

THE USE OF THE COMPUTERS IN TEACHING BIOLOGICAL  
SCIENCES AT SELECTED SECONDARY SCHOOLS

by

Leila El-Assaad

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*This dissertation, written by*

.....*Leila El-Assaad*.....

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.....*Robert J. Casey Jr.*.....  
Chairperson  
.....*Harrison M. Gort*.....

DEDICATION

To my mother, father, sisters, and brothers for their  
love and support

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## CHAPTER I

### Background of The Study

Science is not given the importance and the priority within most secondary schools. In a period in which there is a tremendous amount of activity in science and technology, American schools are not succeeding in producing scientifically literate individuals. Average citizens today lack an appreciation of the value of science and technology in the society (Collette & Chiappetta, 1984).

Derose, Lockard, and Padley (1980) reported that science is given low priority in comparison to English and social studies, and scientific knowledge is rarely considered basic by the state boards of education. In addition, science education is not included in most state need statements. This is an indicative of low interest in supporting high quality science instruction, and many science courses include material which is inappropriate for most of the students. Derose, Lockard, and Padley added that despite the influence of National Science Foundation ("NSF") sponsored curricula and institutes, classroom observers reported that, at all grade levels, the predominant method of teaching is recitation and



lecturing. Also, The textbooks are the basis for the information and homework assignments despite the fact that many teachers criticized textbooks as being inappropriate and difficult for many students. In addition, the domination of the curriculum by the textbook discourages use of inquiry and laboratory methods by the students.

Lomon (1983) reported that technology and science should be taught daily from kindergarten through grade 12. Elementary and secondary schools should play an effective role in encouraging the youths to study science and prepare them to operate technological tools like computers and other advanced machines.

California State Department of Education (1982) stated that:

It is ironic, then, that support for science education has declined in the last decade. Less than 50 percent of high school students in the United States take more than one required year of mathematics and one required year of science. Enrollment in upper-level courses like chemistry and physics stands at 16 percent, respectively, of high school students nationwide. Moreover, students in the United States are taking considerably less math and science than students in other countries such as Russia, Japan, and Germany. For many years the decline in high quality and well attended science education programs has been a source of concern to educators, policymakers, and leaders of business and industry. That concern has led to a reexamination of the status of science

education in the schools and the growing recognition that a knowledge of science is basic to effective citizenship. ( p.1)

Sullivan (1983) determined that technology should be taught at the pre-college level to enhance and improve technological-based decisions by the students. Using technological tools at this level should help students understand new and sophisticated technology. Sullivan added that computers should be an important part of future education. Educational computer software should be related to the existing curriculum and must be available for all students in all learning environments. Training should be provided for teachers to familiarize them with the use of computers in teaching. Computer use at the school level can help students in problem solving, drill and practice, tutoring, and simulations; and it can enhance creativity for the gifted student and help the average student to learn.

#### **Statement of the Problem**

Rapidly expanding knowledge and new technology during the past 50 years have created a marvelous opportunity for science educators to revitalize biology curricula and meet the demands of a scientific and technological society which is changing.

The problem of this study was to : (1) determine the present extent of computer use in teaching biological sciences at selected public high schools; (2) investigate and discover the effects and changes, if any, that have taken place in biological sciences curricula as a result of using computer technology in instruction; and (3) analyze and study the attitudes of science teachers towards the integration of this use.

#### **Purpose of the Study**

Biology has been neglected as all science, in elementary and high schools. There is an urgent need among science educators to revitalize biology education and harmonize it with new technology and social problems (Lomon, 1983). Using the modern technology of computers to teach biology can help solve current curricular problems (Crovello, 1982). Computers can store and analyze data and formulate new concepts. They have an important role in simulating laboratory experiments that are impossible or dangerous to carry out (Schrock, 1984).

The purpose of this study was to determine the extended use and the impact of computers in teaching biological sciences at the high school level and report

the relative curriculum changes and teachers' attitudes as a result of this use.

### Questions to be Answered

Seven questions concerning computer use were generated to guide this research:

1. To what extent has the computer been used in teaching biological sciences?
2. What is the actual practice versus the desirable practice related to curriculum as a result of computer use in teaching biological sciences?
3. What is the attitude of teachers who are presently using the computer in teaching biological sciences towards this device?
4. What is the actual practice versus the desirable practice related to introduction of computer to teach biological sciences at schools which have not yet used this device?
5. What is the attitude of teachers who are not using the computer in teaching biological sciences towards this device?
6. What influence does use of the computer have on student achievement and attitude from the teacher's perception?

7. What are the advantages and disadvantages of using the computer in teaching biological sciences from the teacher's perception?

### **Importance of The Study**

Yager (1982) indicated that there is a gap between biology experienced by researchers and biology taught to students in schools. As stated earlier, NSF studies showed (Stake & Easley, 1978) that high school biology teachers emphasize the textbook and laboratory methods which are not inquiry oriented (Yager & Stodghill, 1979). Few teachers have the ability and skills to operate computers and utilize varied learning possibilities offered by these devices (Barnato & Barrett, 1981). Biology teachers should be aware of new teaching techniques and current findings in learning styles (Frazier, 1984).

This study is important for the following three reasons:

1. It will provide information about changes, if any, which have been brought into the biological sciences curriculum to meet the demands of new technology.
2. It will provide information regarding the congruence between actual and desirable practices related to

curriculum as a result of computer use in biological sciences.

3. It will provide information about the teacher's perceptions and attitudes regarding the use of computers to teach biological sciences.

### Procedure Used in The Study

Descriptive research or survey study was the methodological approach used in this study. Descriptive research enables us to describe, systematically, the characteristics of a given situation or population. Isaac and Michael (1971) describe the characteristics of descriptive research as an "accumulation of a data base." The authors stated that "it does not necessarily seek or explain relationship, test hypotheses, make predictions, or get at meanings and implications" (p. 18).

Data were collected from the public high schools in Los Angeles County during 1985 - 1986. It was derived from four sources: 1) a telephone survey was conducted with 100 public high schools in Los Angeles County to provide basic information on the extent of computer usage in teaching different subjects, especially in biological sciences; 2) a questionnaire was administered to a sample of biological Sciences teachers who are using the

computer in teaching; 3) a questionnaire was administered to a sample of biological sciences teachers who are not presently using computers in teaching; and 4) an interview was conducted with the teacher sample participating to seek more information about the study.

Pilot surveys of the questionnaires were conducted in five different schools during the month of November 1985 to test their reliability and validity. The data obtained from these pilot studies were not included in the study data but were used to incorporate changes into the questionnaires based on the comments given by the respondents.

The first questionnaire was directed to 15 biological sciences teachers who are using computers for instruction in 11 different schools from 6 school districts. The second questionnaire was directed to 24 biological sciences teachers who are not using the computer in 9 different schools from 4 school districts. Interviews were conducted by the investigator with the participating teachers while administering the instrument. Results will be reported and discussed in the findings of this study.

## Delimitations

There were three delimitations imposed on this study:

1. The study was delimited to biological sciences in expectation of curriculum practices and teachers' attitudes related to computer use in teaching. Thus, data generated from this study should not be generalized to any other subject matter.
2. The study was delimited to selected high schools in Los Angeles County; therefore, the findings may not be generalized nationwide.
3. The study was completed between the years of 1985 and 1986.
4. The telephone survey was delimited to 100 secondary schools in Los Angeles County.
5. The number of schools visited was delimited to 20 secondary schools in Los Angeles County.
6. The grades of participating classes in this study were delimited to 9th, 10 th, 11th, and 12th grades.



## Limitations

This study was limited to the following factors:

1. The number of schools visited was limited by budget and transportation constraints of the researcher.
2. The interview process conducted by the investigator could have altered the normal behavior of the teachers interviewed.
3. The study was limited by the openness and cooperation of the participants in this study.
4. The total sample was limited by the time constraints, school year 1985 - 1986.

## Definitions of Terms

For the purpose of the study, the following definitions were established:

Biology. The study of living organisms and systems and their relationships among each other (Ost, 1978).

Biocomputing. Use of the computer in biological sciences.

