectivity from this project, the researcher chose a research methodology which allows issues to emerge from the research data, rather than imposing a problem definition on the research at the outset. Checkland's 'soft' systems methodology does not start with an expressed problem definition; its aim is to identify the problem itself. In other words, the definition of the problem situation is the target of the research.

In order not to end up with inapplicable solutions Checkland's methodology directs the researcher to work within the boundaries of the real world. Once the constraints are known, models are designed within these constraints of the real world i.e. the methodology requires the researcher to work within a real context at all times.

The outcomes of the application of this methodology are a number of sub-situations which will lead to improved effectiveness and efficiency of the system under investigation. The methodology does not set a single global solution. It is always possible to do further research on the improved problem situation to increase that efficiency. Checkland's methodology allowed the researcher to describe and analyse the actual situation.

The focus on real world problems and partial solutions made the methodology an attractive tool to this researcher.

The advantage of methodology are:
i. It provides a framework for thinking about complex situation which has mechanisms to present wandering off into abstraction.

ii. It forces the recognition that the researcher is part of the study and influence it. This concept is frequently glossed over.

iii. It brings to light basic assumptions. This is valuable because not only are the preconceptions of the researcher made explicit, but it also indicates other areas of research in questioning these assumptions.

iv. It forces the researcher to follow where it leads and so the outcome is not necessarily predictable. This avoids the possibility of defining an artificial problem at the outset which might constrain the investigation.

The Checkland methodology follows on from the idea of forming a rich picture of the use of computers in mathematics. This qualitative approach is often intuitively valid but difficult to verify, in contrast to the quantitative approach which may model accurately something which has little relation to reality. Clearly both approaches have their drawbacks and advantages. Checkland’s methodology can be applied in any instance where a conceptual model in sought, for example before any attempt is made at quantitative modelling.

The outcomes of the research investigation are in some ways disappointing however, and the methodology has proved difficult to apply in the educational context. Why should this be so? In the following discussion the researcher identify a number of methodological problems which arose over the period of the investigation.

Methodological and practical problems were encountered in:

. setting up the model
. the problem of inconsistent viewpoints
. the matching of disparate realities
. the problem of not acquiring real viewpoints
. refinement of the model
. collecting data
. time scale

. Setting Up the Model

There were some dangerous stages of the application of Checkland’s 'soft' systems methodology. Two of the problems that were faced by the researcher were related to the building of the conceptual model(s). One was creating a model which was not simply a description of the real world situation and the other was avoiding the creation of an utopian model which has no connections to the real world. The maintenance of a balance point between a simple description of a reality and an idealistic model but the methodology provides a mechanism to enable the model builder to avoid these pitfalls.

Avoiding the utopian solution was achieved by working within the environmental constraints which were suggested by the methodology. In other words, models were created within the real world limitations. Avoiding the creation of a model which was simply a description of the real world was achieved by analysing the descriptive model (rich picture); noting points of tension for example, mismatch of the decision makers’ and users’ goals, and providing mechanisms to reduce the tensions created such a mismatch. Through the survey the researcher found out not only the opinions but also the attitudes of the people in the problem situation. This information and information collected through the literature review and the researcher’s own knowledge highlighted the way through modelling stage. Furthermore, when the researcher reached the comparison stage appreciable differences were found between the conceptual models and the real world situation. This also proved that models were not the reflection of the real world.

Another important point in the present study was
to identify 'the client'. The person who wants to know or to do something or commissions the study. This point brought 'supra-institutional' problems to the scene. In 'supra-institutional' problems a single person or an organisation cannot gain ownership of the problem (Cornock, 1980). Instead there are several partial 'clients' each displaying some of the above characteristics to a greater or lesser degree which when taken together constitute 'the client'. In other words, 'the clients' exist but in a diffuse form, not a single person or organisation. The partial clients are: the researcher and the real world decision makers in the Turkish Ministry of Education. The researcher commissioned the study not the decision makers in the Ministry of Education although they could have done. They may take action as a result of the study and they are most likely derive benefit from it. However, to be more practical, models would have been designed only for these specific schools according to their conditions instead of designing in general for the whole Turkey.

. The Problem of Inconsistent of Viewpoints

Another problem in this study was contradiction between the decision makers' view points. They were skillling a society but they put in a place a project which was designed not to produce IT skills but to support existing curricula. To meet their expressed goals of creating an "IT Aware" and "IT Literate" population the educational innovation needed to be focused on IT skills not on mathematical skills. This would require new courses on "IT Awareness" and "IT Literacy" rather than computers being used as a tool in teaching and learning.

. The Matching of Disparate Realities

This methodology could be queried because of the degree of subjectivity of the research. Subjectivity is, in fact, the characteristic of the methodology itself. The choice of relevant systems, root definitions, and conceptual models were all subjective. However they are all defensible
from the researcher's point of view. As was stated by many authors (e.g. Ackoff, 1971; Churchman, 1978) and by Checkland himself (1981), soft systems modelling is a subjective process because no two people will look at any particular aspect of the world in the exactly same way.

Identifying a system is not a purely objective process since the purposes and interests of the researcher will be involved. There is no single tenable account of a human activity system. Instead there is a set of possible accounts, any of which may be valid according to a particular point of view. The choice of view is subjective and cannot be judged according to its bearing on the problem situation and case must be accompanied by an account of the observer and the point of view from which his/her observations were made. The choice of the relevant system is entirely subjective. But this does not mean that it is an arbitrary choice. Although it is very difficult to judge whether a given relevant system is right or wrong, it is possible to assess to what extent the relevant systems helps in our understanding of the problem situation and contributes to the problem solving (Beishon and Peters, 1976; Ackoff, 1971; Checkland, 1972).

The 'soft' systems methodology is explicitly based on interpretive theory. According to Burell and Morgan interpretive theory is subjective and interpretive thinkers see social reality as it is (Burell and Morgan, 1979). The social world is seen as being the creative construction of human beings. "Problems" arise when individual actors' perception of reality do not overlap (Jackson and Flood, 1991, p. 186). Interpretive theory seeks and establishes or re-establishes mutual understanding to bring perceptions back into congruence so agreement that shared view can form the basis of actions to take. This affects perceptions from the boundaries of the problem. The social world has no real existence therefore outside the consciousness of human actors.

"They believe that only suffication that can be obtained for social system changes is that they are arrived at through open debate in which
concerned actors achieve a consensus about the nature of their objectives and the changes they wish to bring about in social systems" (Jackson, 1985, p. 144).

It follows that in studying the social world we cannot follow the methods of the natural sciences. Instead we must proceed by subjectively trying to understand the point of view and intentions of human actors who construct that social world. Therefore, the importance lies in soft systems thinking of probing the 'Welstancshaung' or the 'appreciative' systems (Checkland, 1981) that individuals employ in understanding and constructing the social world. In this study, however, it was not possible to bring about congruence of perceptions because the players had perceptions so far apart that could not overlap. This was a major problem when reviewing the perceptions of the teachers and the students.

The Problem of not Acquiring Real Viewpoints

The methodology allowed the researcher to search for opinions, attitudes of users and opinions of decision makers, because of the context the researcher felt that users and decision makers often gave the correct answer, but it did not give the objectivity. Therefore, the models cannot be used as basis for manipulating the real world, but they can only be used as a structure to debate among the various actors concerned with problem situation. One of the other impacts of the subjectivisms is that soft system methodology tries to work for change at the level of ideas (Jackson, 1985). But if people's 'Welstancshaung' is linked to other political and economic structure in a constraining social totality they may not be so easily changed. Changing of 'Welstancshaung' might depend on changing other social facts. Churchman's, Ackoff's and Checkland's methodologies provide little direction as to how to operate in the circumstances where the conceptual model demands radical reform of a society with no tradition of rapid change (Churchman, 1971; Ackoff, 1979; Checkland, 1981). It may be
that the methods they employ are not appropriate to the social systems with which they seek to deal (Jackson, 1985).

In this respect, this methodology and its results cannot work in Turkey's conditions because the cultural and political structures of Turkey are not yet flexible enough for reformist movements.

The methodology is dealing with human activity system. Any human activity system is socially and culturally bound. Societies' culture, politics and traditions affect the human nature. Therefore, the methodology cannot be equally workable in all societies.

. Refinement of the Model

In the present study, the problem is neither client owned nor impossible to own but seems to be somewhere in between. To improve the present study it would be possible to debate the differences between the conceptual models and the real world mechanism with the decision makers, and recommended by Checkland, although they are not the 'real client'. It is recommended that further work should be done to clarify the notion of 'the client'. The methodology would be more successful if the decision maker and users (teachers and students) were the owners of the problem. The inability to complete stages 6 & 7 of the study was perhaps one of the more severe limitations of the present research.

The validation of models is very important. Checkland suggests a different kind of validation for systems methodology. This validation is based upon respect for the point of view and aims all the participants affected by the intervention which is called 'participative criteria' (Ackoff, 1981).

This methodology requires improvements to the system under investigation to emerge from a generalized and theoretically enhanced debate about feasible and desirable changes as perceived by participants involved in the problem situation. Participants play a significant role in soft systems methodology and the difficulties faced here in defining players was a serious drawback in implementing this research. In the present study, participants knew too little
to meaningfully contribute to the 'rich picture' and this affected the debate about feasible and desirable changes as perceived by these participants. The data provided by these players needed to be of sufficient quality for a meaningful description to take place.