Educomputing. Use of the computer in education.

Microcomputer. Computer based on microprocessor technology. It has a small but impressive memory (Peterson, Bowyer, Butts, & Bybee, 1984).

Computer. Device for information retrieval, data accumulation, data analysis, simulation and systems analysis, decision-making, experimental control, course review, computer-managed instruction, and word processing (Crovello, 1982).

Computer Assisted Instruction (CAI). "It refers to instruction actually performed by the computer and its associated consoles for the students" (Hicks & Hunka, 1972, p.1).

Computer hardware. Consists of the physical components of a computer such as keyboards for input, discs, video display and printers for output ( Crovello, 1982).

Computer software. A program entered into the computer to indicate what operations can be performed (Crovello, 1982).

Computer simulation. Use of the computer to simulate any experiment without the restrictions imposed by time, teacher preparation, and cost of materials (Kosinksi, 1984).

Demonstration Method. Method to demonstrate a series of event, or witness a phenomenon (Peterson, Bowyer, Butts, & Bybee, 1984).

Field Trip Method. Method which provides students

with experiences that take place outside the classroom (Peterson, Bowyer, Butts, & Bybee, 1984).

Hands-on experiences or Laboratory Method. Method which allows students to solve problems or apply knowledge to concrete situations (Peterson, Bowyer, Butts, & Bybee, 1984).

Innovation. Implementation of educational changes or educational reforms in the classroom (Fullan, 1982).

Inquiry Method. Helps students solve problems by directing their own search to find answers (Peterson, Bowyer, Butts, & Bybee, 1984).

Science. A body of established knowledge, a way of investigation, and a way of thinking (Collette & Chiappetta, 1984).

Technology. The applications of science to real life (Collette & Chiappetta, 1984).

#### Outline of the remainder of the study

The remainder of the study includes the following chapters:

Chapter II includes a review of literature related to the use of computers in high schools and the relationship between science and technology. Also

included is an overview of teacher's attitudes towards computer technology and innovation.

Chapter III describes the methodology and procedures used to gather information needed for the study.

Chapter IV reports the data collected and findings.

Chapter V presents a summary of the findings, conclusions and recommendations of the study.

## CHAPTER II

### REVIEW OF THE LITERATURE

#### Organization of the Chapter

This chapter includes six sections. The first section deals with the review of literature pertinent to the history and nature of science teaching at the secondary school. The second section investigates: 1) computer uses in science; and 2) the importance of this device in biological sciences. The third section focuses on computer simulation in teaching biology. The fourth section includes the educational software available in this field. The fifth section reviews the literature on the attitudes of biological sciences teachers towards using computers in teaching, and the sixth section focuses on the attitudes of teachers, in general, towards innovations and changes in teaching. The last section includes a summary of this chapter.

## I. Review of the Science Education Program at the Secondary School

In 1983, the National Science Board Commission ("NSB") on pre-college education in mathematics, science and technology reported that there are shortages of science and mathematics teachers in the school systems. This decrease of qualified teachers results from a decline of interest in teaching, inadequate training and low status as a profession. Thus, most science and mathematics majors today are attracted to careers in business and industry (Lomon, 1983).

The Commission recommended that science and technology taught at the secondary school should not only emphasize problem-solving skills, and develop creative thinking in students, but should be used to improve technological-based decisions and facilitate student participation in a post-industrialized society.

Melton (1980) indicated that only 21 percent of schools in the whole nation require more than one year of science for graduation from high school. He added that instructional techniques for science are mostly lecture or discussion. Smith (1979) pointed out that secondary science education does not have a well-defined theory or philosophy which provides a basis for curriculum and

instruction. The author believed that the purpose of education, especially science education, seems unclear and uncertain in the secondary school. Based on the relationship between science and technology, actual science programs lack effective technological techniques. Smith (1979) added that science teachers have been dependent on textbooks, and science has been taught by rote.

#### The Need for Change in Science Education

In 1970, there were many serious societal problems related to science education which was criticized as demonstrating a lack of support to people and environmental concerns. During this period, the NSF decided to support the implementation of a new curriculum based on new science topics such as sex, reproduction, and social issues and as a result, developed in-service and teacher education activities in these areas (Yager, 1982). Stein (1977) described the discontentment with science, when he stated that:

Widespread dissatisfaction with science became evident in the late 1960's. The public had been oversold on the ability of science and technology to solve economic and social problems, and distinctions between principles and their applications were and continue to be blurred. Under these circumstances, disillusionment with science was inevitable. (p. 527)

Bindel (1978) cited some goals that new science programs should include topics such as: use and appreciation of technology in daily life; understanding of self and societal matters; and preparation for advanced studies and research. Denny reported that the actual science curriculum does not apply these goals in the classroom. Bindel described the crisis in science education at the secondary school and the lack of interest of science teachers in teaching:

In working with teachers and school systems, I am constantly aware that schools are dropping science classes, programs, and teachers. I believe many secondary science teachers are losing their students and their jobs because of their lack of motivation and poor attitudes. (p. 116)

Few changes have occurred in instructional strategies, schools' implementation and articulation of science materials. Inquiry teaching is rarely used in the classroom, and student centered activities are not emphasized in science. It seems that providing up-to-date science programs in schools is not an important matter and not considered basic in teaching students. Science teachers are more concerned with classroom problems such as discipline than articulation of the science program (Yager & Stodghill, 1979).



Science curricula at the secondary school should be revised by scientists, science teachers and educators. Science teachers have to keep in touch with universities and research centers to enhance and update their teaching (Derose, Lockard, & Padley, 1980).

### The Nature of Biological Sciences Teaching at the High School

Learning biology is basic for everybody and may help people create new roles oriented to their future life and solve social problems (Ost, 1978). Kieffer (1977) asserted the important role of biology in today's life.

The assertion that we are living in a "biological revolution" comes as no surprise to anyone. It has been emphasized on a number of occasions and from a variety of sources that the major scientific discoveries in the near and long term future will be in the life sciences-biomedical areas (physics had its day, then chemistry and now it is biology's turn). Further, some of the major problems in this and the next century will be biological or will have a significant biological component associated with them. The new circumstances of life today coming out of these developments is having and will continue to have enormous implications for ethics. (p. 80)

The major results and outcomes of studies sponsored by the NSF showed that biology is textbook oriented in most school programs. Biology teachers use a textbook 90 percent of the time and make few decisions about their

biology curriculum (Stake & Easley 1978; Beisenherz, 1982). Science as inquiry is rarely practiced in the classroom or the laboratory, and biology teachers at the high school level generally emphasize the textbook (Yager & Stodghill, 1979). The current crisis in teaching biology resulted from a decline in standards, lack of funds required for effective programs, less commitment to science, lack of expertise in biological education and relaxation of graduation requirements. New curricular programs, new approaches to science, and a new in-service teacher models would be a solution to the biology crisis. Science education needs a new rationale and purpose to relate to societal problems, and it should be ever changing, like science. The real solution for the biology crisis must begin by redefining of the major goals of school discipline (Yager, 1982).

Jungck (1985) criticized science textbooks for focusing only on facts and principles, thus failing to attract students to science.

I believe that this is where they fail us most; namely, by focusing on facts and problems formulated in a 'normal' science tradition (paradigm). We fail our students most by not raising the questions to which we have no good answers. I furthermore would argue that we fail to attract certain students to science because they see science as fixed with all of its major problems already solved rather than a dynamically

growing approach to difficult problems, some of which have not yet been even articulated. (p. 265)

Biology content should include elements of science and technology such as nuclear power, chemicals and radioactive materials, sex education, energy resources, population growth, genetic engineering, abortion, birth control, and conservation of energy (Hickman, 1982). Hickman added that it is obvious that science and technology are common elements among these issues.

Using inquiry in teaching biology, and moving away from emphasizing content, would help students learn more about changing human conditions and cultural institutions (Ost, 1978). One approach in teaching biology is to challenge students. If learning is too easy, students remain at their present level of intellectual functioning. Another approach is to take into account the present intellectual level of the students. If learning is too difficult, lack of success may decrease their willingness to learn new tasks (Wright & Spiegel, 1984).

#### Summary

Most of the science educators agree that science curricula at the secondary school need to be revised and up-dated. Many science educators recommend that science

teaching should be based on problem solving skills and enhance creative thinking in students.

Science programs suffer from many serious problems such as: lack of relationship with societal issues and technology; and lack of support to students needs. In addition, the number of qualified science teachers decrease as a result of lack of interest in teaching. Science teachers seem more interested and occupied with classroom problems than providing and implementing updated science programs in their schools. Textbooks are the major instructional method used in teaching science where lecture and discussion are emphasized.

Teaching biological sciences is very important for students because most of the major social problems in this century have biological component issues related to them. Unfortunately, many studies show that biological sciences is taught by rote at most of the secondary schools, and inquiry techniques are seldom practiced in teaching these subjects. The current crisis in teaching biological sciences at the secondary school level results from a lack of funds and interest in those subjects, decline in standards, and lack of expertise and training in teaching. In most secondary schools, biological sciences needs a redefinition of its major goals, new

approaches and in-service teacher models, and new curricular programs. Biological sciences content should raise new issues which stimulate students to learn and should emphasize subjects that have science and technology as common factors.

## II. Science and Technology at the Secondary School

The average citizen in the United States lacks knowledge and familiarity with science and technology to cope efficiently in this technological era. There are many causes for this critical problem, such as: 1) science curricula in the school systems do not emphasize the importance of science; 2) the decrease in the numbers of science teachers; and 3) little time is devoted to science at the pre-college school level (Lomon, 1983). The author added that technology and science should be taught daily, from kindergarten through grade 12, and that elementary and secondary schools should play an effective role in encouraging youths to study science and prepare themselves to operate technological tools like computers and other advanced machines.

Greeno (1983) criticized education in the school systems as suffering from many problems and reported that

educational content of different subject matter does not enhance learning skills, problem solving, reasoning, and programming. The author suggested a good technology education program based on computational systems to help students understand the role of technological issues in human life. Greeno (1983) stated:

The growing role of technology, especially computational systems, in human affairs implies a critical need for education that prepares students to understand and use technological resources. Recent research has provided information about properties of knowledge required for understanding technical systems such as electronic device and power plants, and these findings suggest important issues for the development of education for technology. (p. 114)

Tornatzky, Eveland, Boyland, Hetzner, Johnson, Roitman, and Schneider (1983) have defined the casual links between technology and innovation. They stated:

Thus far, two approaches to defining technology and innovation have been distinguished : analysis of innovation as an organization task, and analysis of innovation as reflected in perceived characteristics. Evolving work in both bodies of literature is leading to a more developed understanding of the concepts of technology and innovation. The organizational literature has moved from a simple view of technology as machine and organization as hierarchy to a conceptualization of enormous possible variety in technology/organization systems. Likewise, the understanding of innovation characteristics has evolved from a concept of invariant attributes to that of perceptual gradients affected by setting, participants, location and stage. (p.12)

Hicks and Hunka (1972) described new trends and changes in education as a result of advanced technology. They indicated that students and teachers should be influenced by the computer technology, and especially by CAI.

The fruits of the technological development will appear soon in the schools in the form of CAI, and not just because technology can aid education. School systems are already turning to CAI in the hope that it will help to solve the problems of mass education and the problems of education of the culturally disadvantaged. Companies are beginning to push the use of CAI as an important component of computer sales. The federal government, indirectly but nonetheless effectively, supports the development of the components of CAI continuously through its search for advanced hardware and software. (p. 21)

Computers have been used in different ways to improve the learning environments: 1) to teach programming; 2) to improve thinking skills; 3) to learn new concepts and skills; and 4) to create data bases. Also, the computer is used to help simulate experiments which are unavailable to the student because of time, lack of funds, or danger in performing the experiment. In this mode, the computer can serve as a laboratory to discover new concepts and skills (Sullivan, 1983).

Using the computer in secondary education is very important. It can be used in technology education for computation, gathering data, processing information,

testing models, and describing processes and procedures (Lomon, 1983). Data processing can be used at the school setting for registration, attendance records, scheduling and other tasks. It provides calculation and analysis. Computers can aid individualized instruction by providing individual paces and sequences for each student. They can even be used to administer tests to students for diagnostic purposes (Unruh & Alexander, 1970).

#### The Use of the Computer in Biological Sciences

During the 1970s, the use of computers in biological education has increased as a result of a decrease in computer cost. Biologists have used computers for data accumulation in laboratories and molecular graphics. The major uses of computers have included information retrieval, multivariate analysis, and laboratory simulation experiments.

Computer sizes vary greatly. First, maxicomputers were available. Second, minicomputers became available in the late 1960's which have been used in biological research and teaching laboratories. By 1980, microcomputers became widely available to biology teachers. They are based on the micro/processor technology (Crovello, 1982).



In 1979, a survey was conducted by Crovello (1980) involving 297 departments of science to determine the extent and nature of computing in bioeducation. He reported that lack of funds, time, equipment, and training were the reasons which have been cited by department chairmen for lack of computer use. The areas of biology using computers in teaching most include: ecology (18 percent); general biology (10 percent); cell biology and physiology (10 percent) applied biology (9 percent); and genetics (6 percent ).

Computers can store and analyze data and formulate new concepts. They have an important role in simulating laboratory experiments that are impossible or dangerous to run (Schrock, 1984). Tennyson (1980, 1981) and Self, Self, and Rahain (1984) have used CAI in conjunction with the audio-tutorial approach, to provide updated information about student's achievements and improve the performance of poor readers in biology.

The use of CAI in biology laboratories is highly appropriate because experiments can be done quickly and without major material requirements. A quality CAI with an understanding of biological principles can improve laboratory instruction (Kosinski, 1984).

At the University of Notre Dame, McMillen and Esch (1984) collected data of a species distribution by using a microcomputer. They developed a system to monitor physiological activities in laboratories. These activities included turtle heart contractions and frog muscle contractions.

Computers can be used for writing biology tests. Vittitoe and Bradley (1984) described a program which stores multiple-choice and essay-type questions. The questions stored can be related to many subjects such as ecology, genetics, or biochemistry. The program enables the teacher to make different formats of the same test material. This program for writing tests is useful, especially in over-crowded classrooms where cheating can be a problem.

#### Summary

Technology and science are not taught daily in the secondary school, thus, most students lack familiarity with these subjects. Schools are not preparing youths to cope in a technological society. Computer usages are not given an important role in teaching science and the educational system is not helping students to use technological resources in their life. Computer technology can be used to improve science education by

helping in gathering data, processing information, drill and practice, computation, simulation teaching, and learning new concepts and skills. In addition, computers can provide individual learning for each student.

The use of computers in teaching biological sciences has increased in the last decade, especially in data accumulation, laboratory simulation experiments, species distribution, monitoring physiological activities, and writing biology tests by storing multiple-choice and essay-type questions.

The major reasons for lack of computer use in teaching biological sciences are lack of funds, time, expertise, training, and equipment.

### III. Computer Simulation in Teaching Biology

Computer simulation is an excellent alternative to experiments which can not actually be performed in most high school laboratories due to lack of time, materials, equipment, or safety. Students can benefit from computer simulation by developing strategies of inference from experimental inquiry. This learning approach provides a scientific, as well as, educational, strategy that is seldom available in a laboratory (Jungck, 1982, 1984). Using computer simulation in biology education can

provide students with the experience of real bio-societal systems. Computers can provide individual instruction which allows students to learn at their own pace and evaluate alternative decisions (Crovello, 1982).

Simulations are an excellent utilization of computers and can be entertaining and imaginative. Simulation has been used in many areas in biology, including genetics, cardiopulmonary physiology, and population dynamics (Kosinski, 1984).

Since the expansion of educomputing in the 1980s, many teachers have wished to learn more about programs that are pedagogically important for students. The microcomputer programs today should challenge students, both cognitively and effectively (Heinze-Fry, Crovello, & Novak, 1984). Peard (1983) cited some of the factors for a good educational program such as maximum student control, immediate feedback, and simulation of biological events. Software used in biology education may be written by biologists themselves or purchased retail (Crovello, 1982).