One criticism for the effective implementation of the methodology is that all the participants of a system are prepared to enter into a free and open discussion about changes to be made. Privileged participants of the system (in terms of wealth, status or power) have their dominant position and submit their privileges to their own criteria (Rosenhead, 1976). It is essential that the ability of some participants to impose sanctions on others, because of their power, must not affect the discussion which is inevitable in practice. In many social systems, whether at 'company', 'regional' or 'national' level, great inequalities exist, and the kind of unconstrained debate envisaged here cannot possibly take place. Since inequalities exist in the distribution of resources and power in societies, this methodology cannot be applied without the players showing a willingness to enter into free dialogue. If the social system has the opportunity for a reasonably full and open discussion, and if there is a balance of power and resources between participants the methodology can be used successfully (Jackson, 1982). No society is 'equal' in the sense required by Checkland. In the case of Turkey these inequalities are very large. At this point, in time, 'soft systems' methodology is not an appropriate to Turkey because participants in the present study do not have equal power to debate for feasible and desirable changes. Whereas it is essential that all actors have an equal say in discussion teachers and students do not have any right to affect the situation; only decision makers have this power.

The actors (teachers) here are not 'clients' who control the whole system or take any control action since regulations, legislations or sanctions are not under their control. It would be useful to see how far they could go in changing the system. They can only change things under their control e.g. schools. Improvements of individuals' contributions to the system would have ensured a more
effective re-modelling of the problem situation. Of course, teachers want to improve their teaching conditions but if they are not responsible for the decision making which affects schools, it is not surprising that they do not feel 'ownership' of the project. In other words, teachers were willing but powerless. The hierarchy in administrative and professional bodies is rigid in Turkey and it is not practical for teachers to join the decision making process. For this to happen there would need to be some radical changes in the system.

Collecting Data

Whereas opinions and attitudes of users were considered in the present study, the outcomes of the CAL2 project were not dealt with. The project had started three months before the field surveys were started. The researcher was not able to be in Turkey at the beginning of the study. Pre and post tests would have given valuable insights into the effectiveness of the CAL programme. However attitudinal measures were taken as an indicator of the learners' motivation and therefore of the probable learning outcomes. The students were very negative about using computers in their mathematics learning. This suggests that learning did not take place.

Using attitudes as indirect indicators of outcomes meant this project was less powerful than it might have been but these data were all that were available to the researcher. Attitudes are important. The success or failure of IT in a society is largely dependent on attitudes of people who work with it and live with it. New technology has to be considered in relation to people who are affected by technology and at the same time affect the success or failure of technology.

It would have been useful to look at outcomes (cognitive behaviours) to improve the model and the non-availability of these data can be considered a shortcoming of this study.
The results of using the methodology is not of course a 'solution' to the original problem situation. According to Checkland, problem solving in a human activity system is a continuing process, a process of learning which is never ending (Checkland, 1981). Checkland states that one can start the analysis at any of the seven stages of the methodological cycle and that the methodology is iterative. As one proceeds through the seven stages again and again understanding is enriched. Such multiple iterations require time, however. Time is not a limitation of the methodology but universal problem in educational research. Educational projects often however short life span. One can rarely go back and reinvestigate as Checkland requires. In this respect, present study is flawed, because of the researcher's time limitation it was impossible to proceed through the stages again and again operating the iterative model.

Conclusion
In conclusion, the research has provided a useful descriptive model of the CAL2. There has been a systematic evaluation of the process of innovation and it is now possible to identify problem areas in the innovation process as applied to Turkey. The methodology, however, despite its original attractiveness and promise to capture a complex system, has proved difficult to operate in this educational context.
CHAPTER 9

DISCUSSION AND RECOMMENDATIONS

This chapter is arranged into 7 sections:

1. Perceived need for IT
2. CAL studies in Turkey
3. Purpose and conduct of the present study
4. The main findings
5. Recommendations
6. Suggestions for further studies
7. Conclusion

9.1 Perceived Need For IT

How important are computers to the future economic growth of Turkey? The Turkish Government has placed great emphasis on the importance of IT to the Turkish economy. Is this emphasis justified? Can IT, and computer use in particular, deliver new jobs and industrial opportunities?

Most industrialized notions have a commitment to IT but Turkey has had to temper this commitment for financial reasons. There are major training implications as each nation works to develop an IT literate and capable population. This study has focused on one of the Turkish Government's initiatives to meet these training needs.

Information Technology is essential for Turkey, because the Turkish Government wishes to modernize the economic infrastructure. It is essential to our economic survival to be in electronic communication with developed
countries in all areas of trade. One of the aims of the Ministry of Education is to support this modernization and reconstruction. In general, the policy on computers in schools, is based on maximizing benefits giving as much training as possible to the greatest number of students in society.

When the governments of developing countries like Turkey consider computer policy, this must be backed by an understanding of the potential of computers in integrating systems, improving problem-solving and analysis and improving management.

Once the need for computerisation is accepted the administrative structure for acquisition must be established, hardware and software obtained and people trained. A formal structure for promoting and coordinating implementation must also be established. Both functions could be carried out by official bodies (policy making and regularity bodies), and the implementation could compose network underneath a national computer centre.

Even if the government is strongly committed to adopting computers (IT) in the national interest, many technical difficulties remain.

Any change in society affects the education system. In previous decades changes are so rapid that education must necessarily reflect developments in society. IT, as one of the developments, affects the education system and education must in turn prepare students to cope with the changes brought about IT.

Education should also help the younger generation to anticipate change and adopt to that change in their work place and their everyday lives. Moreover, education can help to influence and determine future changes as well as preparing people to cope with it. New technology should be the responsibility of those who benefit from that technology in order to ensure it is used effectively. People should be determinants rather than being controlled by the technology.

These are various ways to teach people about new information technology in its different forms. This usually involves two types of courses: first technical approaches to computer studies, and computer science and secondly, more
general computer awareness, computer literacy or IT awareness courses for all students at some stage of their school life.

The overall aim is to make student aware of computers and IT, their uses, capabilities and possible effects on society.

It is clear that views on the potential IT in education vary. The role of new technology as a teaching and learning medium is undisputed but there is a problem in teaching and learning about new technology and also maintaining an awareness of wider uses of IT. Computer awareness can sometimes be parallel and sometimes limited to computer literacy.

It is important to make clear definitions of "computer awareness" and "computer literacy". Computer awareness usually means becoming aware of the extent to which computers are part of our lives and the society in which we live. It might include a study of the history of computers, how a computer works, what computers do, where they are used, the impact they are likely to have on society (Terry, 1984, p.4).

Leuhramann (1981) suggests we consider the term "computer literacy" to be derived from a wide use of the term "literacy". He emphasizes that literacy in a languages refers to ability to read and to write, that is to do something with the language. Literacy in mathematics means the ability to do mathematics. The implications for schools is that literacy skills such as these are needed for a person to function reasonably, successfully in modern society.

The term has recently been extended to include computer literacy which implies the ability to do computing. What ought a computer literate student be able to do? A computer literate student should

understand what computer systems are

use computer vocabulary

operate a microcomputer in a work related situation
appreciate what a program is and why it works be aware of applications of computing in commerce, industry and other settings be aware of current trends in It and its social implications (Computer Literacy – A Teacher's Guide FEU, 1983, p. 5).

As a result of world technological developments, the Turkish Ministry of Education had to consider IT, catch new developments in IT, and to try adapt itself to these developments. However there is ambiguity of concept. IT is seen as synonymous to CAL and, the government is supporting CAL in secondary schools.

9.2 CAL in Turkey

Pre 1980, the study and the use of computers in Turkish Educational System were limited mainly to the universities. With the advent of low cost microcomputers, computers have rapidly appeared in Turkish schools. There was an expectation that this would lead to an improvement the quality of education and reduce regional disparities (Fidan, 1988). It was also expected that CAL would encourage young Turks to stay on elementary and secondary levels. Computers have been seen as a panacea.

In order to initiate CAL in Turkey, a project was started and administered by the Ministry of Education, and the Ministry of State for Scientific and Technological Affairs in 1984. This was known as CAL1 and a committee which included representatives from the universities and companies or institutions in the electronic industry was constituted in order to determine the framework of the project.

In the school year 1985/86, a pilot study was begun, a total of 1100 computers were distributed to 121 secondary schools. However this study was not successful for the reasons set out below:

This sudden introduction of large numbers of computers into the education system was not well organized.
The project needed to be carefully planned in order to succeed. However in-service training was introduced without being thoroughly planned. Only a very small percentage of teachers were trained to use CAL, and the training was very generally.

Software was purchased abroad without paying sufficient attention to what the curriculum required. Although the universities and Turkish companies did prepare some software it was inadequate and consequently, this affected the adaption of CAL on the ground. Using computers in education is a complex process involving human, machine, and data/information relationships or interplays. It is an open system. It is a complex process which in using both technical and pedagogical aspects. Those issues should have been taken into account and well organized plans should have been made. Although CAL1 was not successful we learnt a great deal for it, this knowledge was used in the playing of the mind by second phase.

In 1989 another project, entitled CAL2, was started. A committee was again established under the responsibility of the Ministry of Education.

Initially, 46 schools were selected from three big cities (Ankara, Istanbul and Izmir) for the pilot study, commencing in the 1989/90 school year, in mathematics, chemistry, physics and language courses, but just before starting the pilot study the Ministry decided to limit the project to mathematics in three Lycees.

The reasons for the change was the Ministry felt that there was a general problem with mathematics education which justified concentrating the resources on that subject. Students passivity and disenvolvement from the learning of mathematics is a world-wide problem. To cope with these problems and improve mathematics education, the Ministry of Education decided to start the CAL2 project in mathematics. However, the result of the present research shows that using computers in mathematics does not necessarily help to make mathematics easier and more interesting for students, but rather that computers should only be used when they truly enhance mathematics teaching. Using computers for teaching activities can be accomplished without a computer or in
which the computer is superfluous should be avoided, because in those situations the computer is a hindrance.