#### Simulation Models

Kleinsmith (1984) has developed a program named "CODON" to familiarize students with genetic code via computer simulation. Kung, Hill, and Suelter (1983)

described two genetic engineering programs entitled "CLONE" and "SUBCLONE". CLONE teaches students about the human growth hormone gene and DNA. SUBCLONE includes exercises to familiarize students with the specialized role of DNA.

Barnoto and Barrett (1981) described two models, BISON (1976) and POLLUT (1976) which have been developed by the staff at Lawrence Hall of Science, Berkeley, California. BISON is a simulation game that teaches how to manage and maintain a herd of animals. POLLUT is a simulation game that describes the impact of pollution on different water systems such as ponds, rivers, and lakes. These programs benefit students by familiarizing them with many biological factors. These simulations help students look at biological and ecological problems from a practical view point and try to determine solutions to these issues.

#### Summary

Simulations are an important application of computers in teaching biological sciences and have been used to provide students with entertaining and creative learning experience. The student can derive answers to a series of questions by performing experiments which would be expensive, or time-consuming in the laboratory. Many

computer simulation programs have written in genetic engineering, animal development, and pollution impact which introduce students to different biological and ecological issues.

#### VI. Educational Software in Biology

A recent survey showed a relationship between an increased use of microcomputers by students and teachers and a decreased relative percentage of time devoted to drill and practice (Crovello, 1984). Crovello in the same article, reported that the evolution of educational software has several stages. First, the primitive programs which perform simple tasks, gradually became programs which allow the user to employ them without help from an educator before or during the task. Second, the introduction of Intelligent Computer Assisted Information ("I-CAI") which, unfortunately, does not have few if any examples in biology at the time being. I-CAI focuses more on simulation and artificial intelligence and concentrates less on drill, practice, and tutorial strategies. Third, the development of multi-faceted educational software which focuses on a particular subject. This kind of software is still in the future.

Baez (1976) indicated that the production of software should be given more importance than the purchase of hardware. He added that it is easy to spend money buying hardware to teach science and introduce instructional technology in teaching. The problem is to have good software in addition to providing hardware.

Alessi (1984) has criticized the poor quality of CAI commercially available. He has suggested that CAI programs should be based on the completeness of the model of instruction and provide four phases: 1) present of the information; 2) guide the student in learning the material; 3) provide practice; and 4) assess achievement. He added that some common mistakes occur in CAI programs when students begin at phase three or engage in only the first two phases. This will leads to failure in using CAI for teaching and frustration for many students.

Spain (1985) indicated the deficiency of the microcomputer software available. He stated that:

In my experience, most instructional programs, including those that I have authored, are still deficient in one way or another. Often educational objectives are not clearly defined, and if they are, they may not be fully met. In many cases, opportunities for explaining key topics are completely missed. For example, many programs don't take full advantage of the graphics capabilities that the microcomputer offers. Thus, in most cases, there is an

opportunity for the teacher to augment the courseware in many ways. (p. 120)

Educational software will evolve rapidly in the future. Videodiscs are expected to play an important role in education, and biology videodiscs will soon have an impact on "educomputing" (Crovello, 1984). The role of the computer will change from being the tutor to the tutee (Taylor, 1980).

Crovello (1982) emphasized the importance of computer software and indicated that good knowledge of the subject is required to develop any educational program.

Along with people and computer hardware, software is an essential component of any computing system. Software refers primarily to the programs, the set of instructions that activate computer circuitry and hardware. In one sense, it is meaningless to claim that evaluation of software is more important than hardware, because both are essential components. Yet in another sense, software evaluation is more affected by the style, etc. of the interactive session which a program creates, than by the hardware used. Good educational software requires considerable knowledge and effort to develop. Unfortunately, many programs and program packages currently advertised for educational use are not very stimulating. This presents a double danger and a mandate. The first danger is that if an educator purchases a program and on a trial run does not like it, he may discard it and also discard his feelings that the wise use of computers can enhance education. The second danger can occur if the educator decides actually to assign students a poor program because he



bought it and feels he has to make use of it. This will turn students against computers in education. (p. 429)

### Summary

Computer software is as important as the computer hardware and should be highly qualified and well prepared to provide students with the information needed in learning because a poor educational program can turn them against computers.

Most of the commercial programs available are criticized as lacking clear educational objectives and providing just simple tasks such as drill and practice. Software is expected to play an important role in learning in the near future and focus more on problem solving and artificial intelligence.

### **V. Attitudes of Biological Sciences Teachers Towards the Computer in Teaching**

Very little information is available about the attitude of biology teachers in perceiving classroom instruction and other issues (Hickman, 1982). Changes in biology curricula have complicated the role of secondary school biology teachers. Many teachers complain of the inadequacies of the pre-service and in-service education. Workshop and training programs can tremendously help

teachers cope with new changes, including technology in teaching (Mariner, 1978).

Defina (1985) described his feelings towards the different approaches in biology curricula and indicated that he preferred a lecture type lesson more than a process mode.

I admit it. I am a biology teacher who feels more comfortable with a teacher-centered approach. I am not alone. Recent national surveys suggest that biology teachers use primarily a lecture mode rather than an inquiry mode so that biology teaching, in general, remains traditional. (p.48)

Hicks and Hunka (1972) reported that the role of the teacher is essential in teaching and can not be replaced by a computer or any other teaching device. They believed that the interaction between teachers and students is very important for learning in the classroom. The teacher should play a central role to direct interaction of the students, with each other and with the teacher. Interactions among malleable, perceptive, creative, social human beings can never be replaced by the indirect or incomplete interaction afforded by books, TV, or CAI.

A teacher can relate the real-life experiences of a student to his learning in the classroom. How could a computer, except in a limited sense, evaluate or appreciate the student's artistic endeavors? How could

a computer strengthen his friendships and deepen his perceptions of those around him?  
(P.24)

Recently, teachers' attitudes towards computers have become more positive due to an increase of computer use in teaching (Crovello, 1984). Schrock (1984) indicated that the computer is a very important tool and has an important role in simulating experiments, collecting and analyzing data. Few teachers have the ability and skills to utilize computers and the different possibilities offered by these machines (Barnato & Barrett, 1981). Many teachers refuse to be part of the computer generation. Instead, they prefer programs and subject matter which are pedagogically right for their students (Heinze-Fry, Crovello, & Novak, 1984).

Spain (1985) criticized instructional programs and indicated that teachers can not be replaced by any teaching machine because only the teacher can understand the student's needs.

All too often, it is assumed that if you have good instructional software, the teacher is somehow redundant. The misconception may result from the belief that computers are automatic teaching machines. There are even those who still mistakenly believe that they may somehow be replaced by this new technology. I suppose there is the potential that computers may eventually replace some aspects of teaching. But, anyone who has spent much time looking at available courseware knows that significant replacement

of teachers by computers is still a long way off.

Existing instructional programs are still missing several key features that a teacher must provide. In this respect, they are not unlike textbooks. For example, microcomputer programs cannot fully anticipate the nature of the students who use them. Students' backgrounds are simply too diverse. Only the teacher knows how much the students already know about a given subject. Only the teacher can provide the sympathy and understanding some students need when approaching a new and challenging topic. In addition, a computer program cannot possibly anticipate the instructional objectives of all the courses in which it might be used. Only the teacher knows how the course objectives fit with the program objective and how a particular program would relate to the other material being employed. (p. 120)

#### Summary

In general, just few studies have done to survey the attitude of biological sciences teachers towards new changes in the curriculum and different approaches in teaching and using computer technology in the classroom. Some of these studies show that teachers usually resist to changes and innovations in learning. It seems that workshop and pre-service training are not helping teachers to cope with implementation of new instructional methods. Most of the science instructor prefer a teacher centered approach and use lecture type lesson more than a process and inquiry mode. Generally, biology educators believe that computer can not replace the teacher in the

classroom because it does not have the ability to relate or appreciate the student's achievement. Few biology teachers have the skills to use computers and write instructional programs due to lack of expertise, training, and interest.