Electronic drill sheets and computer tutorials are examples of these types of activities. In Turkey, computers have been used in mathematics for drill and practice and tutorials (66%), educational games and demonstrating (33%). However these activities can generally be accomplished without the computer and at less expense. On the other hand, using the computer to create problem solving situations and simulations, and to encourage discovery learning is beneficial. With these types of activities, the greatest contribution of the computer in the classroom environment is to facilitate changing the role of the students from passive recipient to active participant in the learning process.

Goodyear (1987) argues that great benefits come when both teacher and child feel they are in control of the technology and suggest that one way to do this is to develop 'programming environments' which reduce the static quality of most existing software, a quality that allows for interaction only within firm constraints and keeps the user firmly in an essential passive made.

The effective use of computers in mathematics should be in exposition, problem solving, discussion, and investigation.

9.3 Purpose and Conduct of the Present Study

The overall objective of the research was to study using computers in mathematics in Lycees in Turkey and to create a model for Turkey.

The development of a theoretical framework of using computers in mathematics in Lycees in Turkey is central to this research. Using computer activities in mathematics in an educational setting in Lycees is a system. Its inherent values have been discussed in Chapter 3 of this research but it suffice to mention here that because the system approach is a concept and not a methodology, the researcher has to seek a methodology which uses the systems approach. This led to the choice of Checkland's 'soft' systems methodology in the development of a theoretical framework of using
computers in the development a theoretical framework of using computers in mathematics in Lycees in Turkey for this research. It is a methodology which takes into account the human activity system.

The development and construction of each of the conceptual models in this study form the use of Chapter 6. Using Checkland's 'soft' systems methodology has not only played a significant role in the construction of the conceptual models but also in the comparison of the models with the real world mechanism in Turkey.

To create a model in using computers in mathematics for Turkey. might be helpful in creating new models for the other phases of education. might also be helpful in producing new models for other subject in Turkish schools. might provide easy access for students and teachers to the latest developments in the use of computers in mathematics in Lycees in Turkey.

The development of an effective model for the use of computers in mathematics in Lycees requires an understanding of the current situation in Turkey.

The use of computers in mathematics was limited to three Lycees, all in Ankara, who used CAL as a part of CAL2. There were two hundred and fifty five students, eighteen teachers and five decision makers in this project.

Each school had six mathematics teachers who were involved in this project. Decision makers belonged to the different institutions. The field work for the pilot study and final investigation was carried out between April and June 1990. Data were collected using survey techniques.

In the present study, the survey contained two questionnaires; one for students, one for teachers and one interview schedule for the decision makers. Results of the survey helped to provide a rich picture or descriptive model of current situation. The aim of the survey was to collect data and combine it into a 'rich picture' itself a

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9.4 Main Findings

The survey results demonstrated that teachers used the keyboard blindly. Much of the software was of poor quality and students lost interest in it after seeing it once or twice. Teachers were experiencing local difficulties with power supplies, and with software and hardware incompatibility.

The findings of this study indicate a difference in enthusiasm between teachers and students for the use of computers. While teachers liked using computers (68%), students did not like using computers (64%). In the students' opinion computers made mathematics more difficult and boring. Students' feelings about computers were a combination of boredom, fear and incomprehension (64%); whereas teachers' feelings about computers were a combination of enjoyment and excitement (68%).

This study showed that students were not positive about using computers in mathematics. In particular, they felt that much of the software was badly written and difficult to use, and there was a lack of suitable support material. Therefore students became frustrated and resorted to the more familiar pencil and paper techniques. Because this software was in use students lost interest in the course.

The Ministry of Education wanted teachers to use computers in their teaching, but 33% of them think that the Ministry of Education pushed them to use computers, although the majority volunteered to use computers.

When teachers were asked "to what degree is the Ministry of Education helpful on this issue?" Their answers were "very helpful" or "helpful", whereas, when decision makers were asked "Are you helpful to teachers on this issue?". The decision makers answered the questions as "they
tried to be helpful, but this was not always possible."
Here, the major concern was that they might sometimes damage
their careers, if they were too critical of the Ministry.
Besides, all of the teachers and decision makers agreed that
their in-service training was inadequate on using computers
in mathematics.
The decision makers were aware that the
availability of computer hardware was not matched by an
equal quality and quantity of educational software. The
decision makers were also aware that staff development was
important but fault that Inset training would be best met
later in the project but great attention would be given as
soon as possible.
To achieve effective use of computers in education
both teachers and students need training. If the Ministry of
Education wants its policy to be successful, they can not
neglect preparation. It is not easy to prepare teachers in
the effective use of microcomputers in education.
The actual placement of computers in schools raises
issues such as:

Are project leaders ready?
Are they aware of needs?
Who is going to take the responsibilities for CAL?
Where does the Ministry of Education stand on the
issue of computers in schools?
To what extent should non-educational factors be
taken into account?
Are teachers and principals ready?
Do they perceive the benefits for themselves or
their students?
Have they received adequate training?
Do they need to change their roles to some extent?
Where teachers perceive 'proper education' as
teaching traditional curriculum based on factual
knowledge and requiring of the students detailed
recall for examination purposes?
Are students ready?
What do they think about computer studies?
Do they understand why computers are being
It is not easy to find answers of these questions in the short term, but the Turkish Educational System is trying to answer these questions and others.

9.5 Recommendations

One thing we can say about the role of the computer in education over the next few years is that it is surrounded by question marks and uncertainty. It may be that computers will change the practice of education completely with respect to such fundamental aspects what we teach, how we teach it, and why.

The recommendations, which are suggested here in this section, might be useful and beneficial to the Turkish Education.

9.5.1 Policy on CAL

To have an effective policy we should consider hardware and software requirements, teacher training needs, curriculum changes, evaluative research, support services. Policy in this field is usually developed by the Ministry of Education.

The Turkish Ministry of Education should establish policy making and regular bodies to implement and to advise on CAL.

If the Ministry believes the use of computers is important it can ensure their use by changes in the curriculum as is happening in the UK.

Inevitably, computers in education have brought some changes in curriculum practice that teachers are beginning to employ in order to operate more effectively. It is clear that microcomputers are causing the teachers who use them to engage in new classroom activities, learning strategies, and skill acquisition. The Ministry of Education should pay major attention to the content of the school curriculum.

Structuring the curriculum will focus on teachers’
Training teachers to use computers in their teaching is a difficult problem. If the Ministry believes they must provide shells to the teachers, it can be an initial step for training. What kind of in-service (INSET) programme can be useful for their policy? For the medium term, the plan should also look at initial teacher training. Besides, the Ministry of Education should give big preference to software and hardware that meets certain specifications.

There is no doubt that, research centres on computer based education will play an important role in CAL. Research centres can help to evaluate (formative evaluation) CAL, and to help current training.

Who is going to take responsibilities in changes of curriculum, preparation and selection of software, selection of hardware, pre and in-service training?
Who is involved in pre and in-service training?
Who is involved in the National Computer Board (NCEB)?
What can be most suitable for Turkish Educational System?

These are discussed in detail in section 9.5.2.

9.5.2 The National Computer Education Board (NCEB)

The NCEB is governed by the Ministry of Education. It should be beneficial if the NCEB had an advisory committee. The Turkish Ministry of Education has a committee, but members of this committee should include computer users from industry, commercial (representatives from computer companies for supplying and manufacturing computers), programmers and representatives of the Ministry of Education, teachers, principals already using computers, evaluators, subject specialists. The committee's terms of reference should advice on the Ministry's plan, later the committee should advise on implementations.
One of the aims of this committee is to establish necessary links among Lycees, universities, computer companies and the Ministry of Education.

In this committee, the computer experts from industry and commerce can have a high level of technical expertise but they may not be experts in educational matters, principals and teachers are component in the area of educational development, planning and pedagogy, and the computer scientists and educators from the higher education can be experts in both computer sciences and educators from the higher education can be experts in both computer sciences and teaching and learning, but their expertise is in teaching of university students not in the Lycees' students. Everybody should use their own expertise to help each other and they can work cooperatively as a team.

Choices of hardware for schools in developing countries can be influenced by software availability, established practise in universities, pressure from manufacturers. Choice of hardware should be done with care. The hardware should be serviced and maintained, worthwhile software should be exchanged and initial training should be carried out. These needs all point to central policy decisions on hardware. Standardisations of hardware is an important matter on which the Ministry must rule.

Turkey is still consuming technology rather than producing it. At this stage of CAL project, hardware has to be imported and Turkey has been importing hardware through computer companies and this has given some privileges to computer companies.

To prevent this, an advisory committee could decide to choose hardware. When hardware is imported, there are some problems such as the screen, keyboard, software etc. Issues of hardware which the committee needs to consider are to re-label in the Turkish Alphabet, to know what they want microcomputers to do, how big microcomputers should be.

University staff, computer companies and teachers should all be involved in the decision. Briefly, decisions regarding hardware purchase could most frequently be made by advisory committee, building user input into equipment selection is essential, so that the advisory committee
should be fully aware of goals and needs. For instance, teaching students to use databases might require additional disk drives and upgraded computer memory. An emphasis on word processing requires a large number of printers or networks, using computers for classroom demonstration necessities a large screen display device. Modems need to be provided with telecommunications applications. (Hawkridge and et al., 1990).