#### **VI. Attitudes of the Teachers Towards Innovations and Changes in the Curriculum**

Olson (1982) described many studies that revealed how teachers resist implementation of innovations in the curriculum. These studies have shown that the teaching environment is an important factor in understanding the level of innovation used by the teachers. Most of the time, innovators, from outside the school, rapidly introduce changes in the school without taking into consideration the teacher's concerns.

Curriculum innovators appeared to have underestimated the concerning tendencies of teachers and schools. Researchers following the innovations into schools could only marvel at the extent to which teachers continued to do what they always did. (p. 7)

Innovators focus more on their own concerns than on teachers' interests. Olson reported that understanding and helping teachers use innovations should be a main concern and issue in curriculum changes. He added that outsiders in curriculum innovation may not understand teachers' expectations because they are mainly concerned

about the innovative doctrine or the conditions of implementation (Olson, 1982).

Fullan (1982) indicated that the strategies used by the innovators often do not work because most of the innovations are advocated from the promoters, not the teachers. Frequently innovations are not translatable into practice by the teachers because " they assume conditions to be different from those faced by teachers" (P. 115). Fullan stated that:

Change is a highly personal experience. Each and every one of the teachers who will be affected by change must have the opportunity to work through this experience in a way in which the rewards at least equal the cost. The fact that those who advocate and develop changes get more rewards than costs, and those who are expected to implement their experience many more costs than rewards, goes a long way in explaining why the more things change, the more they remain the same. If the change works, the individual teacher gets little of the credit; if it doesn't, the teacher gets most of the blame. (p. 113)

McLaughlin and Marsh (1979) indicated three teacher characteristics which have different effect on most outcomes of innovative projects: a) years of experience, b) verbal ability, and c) sense of efficacy. Years of experience are negatively related to innovative projects. Verbal ability is related only to student's performance. Teacher sense of efficacy has a strong and positive

relationship to the implementation of an innovative program.

Teacher sense of efficacy was positively related to the percent of project goals achieved, the amount of teacher change, total improved student performance, and the continuation of both project methods and materials. Teacher's attitudes about their own professional competence, in short, appear to have major influence on what happens to change-agent projects and how effective they are. (P. 85)

Louks and Halls (1979) described a model which they called the concerns-Based Adoption Model (CBAM). This model examines the concerns of teachers when they engage in a change and innovation process. CBAM is based on the assumption that change can not happen in a system until the individuals change. They identify seven stages of concern in any innovation: awareness, informational, personal, management, consequence, collaboration, and refocusing. A user's stages of concern move from self, to task, and finally to impact. Louks and Hall (1979) stressed that the teacher's concerns are as important as the innovator's technology. They acknowledge the fact that innovation could not be implemented by teachers unless the innovators attend to these personal concerns.

The power of the concerns dimensions lies in the assumption that the process of change is a personal experience for each individual involved in it. Everyone approaching a change, initially implementing an innovation,

or developing skill in using an innovation, will have certain perceptions, feelings, motivations, frustrations, and satisfactions about the innovation and the change process. (P. 39)

### New Role for the Teacher

Today's teacher role is very important and more advanced than before. Teachers must have knowledge in science and technology and must upgrade their skills in instruction and understanding of subject matter. They should step out from the old role to a new one which is more effective, but more complex. Teachers should not be working in isolation from others. They should cooperate and share with the other staff at the school to develop new goals and curriculum (Unruh & Alexander, 1970).

Maclaughlin and Marsh (1979) reported that educational innovations often fail because the change facilitators and innovators ignore and underestimate teacher training needs. They described a planning strategy which they called "Collaborative Planning."

In this mode, project plans were made with equal input from teachers and district managers. Although this style was rarely characterized by conscious notions "parity", participants at all levels in the system were treated as partners in the process of planning strategies, a collaborative planning style was necessary to both the short-term and long-run success of a planned change effort. (P. 73)



Major changes must happen in science teaching. Obviously, changes should take place in staff roles at the school level, specifically the role of the teacher. Good in-service training must be provided for the teacher to assure effective implementation of new innovations in curriculum and media instruction. New technology, advanced scientific knowledge, and development in media production are factors which give new roles to the teacher (Unruh & Alexander, 1970).

A survey in Speedway High School, Indiana, showed a decrease in the number of biology teachers under 30 years old and an increase in teachers over 50 years old. Increase in age can help bring experience and maturity to teaching; however, aging can reduce willingness to innovate and change in teaching techniques. Biology teachers should be aware of new techniques in teaching and current findings in learning style. The most important role for each biology teacher is to keep biology alive and vital by adapting new ideas for different situations (Frazier, 1984).

Resnick (1977) described the important role of the biology teacher to make the subject interesting for the student. He stated that:

I still believe that the key to teaching biology is the teacher's ability to make the subject exciting for his students. (p. 430)

### Summary

Many studies show that teachers resist to innovations because most of the time innovators underestimate and neglect teacher's concerns in planning and implementing changes in the classroom. They are usually more concerned about innovation techniques than teacher's expectation. Teacher's collaboration and cooperation should be taken into consideration for implementing innovations and any kind of changes in the school setting.

Today, teacher's role is important and very effective. Teachers have more responsibilities in setting goals and developing new curricular programs. Science educators should be aware of the discoveries and new technology which help update and keep the biological sciences alive and vital.

### Summary of Chapter

The first section of this chapter reviews the science education at the secondary school. It points out the need for changes in the pertinent curriculum. Science programs at the secondary school are out-dated

and lack relationships with new technology and lecture is more emphasized than inquiry learning in the classroom. Also, there is a shortage of qualified science teachers due to lack of training, expertise, and interest in teaching this subject.

Teaching biological sciences at the secondary school has been neglected as other science subject. Biology curricular at most secondary schools need to be improved and updated to suit students' life in this century. New instructional approaches and technological techniques should be emphasized in teaching science.

The second section of this chapter includes a review of technology use in science, it emphasizes the importance of teaching science and computer technology daily in the secondary school. Using computers in teaching biological sciences can help in computation, gathering information, drill and practice, simulation learning, and teaching new skills. Lack of money, expertise, training and interest are the major reasons for lack of computer use in the secondary schools.

The third section of this chapter contains a review of the computer simulation uses in teaching biological sciences which have been used in different areas in this subject, especially in laboratory experiments in case of

lack of equipment or for safety reasons.

The fourth section of this chapter reviews some of the educational software available in biological sciences. It focuses on the importance of highly prepared computer programs in teaching science and criticizes some of the commercial software as being dull and superficial.

The fifth section includes a review of the attitudes of biological sciences teachers towards the computer in teaching. It indicates that some of the teachers have negative attitudes towards computer use because they feel that computer does not have the ability to communicate with students. Most believe that lack of funds, training, and interest are the principals reasons for lack of computer use in the classroom. The last section reviews the teacher's attitudes towards innovations and changes in the curriculum, and the new role for the teacher in today's life. Also, This section includes several studies which show the resistance of the teachers towards changes in the curriculum. Generally, the innovators have different concerns and expectation than the teachers. Today's teacher has very important role to play in planning and implementing any changes in the classroom. Biology teachers have the responsibility to

update and improve their science programs to keep them related to new technology and societal needs.

## CHAPTER III

### METHODOLOGY

#### Organization of the chapter

This chapter includes seven major sections. In the first section, an overview of the study is described. The second section includes the restatement of the problem, and the third section contains the research questions. The fourth section describes the population and the sample who participated in the study. The fifth section explains instrumentation of the study, i.e. methodological procedures used to construct the questionnaires and the teacher interview structured. The sixth section describes the pilot study and the validity and reliability considerations, and the seventh section includes a description of the data collected for use in this study. The last section contains the procedures used in analyzing the data collected.

## Overview

The survey approach was chosen for this study to investigate various aspects of computer use in the teaching of biological sciences at selected public high schools in Los Angeles County. A phone survey was made by the investigator to 100 public high schools to find out the extent of using computers in different subject matters with a special emphasis on biological sciences. Based on the data collected from the phone surveys, two questionnaires were constructed.