The objectives of NCEB could be the following:

. to encourage cost effective learning and application of microcomputer through Ministry of Education

. to guide users in acquiring hardware and software

. to provide students with a broad understanding of computers and their use

. to develop and distribute curriculum materials, including books, computer software, suitable for the school curriculum in accordance with regulations set by the Ministry of Education, and the establishment of teacher training

. to support teachers in becoming more effective in the classrooms by changing their traditional role

. to improve the quality of school administration through the use of appropriate technology

. to provide doing research for evaluation and improvement of the system.

If we see NCEB as a system, as in every system, NCEB will have subsytems such as: Curriculum Development and Pre and In-service Training Centre, Educational Software Centre, Technical Support Service and Research Centre. Curriculum Development, and Pre and In-service Training Centre is responsible for developing the course in
IT an for training teachers, principals, changes and development of curriculum, the educational software service is responsible for design and production of software and its management and maintenance; the technical support service is responsible for acquisition, installation and first line maintenance of computer hardware; the research centre is responsible for carrying out pilot studies in schools and prove its capability in terms of know-how, provisions of personnel and hardware and preparation of software/courseware. This will help to evaluate and test the system and contribute improvement of the system.

Each centre has their own monitor and control system. The aims of the monitor and control systems are understanding needs and standards, implementation and involvement, the adequacy of the resource needs derived, use of resources in order to assist obtaining and allocating, performance of each activity, performance of each subsystem.

Functions and facilitations of all these centres are discussed in detail. Recommended administrative structure of NCEB is shown in Figure 9.1.
NCEB can have a network or a web gradually extending to every provinces to help teachers, principals, and each units are governed by the main NCEB in the Ministry of Education.

NCEB should have its own programme. Its programme should be prepared by the Ministry of Education and State Planning Organization (SPO) together. SPO can offer a high level of scientific and technical ability as well as experience in education and planning.

There are several important components of NCEB's programme. These are: Philosophy, Application, Funding and Evaluation. The programme could begin development of a Philosophy of CAL. The Philosophy and all decisions related to CAL should be consistent with the educational philosophy already in place in the educational system and NCEB. Consistency between CAL philosophy and educational
philosophy is essential. Once that philosophy is agreed upon then appropriate CAL applications can be identified based on the philosophy. Determining appropriate applications is an important programme. These decisions should take into account the philosophy of both CAL and pedagogy. Identifying a number of applications is a key decision. Some applications can be made from level to level. Once those applications are chosen, it becomes possible to determine which equipment will best suit each application and how much of that equipment is needed. These should be in an environment in which funding will be available to implement the plan. The budget is a critical component of the programme. The programme is limited by the budget. The Ministry of Education should spare some percentage of its own budget, undoubtedly, this cannot be enough, so other Ministries can give some amount from their own budget and donations may come from the private sector.

This budget should have provision for the following:

**Hardware**
- Computers (new and replacement)
- printers
- peripherals
- upgrades
- maintenance and repair

**Software**
- purchase

**In-service Training**
- presenters
- substitute for teacher release
- materials

**Supplies**
- blank diskettes
- printer ribbons
- printer papers

**Facilities**
- electrical upgrades
- remodelling of space
- furniture
Surrounding the process should be frequent formative evaluation to help in slight course corrections and periodic summative evaluation to gather data on impact.

Formative evaluation is particularly important in CAL. Evaluation instruments need to be developed for students, teachers, administrators and instruments could be developed by the research centre. The results should be analysed and used in revision of the system. In addition, teachers and administrators should receive information summarizing the findings of the evaluation process. This evaluation should occur on a regular cycle, in a short term 2 years could be considered appropriate in that this amount of time allows for teachers to have implemented the plan and for students to have had sequence of experience of long enough duration to make a difference. In the long term, this period could be considered in every 4 years.

Beside formal education, continuous, informal assessment of computer related activities is necessary. The research centre should observe activities in schools, meet with advisory committee, meet with classroom teachers. These kind of data are essential in making improvements in the system and its implementation.

NCEB needs to establish a philosophy and guidelines to aid their decision making. Briefly, as a first step, a proposal for the establishment of a national development programme could be prepared and submit. In this programme aims of policy, purposes, requirements of computer education, establishment of computer education centre and so on should be put clearly.

In NCEB, universities, Lycees (schools) and computer companies each have a very important place. They should be in contact with each other. The establishment of help structure could be one way forward, for example, lycees could have computer clubs. In these clubs, teachers can also prepare software and there should be a network web among lycees, and in this way, they can share their programmes, and self help between schools could be established. Membership should be open to all students. These clubs could be aimed at developing students interest in computers and computer applications, and schools can also present students...
with more elements of "computer awareness" (Culley, 1988). Teachers involved in computer clubs are expected to contribute some knowledge of programming so that interested students can write simple programmes. Students can join the clubs after school time e.g. weekends. Universities and computer companies could give considerable help and pay attention to computer clubs. Principals should also play an active role in the development of computer clubs for the schools, and support people who take responsibility for computer clubs. The principal should encourage teachers and students to use computer appropriately in computer clubs.

Curriculum Development and Pre and In-Service Training Centre

One of the responsibilities of the Curriculum Development and Pre and In-Service Training Centre will be to evaluate curriculum changes and developments as on CAL is implemented.

The effects of technology on education are likely to be both direct and indirect. On the one hand technology itself is being increasingly used within education. On the other hand, the more general social changes caused by the technology will themselves contribute to change in education. For these reasons, a critical and informed stance should be developed for future education. The new technology has affected the curriculum. So, we ought not to focus on new software packages or programming techniques but rather on the educational changes which are taking place.

It is gradually becoming clear, therefore, that the curriculum issues raised by modern technology extend to almost all the design characteristics of current education including the form and shape of schools themselves, learning the debate about content and process learning, the process of teacher education.

The Commonwealth Guidelines (1987) suggest different curriculum choices which derived from discussion between representation of industrial and developing countries.

...to equip all students for the future on basic
skills
. to create people skilled in IT, who can be helpful for existing economic sectors
. to use new technology to enrich the existing curriculum by using computers which can extend traditional ways by offering new opportunities
. to promote change in education by preparing new curriculum.

As a part of the CAL project, Turkey should re-think her curriculum goals. Computers offer the means of greatly enhancing the ways in which learning takes place in schools, but they will only be effectively used if they are seen in the context of the whole curriculum and incorporated with the other learning resources into an integrated whole. They should be used to do only what they can perform as well as or better than other methods. Variety is important in maintaining motivations and so computers should not be used to the exclusion of other activities and care should be taken to ensure that real experiences and social activities are also included. The aim should be to design a good integrated learning package for each section of the curriculum which makes balanced and sensible use of the available resources and activities.

The present study showed that the efforts have been directed at integrating computer software into existing school curriculum in Turkey. However, it did not work if the aim is to integrate the computer into the curriculum a range of curriculum materials must be available, including, for example, lessons plans and guides showing how the particular pieces of software which can be integrated into the curriculum. This implies developments occurring within the established curriculum structures and using computer based technology to produce learning materials and packages for enhancing and improving the existing system in the short term. These packages can help to improve learning by making it easier for students. To enrich the existing curriculum, new technology should be used with textbooks, audiovisuals and educational software. In the long term radical changes in the curriculum may be necessary. Teachers can adopt 'more
relevant' curricula and bring educational opportunities to a larger number of people. LOGO, simulations, microworld etc. could have an impact on the curriculum and schools, but this radical change can cost a lot in the short term for Turkey, besides this will require more qualified staff.

Curriculum specialists, measuring and evaluation specialists, teachers (for subject matter) should work together on curriculum.

In Turkey, teachers have rarely been trained to use computers in their initial training. Teachers training schools' curriculum should be revised, and initial teachers should be trained in the use of computers in their teaching.

Teachers were seriously concerned about whether or not the work of their students is according to their syllabus and to be examined in Turkey. Computer education has not yet become part of the national curriculum. Whereas, Turkey has already had a national curriculum. Initially, the new curriculum materials could be adapted. The studies which have already been done in European countries can be taken as a model, and to be adapted into Turkish National Curriculum, and then their own model could be created in long term.

One of the aims of education is to demand specialised manpower. The vocational side of curriculum is also very important for Turkey. The ratio of unemployed is increasing and there is an urgent need for intermediate manpower. The vocational aim of the school is to prepare students to go out to work with the ability to use modern technology (Olson, 1988). There are defects in how vocational education is being built into the system and effort is needed to increase the integration of academic and vocational elements of the curriculum.

One of the aims of curriculum changes should be helping students towards computer related jobs. The vocational sector is the entry point for IT. That is why, allowing parallel study of vocational and economic options with an curriculum should be established (Hawkridge and et al. 1990). Hence, more students should be trained so as to increase the efficiency of the existing industrial, commercial and agricultural sectors and contributing to the development of industry. In Turkey, the main source of such
people has been computer science and engineering departments of universities, but secondary schools should train more students and able to devise such courses to prepare them for the industrial, commercial and agricultural world.

The curriculum should also aim to achieve these goals, in this way, may be, technology oriented school leavers can join the work life at an early age.

In Turkey, the structure of the curriculum is very rigid and hierarchical, firstly, the hierarchical order should be changed and teachers should have been involved in the decisions in this centre and they have to be given some flexible rights to make some changes, when necessary.

One of the most important things is to introduce computer awareness and literacy as an essential element in each of the core curricula e.g. mathematics, physics, language etc. These should be done in the Turkish Educational System. One of the other responsibilities of the Curriculum Development and Pre and In-service Training Centre will be to train teachers, principals of schools, curriculum specialists, and so on. Training is necessary and very important for them.

As a beginning, teachers and principals can be the starting point for training.

In-service training is a means of helping teachers become aware of the issues related to CAL. Teachers need confidence in hardware use and in particular in mathematics. They also need confidence in the understanding of the problem solving software.

At the beginning, teachers need to learn about how the computer can be used as a learning environment for their particular students and for their particular subject. They need themselves to be literate in all possible uses of computers. This will lead teachers to gain an understanding of the capabilities of this technology, and it will also help them to gain confidence in hardware and software use. Over the next few years, while many teachers can participate in development of computer based learning materials, others can understand and perhaps modify for their own use, programs developed by others.

During the in-service training if software can be
offered to teachers for effective use in schools, classroom teachers can only give answers concerning the relevance, pedagogy, sequence, level etc. (Langhorne; Donharm; Gross and Rehmke, 1989).

If computer literate teaching is to be met, in-service training course should be an on going process and offered within the schools.

As has been mentioned already, the present study showed that in-service training was inadequate for teachers in Turkey. Computers were only used for drill and practice (66%), educational games and demonstrations (34%). And this affected students' and teachers' feelings and opinions. Students did not like using computers in their learning. If computers had been used for problem solving, results could have been different for students and teachers. Students would have seen how computers could be useful for their learning. Besides if software was on problem solving, critical thinking, teachers could have thought differently.

As an on-going process, in-service training should be as a part of NCEB. Contents, methods, schedules, expectations and personnel for training should be planned very carefully. Training should start in the early days of application of CAL.

Each school should consider using their own computer 'experts' who would be available for follow up questions and problems. Experts can be employed by the NCEB. Moreover, teachers can take control of some aspects of the in-service training such as curriculum decisions, selection of textbooks and software, scheduling decisions and other decisions. That is important in diffusing their sense of powerlessness. It is very important for teachers to examine software in order to assess its potential use in their classrooms can have a value if teachers have the skills both to judge the value of software and to integrate its use effectively to meet specific curriculum and learner needs. Therefore, in-service training has also to deal with these aspects of the use of software.

Providing social, financial and psychological support for teachers is an important factor in establishing positive teacher attitudes towards staff development.
Curriculum Development and pre and in-service training centres could provide a comprehensive in-service training program in Turkey. Pre and in-service training courses could be on IT literacy and their usefulness, applications of computer technology in lessons, learning details on hardware and software, evaluation of software, using specific software, selection of software, BASIC, LOGO etc.

As already mentioned in Chapter 2, the training programmes in mathematics departments for mathematics teachers before 1980's did not include any computer related courses in Turkey. Therefore, most mathematics teachers who graduated before 1980 have insufficient knowledge to teach computer studies adequately. Therefore, a considerable benefit can be gained in placing the student's teacher who has learned at university to use computers in his/her teaching can help to bring technologies to the experienced teacher who has not previously worked with computers.

The Ministry might consider developing a series of formal qualifications for In-service training in general and for IT in particular. To encourage them, teachers who attend the courses could receive a certificate and become an approved computer studies teacher.

School principals play a very important place in using computers in their school. They can come face to face with a wide range of problems such as problems of providing teaching and supporting staff, suitable rooms, time tabling of classes so on.

The present study showed that principals were not involved in CAL in Turkey, they were only told which schools would get computers and with what level of support without negotiations. Principals did not have any effective say in whether or not, they were to receive computers. Whereas, principals are the main administrative force at the school, he/she should be best placed to receive immediate benefit from computer technology. They have much power to influence the innovation. In many instances, principals mediate aims of the policy makers, and their attitude may make or break the project. Hence the importance of strategy their needs
should be satisfied as early as possible in the innovation.

In the early stage of the project, principals should join the in-service training course and encourage the teacher and the student who are using computers in their teaching and learning, aware of importance of IT for their schools, how to use computers and software for administrative purposes.

One of the most important problems is to train the trainers for work in computer education. Staff who take the responsibility of training teachers to make sure that hardware and software perform reliably in schools and it is vital to the success of computer education. Turkey involved in computer education already have a growing computer using sector which itself needs services of trained personnel.

What can be done for training trainers? It should be the first step to train them before starting the project. Some approaches could be taken such as:

. Young graduate computer scientists, educators could be employed and given their specialized (overseas) training in the production of educational software, evaluation of software, hardware maintenance, in-service training, curriculum development etc.

However, these can be done in the long term. To solve the problem in a short term,

. Foreign advisers and specialists, who are already very experienced in computer education to train people, could be invited to Turkey, and educationalists can take advice from them.

This approach could be more suitable and cheaper for Turkey. When specialists come to Turkey, they could train as many people as possible.

Teachers can be deemed to have acquired the necessary skills through their initial training but this situation is rare. Generally, in developing countries, computer scientists work either in higher education,
industry or commerce, but it is difficult to find them as a teacher in the secondary education. As a first step, the Ministry of Education could develop a cascade training. A cascade approach to training is one in which those who initiate the training programme set out to train a group of trainers rather than the classroom teachers themselves (Hawkridge; Jaworski; Mcmoha, 1990, p. 80).

One or two teachers from each school can be received and trained, in other words specially trained teachers train others until there is enough, but an efficient plan is necessary for cascade training. Teachers, who were chosen to take the lead in helping other, should be more knowledgable and experienced than others. But in the cascade approach experience has shown that the cascade models need to be operated with extreme care, as it is all too easy for all the knowledge to cascade into a deep puddle in one person (Griffin, J.P, 1988). For the approach to be successful co-ordinators need to be given time release in order to fulfil their training role.

For an effective cascade training, at each level trainers should have available support structure and an effective communication system to help teachers as they carry the training further down the cascade. Because there is not a strong infrastructure for supporting the lower levels of the cascade. Whereas cascade training might not be able to operate effectively at lower levels without advice from higher levels or without technical support and financial resources may not be enough for these.

There is a doubt that cascade training might not be used in Turkey. As in every developing country, in Turkey decisions are affected by many factors such as politics, economic, fiscal. There can be some problems for cascade training. For instance, choosing teachers who take leading roles in the cascade. Who is going to take responsibility? Which teacher is going to be chosen? Which criteria will be important? When teachers, who are involved in cascade training, make decisions for themselves, they might get criticism from their colleagues. Cascade training might be a difficult approach under these conditions. The Ministry of Education should think carefully about cascade training,
inaugurating a training cascade is an important step towards improving the in-service training and CAL.

The Educational Software Centre

The educational software centre is responsible for the design and production of software, and its management and maintenance. This centre could have a software library which can include other teaching materials such as video tapes, slides, books to support software. Schools could be able to borrow software or copy the programs. In the selection and management of software, a team based approach could be best. The advantages to this approach are that it allows for maximizing the use of human resource while minimizing duplication of effort and inappropriate purchases. Educators from education departments at the universities, technical staff, software developers, classroom teachers should work together.

The selection of software is one of the most important tasks in CAL. Which software should be chosen? Of course, it depends what it is needed for? The variety of software is very wide such as instructional software, simulations, modelling, wordprocessing, statistical software, programming language, for example, LOGO, PROLOG, administrative software etc. The list can be extended to every curriculum area.

Selection of software for microcomputer parallels the selection of other nonprint media. Software should meet a specific curricular need. It should be effective instructional design. In Figure 9.2 Software selection criteria is shown.
Microcomputer software is used with hardware, software and hardware need to be introduced in schools together. They cannot be separated from each other.

Software should take advantage of the computers capabilities for interaction, to encourage students to study by themselves without teachers.

Software should increasingly be a major cost. As hardware falls in price there is no similar decrease in the price of good software. Suited to the curriculum, easy for teachers and students to use, reliable and fast in its working, and fully documented in language understandable to its users. CAL packages could help students to prepare for the university entrance exam.

This study showed that there was not enough appropriate, and good quality software in Turkey. Hardware was manufactured by the computer companies and computer companies prepared software accordance with the Ministry of Education's regulations. Whereas, preparing software should also be universities' responsibility, instead of only computer companies' responsibility.

Teachers should be involved in selection and evaluation of software. All teacher training, whether at the pre-service or in-service stage, should include training in assessing and selecting software. This should be part of training in the pedagogical uses of IT which teachers need to supplement the introductory training they usually receive.
in the operation of microcomputers and in their classroom use.

This centre could have selection and evaluation of software committee. Selection of software committee could include classroom teachers, representatives from the Ministry of Education, curriculum specialists, computer scientists; the evaluation of software committee could include classroom teachers, curriculum and measurement and evaluation specialists, and administrator who are familiar with CAL and possess of working design knowledge of instructional design. Committee should have a standard evaluation instrument which contains a comprehensive set of criteria to help ensure both consistency and quality, but it cannot be easy to set such criteria in the short term, therefore, they can adapt or adopt an evaluation form that has already been developed and field-tested. This form provides a framework for evaluators to examine the quality of software. This form should contain criteria about whether it meets a specific curricula need allows people to teach better, can be easily used or not, what the potential uses are. To use a consistent set of criteria a file of completed evaluation form is a valuable source of information when questions arise regarding the status of a particular piece of software. The forms are an effective tool for providing procedures with feedback regarding their product.

Producing software could be under the responsibility of the Ministry of Education, but commercial produced materials would also be welcomed.

The quality of most developing and marketing suitable educational software is very high, so software can be imported, but choices should be made very carefully for educational and cultural reasons.

The Research Centre
One of the important units of the NCEB is the Research centre. It may contribute to the improvement and evaluation of the system. At the beginning of the Project, there could be some problems and questions in mind such as:
What are the effects of computers in education? Did they affect the results of teaching and learning? If the software is not suitable, how can they get better software? Does the software fit the curriculum? Is the in-service training enough for teachers?