One questionnaire was addressed to teachers who are using computers in biological sciences, to evaluate: a) computer practice related to curriculum; and b) teacher's attitudes towards computer use. This questionnaire is presented in Appendix A. It was developed by the investigator. The design was adapted from the questionnaire created by Rundall (1970) in his dissertation at the university of Southern California.

The second questionnaire was administered to a sample of biological sciences teachers, who are not using computers in teaching, to evaluate: a) lack of computer practices in the curriculum; and b) teacher's attitudes towards the computer as a teaching tool. This questionnaire is represented in Appendix B and was also

developed by the investigator. The design was adapted from the questionnaire created by Rundall (1970) in his dissertation.

An interview was conducted with the teachers who are using the computer in teaching to evaluate: a) changes caused by the computer in the biology curriculum; and b) the success of student's achievement and attitudes from the teacher's perspective after introducing computers in teaching. Also, an interview was conducted with teachers who are not using the computer in teaching biology to assess: a) their opinion concerning the computer usage in teaching, and b) their feeling about this study.

In November 1985, a pilot study was conducted with 5 biological sciences educators. Changes were made in both of the questionnaires based on the suggestions given by the pilot sample.

After reviewing and revising the questionnaires by the committee chair, the questionnaire structured for the computer user was submitted to 15 biological sciences teachers in 11 public high schools from 6 school districts. The non user questionnaire was distributed to 24 biological sciences teachers in 9 high schools from 4 school districts. Both of the questionnaires were administered personally by the researcher. More details



about administering the questionnaires and conducting interviews with the teacher sample are explained in upcoming sections of this chapter.

#### **Restatement of the Problem**

Science programs in secondary school suffer from many problems and need to be revised and revitalized. Curriculum should be renewed, and teaching methods in the classroom should be more related to the new techniques. Lecture and recitation are not suitable anymore for the student whose life is going to be affected by the technology and new discoveries in this century. Using computers and other technological tools has become an urgent necessity for a good and an updated science program .

As identified in chapter I , the problem of this study was to find out the extent of computer use in teaching biological sciences, report the practices related to this use, and study the attitudes of teachers towards this device. In this regard, an investigation was made by the researcher in selected secondary schools in Los Angeles County. The investigator used the following instruments to gather the information: a) Phone survey,

b) two questionnaires, and c) interviews with teachers who answered the questionnaire.

### Research Questions

To identify the research problem of this study, seven research questions were formulated:

1. To what extent has the computer been used in teaching biological sciences?
2. What is the actual practice versus the desirable practice related to curriculum as a result of computer use in teaching biological sciences?
3. What is the attitude of teachers who are presently using the computer in teaching biological sciences towards this device?
4. What is the actual practice versus the desirable practice related to introduction of the computer to teach biological sciences at schools which have not yet used this device?
5. What is the attitudes of teachers who are not using the computer in teaching biological sciences towards this device?
6. What influence does use of the computer have on the student achievement and attitude from the teacher's perception?
7. What are the advantages and disadvantages of

using the computer in teaching biological sciences from the teacher's perception?

### Population and sample

#### Selection of the Sample

For the purpose of the study, the sample population consisted of biological sciences teachers, science chairs, and curriculum specialists at public high schools in Los Angeles County. This sample included 39 biological sciences teachers from 20 high schools in 10 Los Angeles County school districts and was limited to those teachers who were willing to participate in this study.

The selected participating were 27 science teachers and 12 science chairs grouped as follows: a) 11 teachers and 4 science chairs from 11 public high schools who are currently using computers in teaching biological sciences; and b) 16 biological sciences teachers and 8 science chair from 10 public high schools who are not yet using computers in teaching.

#### Procedure Used to Select the Sample

The population sample was selected from high school biological sciences teachers in school districts located in Los Angeles County. The time required for the interview (30 minutes) and the financial limitations of

the researcher were the major constraints in selecting the appropriate sample. Therefore, it was decided to use volunteers as the sample of this study. The procedures used to select the sample were as follows:

1. During December 1985, the Science Education Office, Division of Curriculum and Instructional Programs provided a list of Los Angeles County high schools from which a possible sample could be drawn. The same office also furnished a list of the principals, science chairs, and people to contact regarding the biological sciences programs in the high schools.
2. The researcher made telephone calls to 180 high school from the list. The purpose of the call was to introduce the investigator, explain the purpose of the study, and request school participation in this survey.
3. Permission was granted by 100 high schools in 50 school districts to conduct the phone survey inquiring into the extent of computer use in teaching sciences. The purpose of this survey was: 1) to find out the frequency and the percentage of computer use in teaching computer skills, math, business, physics, chemistry,

biological sciences, English, reading, journalism, special education, bilingual program, industrial educational arts, social studies, library science, and other subject matters at the school participants; and 2) determine if the computer has been used regularly or occasionally in teaching sciences.

4. Permission to administer the questionnaires was obtained from 39 science chairs and/or biological sciences teachers. Time, date, and place for the interviews were set during January and February, 1986.

#### Instrumentation

Instrumentation for the study consisted of a phone survey and two questionnaires (one for computer users and the other for the non users ), and the structured interview. The computer user questionnaire is presented in Appendix A and the non user questionnaire in Appendix B. Interviews were conducted with the teachers who participated in the study.

#### The Computer User Questionnaire

The computer user questionnaire consists of three parts constructed by the investigator. The first part

includes 5 questions. The first 4 items have 2 sections related to the actual and desirable practices of using computers in biological sciences. The second part consists of 10 Likert-type items to solicit teacher attitude towards using computers in teaching biological sciences. In the third part of this instrument, general demographic information and background of the participating teachers were requested.

#### The Non User Questionnaire

The questionnaire for the non users of computers in teaching biological sciences also consisted of three parts which were constructed by the researcher. The first part of this questionnaire included 7 questions. The first 5 items have 2 sections related to the actual and desirable practices of implementing computers into biological sciences.

The second part of this instrument consisted of 6 Likert-type items to study teacher attitude towards using computers teaching biological sciences. In the third part of this instrument, general demographic and background of participating teachers were requested.

#### Teacher Structured Interview

The purpose of the interviews was to supplement the other instruments used in this study and seek more

information from the respondents. The type of interview items used in this study was open-ended. Open-ended items will "give the respondent a frame-of-reference with which to react, without placing any constraint on the reaction, and allows flexibility, depth, clarification, and probing" (Isaac & Michael, 1971, p. 98).

The teacher interview for the computer user participants consists of seven open-ended questions to obtain supplementary opinions concerning this use:

1. In what way, if any, has the use of computers changed biological sciences curricula?
2. Do you believe that computer use in teaching has been beneficial to student achievement?
3. Do you believe that computer use in teaching has been beneficial to student attitudes?
4. In your opinion, what are the advantages of using computers in teaching biological sciences?
5. In your opinion, what are the disadvantages, if any, of using computers in teaching biological sciences?
6. Do you write your own software programs in biology?
7. Please make any further comments which you think relevant to this study.

In addition, interviews were conducted with the teacher sample which is not using computers to ask their opinions about the introduction of this device in teaching and their comments on this study.

### Pilot Study

A pilot study was conducted on both of the questionnaires to determine the appropriateness and feasibility of the methodology used to obtain the necessary data. The pilot instruments were presented to 5 specialists in biological sciences education. Changes were included in the instruments based on the suggestions given by the pilot responses. After revising both of the questionnaires, they were presented to the Committee chairmen for final approval. His comments and advice were incorporated into the instruments.

### Validity and Reliability Considerations

Judgments of specialists in the area of biological sciences education were applied to reach a consensus regarding valid and relevant questions. It was not feasible to obtain estimates of reliability, as the administration of the questionnaires on two occasions would probably have created resentment and hostility from the respondents leading to restored answers. "Aside from



practical limitations, retesting is not a theoretically desirable method of determining a reliability Coefficient" ( Isaac & Michael, 1971, p. 89).