The list of unanswered questions is much longer.

There is no research project involved with CAL 2 project in Turkey. But Turkey definitely needs a research centre. In this context a close cooperation among departments of computer science, and education as well as teachers, principals, curriculum specialists needs to be established.

Turkish Universities should have new responsibilities for conducting the research at various phase of CAL project. To identify when, who and why CAL has been successful or unsuccessful and to diagnose the reason will help to create situation, computer scientists, educators, school principals and teachers should take part if the research centre is to work effectively.

Technical Support

Technical problems can give students and teachers a hard time. The Ministry's plan should also take into account the need for support services. The need has arisen because teachers are likely to feel nervous about the new technology. The centres can help teachers to meet their particular needs, technical advise or hardware and software.

If education authorities cannot provide full support, there should be an infrastructure supporting development in the commercial sector.

9.6 Suggestions for Further Studies

Computer studies in education have been started and the Turkish Government was involved in significant financial expenditure to support the placement of software and hardware in schools, but computer studies have been started
only in mathematics. There has been no support for other subject areas for IT literacy and awareness. As have already mentioned, there is an ambiguity of concept between IT literacy and awareness and CAL. It has been taken as if it was CAL. First, we should integrate computers and IT to part of culture and society. Hence, all students should have experience and become confident in using computers in their schooling. This aspect has led to the development of courses such as 'computer awareness', 'computer literacy'. They aim to give students and understanding of the applications, then we can use computers and IT as teaching and learning resources. This aspect has led to the integration of IT into curriculum.

This research has concluded that an educational system in the modern society has been transformed economically by the growing operational significance of information and the increasing sophistication of the technology available for processing that information, and therefore the schools should not lag behind.

The research has explicitly brought out a theoretical framework for using computers in mathematics in lycées. The value of using computers has been viewed as problematic because of CAL's unique properties.

Efficiency and effectiveness are mentioned as concepts related to cost effectiveness of educational systems and its productivity in terms of quality of CAL for decision making.

The research has developed a comprehensive conceptual framework for using computers in mathematics. The most obvious conclusion has therefore been that there is a clear need for further research based on some of the issues raised on findings of the research.

A possible starting point for further research, is the testing of the developed theoretical framework for using computers in mathematics in some other level of education and schools. The researcher is of the opinion that through

\footnote{CAL should have been taken into account in this research, because a model was created for Turkey, and CAL was more important than computer literacy in Turkey because of ambiguity of concept.}
such study, the paradigms of the conceptual models of using computers in mathematics built would not only become more defensible but also other computer using problems in the education area would emerge.

Research into using computers in mathematics in Lycees requires building a theoretical framework based on a system approach and any associated systems methodology so as to be able to determine the practicability of using computers in mathematics (CAL) concept in Lycees is beyond technical solutions. It is a human factor problem. Turkey currently does not have expertise in educational computing. More people have expertise in industrial computer use, but they do not know a lot about the pedagogy of computers in education. Therefore, more research should be done into training qualified people in using computers in education. Besides, the evaluation of CAL2 project further work is required. Research should be done to emphasize this need to overcome problems and to develop the system.

9.7 Conclusion

Introduction and dissemination of computers for education is an innovative action in the Turkish case. The steps for implementation and dissemination of this innovation need to be taken with care, and the social, economic and political conditions of the country and the cultural characteristics of the schools should be taken into consideration.

Integration of computers into classroom teaching in all subjects might be an important aspect of reform in Turkish Schools in future. Barriers in the way of computers in Turkey will not be overcome quickly and easily, despite national investment in computers for education. When the economy gains strength, it might be possible to put more money into schools. But, finance is not the real problem. Major improvement cannot be achieved until there is a pool of well trained and capable teachers, suitable and adequate hardware and software is available and work in lower forms is fully consolidated. All these could be successful with carefully planning. An Educational Development Priorities
Five Year Plan could be prepared.

With a two year master plan, a pilot study in a small number of schools to build experience in the training of teachers and the development of curriculum at this level, as a result of these studies a relatively long-term view can be taken.

Since the Ministry of Education considered the non-educational aspects of introducing computers into schools, the Ministry should also consider the arguments in broad administrative terms. They must develop, implement and monitor a plan of action for approval within the policy framework.

Projects should be carefully monitored from the beginning. Monitoring methods are growing more sophisticated and promise to provide the kind of information the National Educational Computer Board (NCEB) will need when it recommends future action to the Ministry of Education. Plans for the next two - three years are to consolidate the IT foundation course, widen the scope of the project until all schools are involved, look at extensions to the curriculum of the IT foundation course, and build up experience in developing and using CAL across the curriculum. Moreover, to create an IT literate and capable population, new courses should be arranged and the objectives of computer studies in education should be revised carefully.
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Turkel, S. B; and Podel, D. M. (1984), Computer assisted


# APPENDIX A

## NUMBER AND MAKES OF COMPUTER IN TURKEY IN SCHOOLS IN 1989/90 SCHOOL YEAR

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**SOURCE:** Report of the Committee of Turkish CAL2 Project, 1989.
APPENDIX B
The Syllabus of Some Departments of Mathematics' Education in Some Turkish Universities

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Source: Annual Courses’ Catalogue of Hacettepe University 1988/89 School Year
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APPENDIX C
GLOSSARY

Activity  A neural term for carrying out of an act, contrasting with action behaviour. The word is used in human activity system to emphasize that such systems are not descriptions of observed real-world action.

Actor  In CATWOE a person who carries out one or more of the activities in the system.

CATWOE  A mnemonic of the six crucial characteristics which should be included in a well formulated root definition.

Climate  A characteristic of a problem situation; it is the relation between its elements of structure and its elements of process.

Communication  The transfer of information

Comparison Stage  In soft system methodology, stage 5, at which the expression of the problem situation is compared with the conceptual models of relevant systems.

Conceptual Model  The structured set of activities (expressed as verbs) which are the minimum necessary activities for the system to be the named in the root definition.

Conceptual World  A world of intellectual constructs or ideas which only exist in thought or imagination.

Customer  In CATWOE the beneficiary or victim of the system's.

Hard Problem  A problem, usually a real-world problem, which can be formulated as the search for an efficient means of achieving a defined end activity.

Hard Systems Methodology  Systems based methodology, also known as systems engineering, for tackling real-world problems in which an objective or end-to-be-achieved can be taken as given. A system is then engineered to achieve the stated objective.

Hierarchy  Ranking of entities according to a principle.

Human Activity System  A national purposive system which expresses some purposeful human activity, activity which could in principle be found in the real world. Such systems are notional in the sense that they are not descriptions of actual real-world activity but are intellectual constructs; they are ideal types for use in a debate about possible changes which might be introduced into a real-world problem situation.
Input That which is changed by a transformation process. Inputs may be concrete or abstract.

Model An intellectual construct, descriptive of any entity in which at least one observer has an interest. The observer may wish at least one observer has an interest. The observer may wish to relate his model and, if appropriate, its mechanism, to observables in the world. When this is done it frequently leads —understandably, but not accurately— to descriptions of the world couched in terms of models, as if the world were identical with models of it.

Output That which is produced by a transformation process. Outputs may be concrete or abstract.

Problem-Content System A conceptualization of the problem situation which contains the role problem-owner.

Problem-Owner A role in the problem content system occupied by the person most likely to benefit from an improvement in the problem situation.

Problem Situation Mesh of entities, activities and relationships which someone perceives as problematic.

Problem Solver Role in the problem solving systems. The problem solver uses the methodology to take recommend action to improve aspects of the problem content system.

Problem Solving System A conceptualization of the problem situation which contains the role of problem solver.

Process Those elements in a problem situation which are characterized by continues change.

Real World World of things that actually exist or occur in fact.

Real World Problems A problem which arises in everyday world of events and ideas, and may be perceived differently by different people. Such problems are not constructed by the investigator as are laboratory problems.

Relevant Systems A human activity system which an investigator using soft systems methodology names likely to yield insight in later stages of the study. For each relevant system a root definition is formulated and a conceptual model built.

Rich Picture The expression of a problem situation compiled by an investigator, often by examining elements of process, and the situation climate.

Root Definition A concise verbal statement of human activity system.
Soft Problem A problem usually a real-world problem, which cannot be formulated a search for an efficient means of achieving a defined and; a problem in which ends, goals, purposes are themselves problematic.

Soft Systems Methodology Systems based methodology for tackling real-world problems in which known-to-be-desirable ends cannot be taken as given. Soft systems methodology is based upon a phenomenological stance.

Structure An element in a problem situation which is static or changes slowly.

Sub-systems Equivalent to systems, but contained within a larger system.

System A model of a whole entity; when applied to human activity, the model is characterized fundamentally in terms of hierarchical structure, emergent properties, communication and control. An observer may choose to relate this model to real-world activity. When applied to natural or man-made entities, the crucial characteristics is the emergent properties of the whole.

Systems Thinking An epistemology which, when applied to human activity is based upon the four basic ideas: emergence, hierarchy, communication, and control as characteristics of systems. When applied to natural or designed systems the crucial characteristics is the emergent properties of the whole.

Weltanschauung CATWOE the image or model of the world which makes this particular human activity system a meaningful one to consider.

Wider System Equivalent to system but containing it.
APPENDIX D

TEACHERS' QUESTIONNAIRE FOR FINAL STUDY

This is not a test of any kind. It is a questionnaire aimed to find out use of computers in Mathematics in Lycees in Turkey, and to identify the problems in order to suggest to improve the service. Therefore, please answers the questionnaire as accurate and sincere as possible.