Isaac and Michael (1971) define validity information as "the degree to which the test is capable of achieving certain aims." (p. 83). There are four different types of validity: 1) content validity which indicates how the test content defines what it claims to measure; 2) criterion related validity which compares the test with the criterion external variable. This type of validity is used for test prediction; 3) construct validity which evaluates the qualities of a test; and 4) face validity which "often is used to indicate whether the instrument, on the face of it, appears to measure what it claims to measure." (p. 82). The questionnaires were fully answered by the pilot sample which imply that the content and face validity were established for both of the instruments. The construct validity was supposed to be secured by assuming that the teachers participating answered the questions honestly and frankly. The criterion validity was not observed because this study was not planned to predict certain criterion variables.

### Data collection

The investigator conducted a phone survey to collect data related to the use of computers in biological sciences, physics, chemistry, math, English, reading, computer skills, business, and other subjects. The researcher surveyed 100 high schools in 50 districts.

Interviews and distribution of questionnaires took place in January and early February 1986 in the school of each participating teacher. The survey study included the following procedures:

1. The researcher/the interviewer introduced herself and explained the purpose and the procedure of the study.
2. The computer user questionnaire was administered to 15 biological sciences educators in 11 schools who are currently using computers. The non user questionnaire was confined to 24 teachers in 9 schools where computers have never been used to teach biological sciences.
3. Each meeting concluded with an interview of each participating teacher.

The survey process resulted in a total of 39 questionnaires and interviews. These interviews were recorded on audio tape cassettes for later analysis.

## Analysis of the Data

Data analysis included the following procedures:

1. The data collected from the 100 phone surveys, regarding the extent of computer use in teaching were analyzed. The results and findings are reported in chapter IV.
2. The taped interviews of the computer user sample biological sciences were transcribed into written form. The transcribed data along with the questionnaire results are presented in the finding of this study.
3. The taped interviews of the non user sample were reported in written form and will be presented, along with the interview questions in chapter IV.

### Format of the questionnaire

The computer user questionnaire consists of 15 items. The first 5 items deals with the computer practices related to biological sciences curriculum and the last 6 items focus on teacher's attitudes towards computer usage. The first question asks if computer software has been used in tutoring, drill and practice, demonstration, simulation games, and learning new skills to find out the different uses of computer in teaching biological sciences. The second item asks if

computation, data gathering, information processing, and model testing have been applied in the science programs to determine the computer applications in teaching biological sciences. The third item asks if new approaches to science, new in-service teacher models, redefinition of major goals in science, and new rationale and purpose relating to societal and technological problems have happened in the biological sciences curriculum as a result of using computers to assess and evaluate the changes caused by this usage. The fourth item is constructed to indicate the methods of teaching emphasized in the classroom. The fifth question asks if the biology curriculum at the school sample has changed a lot, a little, replaced by a new curriculum or stayed the same to determine the degree of change caused by the computer in the curriculum from the teacher's point of view.

Items 6, 7, and 8 ask about the teacher's attitudes towards the benefits of using computers in teaching biological sciences. Questions 9 and 10 are constructed to determine the teacher's attitudes towards the computer usage in helping students in learning and giving them positive feedback. Items 11, 12, 13, 14, and 15 are constructed to study the attitudes of biological

sciences towards the introduction of computers in teaching.

The computer non user questionnaire consists of 12 items. The first 5 items focus on the in-service computer training and the accessibility of the computer for teaching at the schools participated to find out if the biological sciences department at these schools are planning to encourage and introduce computers in the classroom. Item 6 deals with the relationship between the biological sciences programs and the new discoveries and technology by asking the participating teachers to rate their curriculum as up-to-date, good, out-dated or poor. Item 7 is constructed to find out the causes for lack of computer use in teaching biological sciences. Items 8, 9, 10, 11, and 12 focus on the teachers attitudes towards using computers in teaching and their perceptions about the effect of this device in improving student's achievement.

#### Summary

This chapter contains an overview which include a brief description of the various aspects of the procedure used in this study. This section summarizes and defines the instruments developed to collect the necessary data

and the nature of the sample and the setting selected for this study. The second section includes a restatement of the problem and describes the major purposes of the study which were to : 1) find out the extent of computer use in teaching biological sciences; 2) report the changes that have taken place in the curricular programs; and 3) study the attitudes of biology teachers towards this use. The third section contains the seven research questions which are generated to identify the research problem and guide the study. The fourth section defines the population and the sample used in collecting data. It describes the selection of the sample from the biological sciences teachers at public high schools in Los Angeles County and the procedure used in choosing it. The fifth section contains the instrumentation constructed for this study which consisted of a phone survey, the computer user questionnaire for the teachers who are using the computer in teaching biological sciences, the non user questionnaire for the biology teachers who are not using this device, and the structured teacher interview which has seven open-ended questions. The sixth section describes the pilot study and the procedures used to determine the validity and reliability of the instruments. The seventh section

includes the procedures used in collecting data for the study and a description of the format of the questionnaires. The last section contains the analysis of the data which result from the 100 phone surveys, the questionnaires, and the taped interviews.

## CHAPTER IV

### FINDINGS

This chapter includes seven sections which present the data and findings related to each of the seven study questions. A summary of the findings is presented at the end of the chapter. The findings are summarized in tabular form to enhance readers understanding and clarification of the data.

#### Research Question 1

To what extent has the computer been used in teaching biological sciences?

The purpose of this study question was to find out the extent and the integration of computer use in teaching at the participating schools. The findings of this research question were based on the phone survey to 100 secondary schools in Los Angeles County. The phone survey was conducted with a representative from the curriculum office at each school.



The phone survey includes the following questions:

1. Do you use computers in teaching?

If the answer was yes, the investigator asked the next question:

2. Please indicate in which subject matters do you use computers in teaching?

The participant who indicated the use of computers in biological sciences, physics, or chemistry were asked the following question:

3. Do you use computers on a regular basis or occasionally?

The last question asked the participants who have used the computers in biological sciences the next question:

4. In which areas has the computer been used in biological sciences?

Table 1 shows by frequency and percentage the extent of computer use teaching in 100 secondary schools.

Table 1  
School Use of the Computer in Teaching

---

Subject matter	Frequency/Percentage N = 100
Computer Skills	100
Math	62
Business	52
Physics	47
Chemistry	42
Biological Sciences	35
English	37
Reading	16
Journalism	6
Special Education	5
Bilingual Program	5
Industrial Educational Arts	4
Social Studies	4
Library Science	4

---

All of the schools that participated in this study have access to computers and use them in teaching one subject or another; however, the extent of use varies from school to school. Also, all of the schools reported that they offer courses which teach computer skills in the areas of word processing, programming, and computer languages such as Basic, Fortran, and Pascal. Most of the schools have used the computer to teach math (62 percent), business (52 percent), physics (47 percent), chemistry (42 percent), biological sciences (35 percent), English (37 percent), and reading (16 percent), but few schools utilized the computer to teach journalism (6 percent), special education (5 percent), bilingual programs (5 percent), industrial educational arts (4 percent), social studies (4 percent), and library science (4 percent). Although 35 percent of the school participants have indicated the computer usage in biological sciences, 47 percent in physics and 42 percent in chemistry, just some of these schools used this device on a regular basis in teaching these subjects (23 percent in biological sciences, 28 percent in physics, and 33 percent in chemistry).

Table 2 illustrates the frequencies and percentage of the schools which have used the computer regularly in biological sciences, physics, or chemistry.

Table 2  
Schools Regularly Using Computers in Science

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Subject matter	Frequency/Percentage N = 100
Biological sciences	23
Physics	28
Chemistry	33

---

Other schools have utilized computers in teaching science but less often due to lack of hardware and software (see Table 3).

Table 3  
Schools Occasionally Using Computers in Science

---

Subject matter	Frequency/Percentage N = 100
Biological sciences	12
Physics	14
Chemistry	14

---

35 participating schools indicated the use of computer software in certain areas of biological sciences such as: physiology, genetics, ecology, animal anatomy, general biology, marine biology, plant anatomy, and nutrition analysis.