The information gathered in this questionnaire will be used to plan a model using computers in Mathematics in Lycees in Turkey as a part of my thesis. So your help and cooperation will support me in exploring the situation to reach to right conclusion.

There are no correct or wrong answers. Nobody will see your answers administrative staff or anyone else. So feel free to express your own opinion.

Instructions are given for each part separately. Answer the questions according to what you really feel rather than thinking of how the questions might be best answered for the researcher.

Thank you in advance for your cooperation.
PART I

I would like to ask you general questions for personal information. Please answer each question by filling in the appropriate information the space provided or by placing a check next to the chosen alternative.

1. Age ........ years

2. Sex
   ... Male
   ... Female

3. How long have you been teaching Maths?
   a. 0-5 years
   b. 6-9 years
   c. 10 and more

4. Which University did you graduate from?
   ............................................
PART II

Please read the following questions and give your immediate but sincere and accurate answer. Sometimes you might write a couple of sentences, other times you have to answer "Yes" or "No" and sometimes you may tick more than one answer.

1. Are you using computers as a teaching aid?
   a. Yes
   b. No

* If yes
   What do you use computers for? (You can tick more than one)
   a. drill and practice
   b. simulation
   c. educational Games
   d. tutorials
   e. demonstration
   f. any others (please specify)

2. How did you decide to use computers in your teaching?

3. How often do you use computers?
   a. never
   b. rarely
   c. frequently
   d. always

4. Do you like using computers?
   a. Yes
   b. No

If not
   Why do not you like using computers?

5. Which alternative word best describe your feelings about using computers? (You can tick more than one)
   a. enjoyable
   b. existing
   c. frightening
   d. boring
   e. interesting
   f. meaningless
   g. any other (please specify)
6. Do you think computers can help students understand mathematics better?
   a. Yes
   b. No

7. Did you take any course on computers when you were student at the University?
   a. Yes
   b. No

*If yes
   What kind of course did you take?

8. Do you think computers are wonderful machines that could do tremendous things for education?
   a. Yes
   b. No

*If yes
   Why?

9. Does your school have specially fitted computer room?
   a. Yes
   b. No

10. How many computers are there in your classroom organization?
    a. one computer for the whole class
    b. one computer per small group (or 5-6 student)
    c. one computer per student (or a pair of student)

11. Do you think computers would affect the role of the teacher?
    a. Yes
    b. No

*If yes
   How?
12. Do you think the value of microcomputers is as a teaching aid indisputable?

a. Yes (You can tick more than one)
   Because a. It raises pupils’ interest
       b. It clarifies difficult ideas
       c. It puts more demands on pupils
       d. Any others (please specify)

b. No (You can tick more than one)
   Because a. It makes teaching more difficult
       b. It obstructs pupils’ communication
       c. It is difficult to use computers in mathematics
       d. Any others (please specify)

13. Can you use any computer programming language?

   a. Yes
   b. No

*If yes
   What computer language do you use?

14. Did you attend any pre-service courses before using computers in your teaching?

   a. Yes
   b. No

*If Yes
   How long?

   a. a month
   b. less than 6 months
   c. more than 6 months
   d. more than one year

15. What kind of course did you take in pre-service education?

   a. IT and its usefulness to arouse interest
   b. Changing attitudes towards the application of computers in the classroom
   c. Obtaining clear information about the use of computers in as vary ways as is feasible
   d. Learning details on hardware and software
16. Have you been in any in-service training course?
   a. Yes
   b. No
   *If yes
   How long did the in-service training take it place?
   a. 6 months
   b. 1 year
   c. More than one year

17. Are you still participating in in-service training programs?
   a. Yes
   b. No

18. Do you think this period is long enough for your progress?
   a. Yes
   b. No
   *If not
   Do you think would it be best provided as
   a. one year full time
   b. one term full time
   c. one day per week for a year
   d. any other (please specify)

19. Do you think in-service training is a good approach to solve problems?
   a. Yes
   b. No

20. In which areas do you need training?
   a. training in computer usage in Maths
   b. training in new styles of maths teaching
   c. both
   d. any other (please specify)

21. What kind of course did you take in in-service training?
   (You can tick more than one)
   a. introduction to computers
   b. computers in maths
   c. programming
   d. using hardware and software
   e. computer use in classrooms
22. Where have you taken in-service training course?
   (You can tick more than one)
   a. in your school
   b. at computer stores
   c. at universities
   d. at firms
   e. at the ministry of education

23. Was attendance at in-service training course recognised
    by certificates or diplomas?
    a. Yes
    b. No

*If not
   Would you like to get a certificate end of the
   courses? Why?

24. Have you got any examples of good practise on how to use
    computers in classrooms?
    a. Yes
    b. No

25. Have you got a wide variety of computer software in your
    school?
    a. Yes
    b. No

*If yes
   Can you use it whenever you want?
   a. Yes
   b. No (Why you can not use it? please specify)

26. Are you involved in the selection of software packages?
    a. Yes
    b. No

*If yes
   On what basis did you make the choices?

*If not
   Would you prefer selecting it yourself?
    a. Yes
    b. No
27. Are you involved in preparing software?
   a. Yes
   b. No
*If not
   Do you want to be involved in preparing software?
   a. Yes
   b. No

28. Do you think it is more difficult to teach some topic without software?
   a. Yes
   b. No

29. Does it allow you to teach better?
   a. Yes
   b. No
*If yes
   How? and what in particular?

30. Have you got a software selection committee in your school?
   a. Yes
   b. No
*If yes
   Who is included by this committee? (You can thikc more than one)
   a. principal
   b. teachers
   c. parents
   d. staff from universities
   e. any other (please specify)

31. Is the use of software part of your syllabus?
   a. Yes
   b. No
*If not
   Do you think it is necessary to change syllabus to take account of computers?
   a. Yes
   b. No
32. Which followings do you think students should learn to use the computers' capabilities for functions? (You can tick more than one).
   a. word processing
   b. statistical analysis
   c. spreadsheet
   d. calculation
   e. database management
   f. any other (please specify)

33. Have computers affected the mathematics syllabus?
   a. Yes
   b. No
   *If yes
   Please explain why have they affected?

34. Do you usually identify mathematical goals in your teaching?
   a. Yes
   b. No
   *If not
   Why do not you identify?

35. In what degree is the Ministry of education is helpful on this issue?
   a. very helpful
   b. helpful
   c. not helpful
   d. not at all

36. Do you receive any degree of encouragement from your principal, head of department or other colleagues to use microcomputers in your teaching?
   a. Yes
   b. No

37. Have computers effected your teaching methods?
   a. Yes
   b. No
   *If yes
   How?
   *If not
   Is your teaching style suitable for computers?
   a. Yes
   b. No
38. Do you use computers for electronic blackboard?
   a. Yes
   b. No

39. Has using computers in maths encouraged you in your teaching?
   a. Yes
   b. No

40. Do you provide coaching and assisting to students?
   a. Yes
   b. No

41. Do you evaluate students' performance?
   a. Yes
   b. No

   *If yes
   For what purpose?
   How often do you evaluate your students' performance?

42. Are you using computers for keeping students' records such as students' numbers, pass rates, subjects studies?
   a. Yes
   b. No

43. Do you have to report your observations on students' use computers in the course?
   a. Yes
   b. No

   *If Yes
   Why do you have to do this?
PART III

Please read the following statements and give your immediate but sincere and accurate reaction. Indicate to what extent each statement is applicable to your own feeling by circling one of the numbers 5 to 1 as follows:

5: strongly agree
4: moderately agree
3: neutral (neither agree or disagree)
2: moderately disagree
1: strongly disagree

1. Students learn Mathematics better by using computers 5 4 3 2 1
2. Computers motivate students to develop positive attitudes to Mathematics. 5 4 3 2 1
3. Computers provide students improve up to their own level and their own time scale. 5 4 3 2 1
4. Computers are wonderful machines that could do tremendous things for education. 5 4 3 2 1
5. Computers also motivate teachers on their teaching of Mathematics. 5 4 3 2 1
6. Computers positively effect the role of the teacher. 5 4 3 2 1
7. Computers encourage collaborate learning. 5 4 3 2 1
8. Computers will take over my job. 5 4 3 2 1
9. In-service training on this subject for teachers is a waste of time. 5 4 3 2 1
10. In-service courses help teachers’ promotion prospects. 5 4 3 2 1
11. I believe that teachers should chose their own software. 5 4 3 2 1
12. The software that I use needs a specific syllabus. 5 4 3 2 1
5: strongly agree  
4: moderately agree  
3: neutral (neither agree nor disagree)  
2: moderately disagree  
1: strongly disagree

13. Computers are expensive machines. 5 4 3 2 1  
14. Computers are exaggerated pieces of equipment. 5 4 3 2 1  
15. The software usually enables me to teach mathematics content better. 5 4 3 2 1  
16. Generally software is technically sound. 5 4 3 2 1  
17. Introducing suitable software is more effective than traditional methods in the syllabus. 5 4 3 2 1  
18. I do not know anything about computers. 5 4 3 2 1  
19. Using computers help to enhance the learning of traditional subjects in the syllabus. 5 4 3 2 1  
20. Computers negatively effected the Mathematics syllabus 5 4 3 2 1  
21. The students probably know more than I do about computers. 5 4 3 2 1  
22. The Ministry of Education is very helpful on this issue. 5 4 3 2 1  
23. Computers have negatively effected my teaching method. 5 4 3 2 1  
24. I use computers as a focus for a class discussion. 5 4 3 2 1  
25. There is nothing wrong with my teaching method. 5 4 3 2 1  
26. I believe that schools should have software selection committee. 5 4 3 2 1
5: strongly agree
4: moderately agree
3: neutral (neither agree or nor disagree)
2: moderately disagree
1: strongly disagree

27. Staff development (in-service training) is an extensive and continues activity. 5 4 3 2 1
28. Computers discourage the group activities. 5 4 3 2 1
29. I feel a sense of insecurity when I use computers in my teaching. 5 4 3 2 1
30. I feel a strain when I use computers in my teaching. 5 4 3 2 1
31. Computers discourage communication between teachers and students. 5 4 3 2 1
32. I do not like computers. 5 4 3 2 1
33. I am happy with computers. 5 4 3 2 1
34. I am too busy to set it up. 5 4 3 2 1
35. I am afraid of using it. 5 4 3 2 1
36. It is a good teaching aid. 5 4 3 2 1
37. I am confident with it. 5 4 3 2 1
38. There are lots of new and exciting software in our school. 5 4 3 2 1

* What are your feelings on this questionnaire? Have you got any comments on it? Please specify it?

I remind you that your response to this questionnaire is strictly confidential. We appreciate your help and look forward to your future cooperation.

Date of questionnaire: .........................

Thank you for your cooperation.
APPENDIX E

STUDENTS' QUESTIONNAIRE

This is not a test of any kind. It is a questionnaire aimed to find out about using computers in Maths in Lycees in Turkey, and to identify the problems in order to suggest solutions to improve the service. Therefore please answers the questionnaire as accurately and sincerely as possible.

The information gathered in this questionnaire will be used to plan a model using computers in Maths in Lycees in Turkey as a part of my thesis. So your help and cooperation will support me in exploring the situation to reach the right conclusions.

There are no correct or wrong answers. The result will, in no way, effect your grades in the course. So feel free to express since nobody will see your paper; teachers or administrative staff.

Instructions are given for each part separately. Answer the questions according to what you really feel rather than thinking of how the questions might be best answered for the researcher.

Thank you in advance for your cooperation.
PART I

I would like to ask you general questions for personal information. Please answer each question by filling the appropriate information in the space provided or by placing a check next to the chosen alternative.

1. Age _______ years
2. Sex _______ Male
     _______ Female

3. What was your final score on Maths before using computers?

4. What is your final score on Maths after using computers?
PART II

Please read the following questions and give your immediate but sincere and accurate answer, some times you have to answer "Yes" or "No", sometimes you may tick more than one answer.

1. Have you got a computer at home?
   a. Yes
   b. No

   *If yes
   What do you use the computer for at home?
   (You can tick more than one)
   a. word processes
   b. games
   c. scientific applications
   d. any other (please specify)

2. Do you like using computers?
   a. Yes
   b. No

   *If not
   Why don’t you like using computers?

3. Do your parents encourage you to use computers?
   a. Yes
   b. No

4. For what purposes have you used computers in Maths?
   (You can tick more than one)
   a. for drill and practice
   b. for simulation
   c. for solve problems
   d. for educational games
   e. any other (please specify)

5. Which alternative word best describe your feelings about using computers? (You can think more than one)
   a. enjoyable    b. exiting    c. frightening
   d. boring      e. interesting   f. meaningless
   g. any other (please specify)
6. How often do you go to computer room?
   a. never
   b. rarely
   c. frequently
   d. always

7. Do you want to use computers more often? Why?

8. How often do you wish to go to computer room?

9. Do computers make maths classes easier? Why?
   a. Yes
   b. No

10. How do you use computers in the classroom? (You can tick more than one.)
    a. in a group
    b. individually
    c. with the teachers

11. Do you think computers are wonderful machines?
    a. Yes
    b. No

12. Do computers encourage you to talk about computers?
    a. Yes
    b. No

13. Which one do you prefer learning to use computers?
    a. problem solving
    b. drill and practise
    c. educational games
    d. learning how to program

14. How computers do affect your learning?
    a. it makes maths easier
    b. it makes maths boring
    c. it makes maths interesting
    d. it makes maths more difficult

15. Do you like your software packages in Maths?
    a. Yes
    b. No

   *If not
   Why?
PART III

Please read the following statements and give your immediate but sincere and accurate reaction. Indicate to what extent each statement is applicable to your own feeling by circling one of the numbers 5 to 1 as follows:

5: strongly agree
4: moderately agree
3: neutral (neither agree or nor disagree)
2: moderately disagree
1: strongly disagree

For example, if you strongly agree on the following statement, you circle number 5 as follows:

e.g.
Students learn Mathematics better by using computers (5) 4 3 2 1

1. Using computers makes maths more interesting for me. 5 4 3 2 1
2. I learn the maths better through computers 5 4 3 2 1
3. I believe that computers are wonderful machines. 5 4 3 2 1
4. I feel a strain when I use computers in maths. 5 4 3 2 1
5. I know probably more than teachers do about computers. 5 4 3 2 1
6. Computers have increased my achievement in maths. 5 4 3 2 1
7. I believed that computers are not useful in maths. 5 4 3 2 1
8. Computers have made maths classes more difficult. 5 4 3 2 1
9. Using computers in maths is frightening. 5 4 3 2 1
10. I would prefer to go to computers room more often. 5 4 3 2 1
5: strongly agree  
4: moderately agree  
3: neutral (neither agree or nor disagree)  
2: moderately disagree  
1: strongly disagree

11. Software usually enables me to learn something I could not otherwise learn. 5 4 3 2 1
12. Computers cause to develop negative attitudes to maths for me. 5 4 3 2 1
13. I do not know anything about computers. 5 4 3 2 1
14. I am happy with computers. 5 4 3 2 1
15. I am afraid of using computers. 5 4 3 2 1
16. It is a good learning aid. 5 4 3 2 1
17. I am confident with it. 5 4 3 2 1
18. There are new and exciting software in our school. 5 4 3 2 1

I remind you that your response to this questionnaire is strictly confidential. We appreciate your help.

Thank you for your cooperation.
APPENDIX F

DECISION MAKERS' SURVEY INTERVIEW QUESTIONS

Do you think computer is useful for Lycees in Maths?

Yes ----- carry on interview

If

Not ----- why don't you think it is important?

and ask questions 2, 6, 7, 8, 9, 11.
Name of the Decision Makers:
Title:

1. Do you think computers are wonderful machines that could do tremendous things for education?

2. Do you think computers would affect the educational system?
   *If yes
   How?

3. Is the value of computers as a teaching aid indisputable?
   *If not
   Why?

4. Can students learn the existing curricula better through computers?
   *If yes
   How?
   *If not
   Why?

5. Why did you decide to start CAL in mathematics?

6. Have you participated in any project related with this one?
   *If yes
   What kind of project the one you involved in? in which level?

7. Are you satisfied with what this project has achieved?

8. Have you got any committee which carries out this project?
   *If yes
   Does the committee work effectively and make efforts to provide coordination?

9. Have you got research centre, software centre, in-service training centre for carrying out CAL?

10. Do you plan another project on this subject for the future?
    *If yes
    What kind of a project?
11. Are you cooperating with other institutions on the project?  
  *If yes  
  Please state

12. What do you think idea of having a suggested model to guide developments in the use of computers in Maths in Lycees?

13. Will it be useful to develop a model for using computers in Maths in Lycees?  
  Why?

14. If a model is created for Turkey, do you want to support?  
  *If not  
  Why? Do you think such a model will lead to certain problems on behalf of you organization?

15. What kind of service do you expect from model on using computers in Maths? Can you explain what kind of benefit(s) you expect from this service?

16. What are your possible funds? Please indicate source(s) and total budget for 1989?

17. How much money have you spent for  
  . Hardware  
  . Software  
  . Staff development  
  . Curriculum design

18. Which one is considered to be highest priority in your project? Can you put them in order?  
  . Hardware  
  . Software  
  . Staff development  
  . Curriculum design

19. How did you choose your software and hardware?

20. Where do you get your software from?  
  . Hardware supplier  
  . Publishers' catalogue  
  . Computer magazines  
  . Any other (please specify)
21. Have you got any plans for preparing and using software?

22. Does your software fit the present curriculum?

23. Did you have any pre-service courses before beginning of the project?

*If Yes
   How long did it last?

24. Is the participation in in-service training courses voluntary?

25. Have you recognized any certificates or diplomas for the attendants?

26. Where are the courses for staff development given?
   . at universities
   . at computer stores
   . at the Ministry of Education
   . at schools
   . any other (please specify)

27. Have universities been involved in in-service education?

*If yes
   In which departments?

28. Do efforts for staff development come from the teachers or from the Ministry of Education?

29. Are you helpful to teachers on this issue?

30. What do you do for teachers who use computers in their teaching?

31. Do the schools' principals take active role in using computers in their schools.
   a. Yes
   b. No

*If not
   Why they do not take any place in this project?

32. Have you got enough staff who can take responsibility on this project and carry out this project?

33. Have you got community pressure or community support?

34. In your opinion how will computers affect the teachers' role?

35. Can they replace the teachers?
36. Do you think using computers have caused or will cause any change in Maths Curriculum?

37. Do you think you will need to make any change in your Maths syllabus?

*If yes
Have you got any plan for changing Maths curriculum?

*If yes
How?

38. Do you think students must learn how to use the computers' capabilities for functions such as word processing, statistical analysis, spreadsheet or should they only learn how to write program?

Thank you for answering my questions

Date of Interview ..................
## APPENDIX G
Analysis of Students' Responses

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<th>PERCENTAGE (%)</th>
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