Table 4  
Use of the Computers in Biological Sciences

Biological sciences areas	Frequency N = 35	Percentage
Physiology	11	31.42
Genetics	8	22.85
Ecology	5	14.28
Animal Anatomy	4	11.42
General biology	4	11.42
Marine biology	1	2.85
Plant anatomy	1	2.85
Nutrition analysis	1	2.85

In addition, an interview was made with 39 biological sciences teachers in 19 different schools to seek more information about the use of computer in teaching this subject. This sample included 15 teachers from 11 public

schools who are currently using computers in teaching biological sciences and 24 teachers from 10 other public high schools who are not yet using computers in teaching this subject.

When the 15 biological sciences teachers who are presently using the computer in teaching asked if they write their own software, just 3 teachers interviewed indicated that they prepare their own software. The other 12 teachers reported that they don't have the skills and the time to write programs in the biological subjects. In addition, the majority of the teachers interviewed believe that computer simulations offered in biology are simple and uncreative, and most of the software available is more descriptive and less qualitative. In this regard, some teachers interviewed pointed out that they have computer software in biological sciences, some of them have been effective, and others have not. They tried to develop their own software at the school, but with only moderate success. Most of biological sciences teachers participated indicated that they need more computer hardware and software.

Some biological sciences teachers reported that they understand what the computer can do; however, they do not feel comfortable in presenting to the classroom due to lack of time and/or skills. One science chairman indicated that biological sciences is currently the hardest subject to teach in schools because it is academically difficult with a lot of preparation, equipment monitoring, and laboratory work.

The majority of the teacher interviewed believe that math is much easier to teach with computers because hundreds of software programs have been written in this subject. They also indicated that computers are easier to use in physics and chemistry because these subjects are more computer oriented than biological sciences that deal with living things rather than symbols and numbers. Thus, it is much harder to write software in biology than math or physical science. In addition, they indicated that they do not have the time nor expertise and skills to write adequate programs even though most teachers criticized commercial software as being unsatisfactory. One teacher interviewed felt that the software in biological sciences is not good enough in terms of simulation, but in terms of tutorial and computer assisted instruction (CAI). The computer can be a method

of communicating what is in the textbook or the teacher mind to the students.

The findings from this survey study shows that not all teachers have used computers in teaching biological sciences at the same school. As one science chairman indicated that there are not enough computers to satisfy everybody, and some teachers do not have a strong biology background nor interest in computers. Most participating teachers complained that an inadequate amount of computers were available due to lack of money.

#### Summary of Research Question 1

All of the 100 secondary schools that participated in this study indicated that they have used computers in teaching one subject or another. All of them reported that they teach computer skills which include programming, word processing, and computer languages. 62 percent of the schools have used computers in math, 52 percent in business, 47 percent in physics, 42 percent in chemistry, 35 percent in biological sciences, 37 percent in English, 16 percent in reading, 6 percent in journalism, 5 percent in special education, 5 percent in bilingual program, and 4 percent in industrial educational arts, social studies, and library science.

Most the teachers who participated in this study



commented that they like and encourage the use of computers in teaching biological sciences, but the majority complained that they are not enough computers accessible, and expressed dissatisfaction with the available commercial software as not being creative and stimulating for science education. In addition, science teachers indicated that better software and good computer in-service training will enhance the use of computers in the classroom.

## Research Question 2

What is the actual practice versus the desirable practice related to curriculum as a result of computer use in teaching biological sciences?

This research question was intended to find out the different applications and uses of computer in teaching biological sciences and the changes that happened in the biology curriculum as a result of using this device in the classroom.

The findings of this section are based on the first part of the computer user questionnaire which includes 5 questions. The first 4 items have 2 sections : 1) the actual practice which has 4 answers ( yes, partially, no, and don't know); and 2) the desirable practice which has 4 different answers ( essential, desirable, questionable, and undesirable). Each participating teacher has been asked to answer each item in this section for actual and desirable practice by circling one of the answers. The fifth item asks the participants to circle one of the related answers. The items are the following:

1. Computer software has been used in our biological sciences program for:

- a. Tutoring
- b. Drill and practice
- c. Demonstration
- d. Simulation games

- e. Learning new skills
- f. Other; please identify

2. Computers have many applications in our biological sciences curriculum, such as:

- a. Computation
- b. Data gathering
- c. Information processing
- d. Model testing
- e. Other; please identify

3. Computers have encouraged changes in our curriculum, such as:

- a. New approaches to science
- b. New in-service teacher models
- c. Redefinition of major goals in science
- d. New rationale and purpose relating to societal and technological problems
- e. Other; please identify

4. The following methods of teaching are emphasized in our classrooms:

- a. Textbooks
- b. Laboratory methods
- c. Computer programmed instruction
- d. Other; please identify

5. Has the biological sciences curriculum changed?

- a. Has changed a lot
- b. Has been replaced by a new curriculum
- c. Has changed a little
- d. Has stayed the same
- e. Other; please identify

Fifteen biological sciences teachers from 10 different secondary schools have answered this questionnaire which was handed in person. In addition, an interview was conducted by the investigator with each participant.

Table 5

Question 1: Computer software has been used in our biological sciences program for:

- a. Tutoring
- b. Drill and practice
- c. Demonstration
- d. Simulation games
- e. Learning new skills
- f. Other; please identify

---

Actual Practice

	a	b	c	d	e	f
Yes	5	4	9	5	3	0
Partially	4	4	6	4	5	0
No	6	7	0	6	6	0
Don't know	0	0	0	0	1	0

Desirable Practice

Essential	4	3	7	4	4	0
Desirable	9	8	8	7	8	0
Question-able	1	2	0	3	2	0
Undesir-able	1	2	0	1	1	0

---

Question 1 asks if computer software has been used in the biological sciences program for tutoring, drill and practice, demonstration, simulation games, learning new skills, and other teaching purposes. All respondents use the computer for demonstration, 7 for drill and practice, 9 for simulation games, and 8 for learning new skills. Table 5 summarizes the teachers' responses to this question.

#### Majority Teacher Opinions

The majority of teachers indicated that they are using computer software for demonstration and believe it to be essential and desirable. It is important to notice here that some teachers reported the use of computers for drill and practice, other teachers interviewed indicated that they would rather use the computer for higher levels in teaching and more creative ways.

Question 2 asks if the computer has been used in the biological sciences curriculum for computation, data gathering, information processing, model testing, and other applications. Table 6 shows that most of the respondents have used computers more for data gathering and information processing, and less for computation and model testing. The majority reported that the practices mentioned above are considered essential and desirable.

Table 6

Question 2: Computers have applications in our biological sciences curriculum, such as:

- a. Computation
- b. Data gathering
- c. Information processing
- d. Model testing
- e. Other; please identify

Actual Practice

	a	b	c	d	e
Yes	3	4	4	2	0
Partially	6	7	7	3	0
No	6	4	4	8	0
Don't know	0	0	0	2	0

Desirable Practice

Essential	4	6	7	4	0
Desirable	11	8	8	9	0
Questionable	0	1	0	1	0
Undesirable	0	0	0	0	0

### Majority Teacher Opinions

Most of the teachers indicated the use of computers for data gathering, and information processing. For actual practice, 6 reported that they have used partially the computer for computation, 7 for data gathering, and 7 for information processing. For desirable practice, just one teacher reported that using computer for data gathering is questionable and the rest of the participants described all the above practices either as desirable (11, computation; 8, data gathering; and 8, information processing ) or essential (4, computation; 6, data gathering; and 7 information processing ). For model testing, just 5 teachers indicated that they have used computers for actual practice (2 answered yes, and 3 partially). for desirable practice, the majority reported that this practice is essential and desirable (4 teachers answered essential and 9 desirable). Most of the teachers interviewed commented that using computers for model testing in teaching needs more time and skills than computation, data gathering, or information processing.

Table 7

Question 3: Computers have encouraged changes in our curriculum, such as:

- a. New approaches to science
- b. New in-service teacher models
- c. Redefinition of major goals in science
- d. New rationale and purpose relating to societal and technological problems
- e. Other; please identify.

---

Actual Practice

	a	b	c	d	e
Yes	4	6	1	2	0
Partially	4	3	2	3	0
No	7	6	11	9	0
Don't know	0	0	1	1	0

Desirable Practice

Essential	7	4	3	4	0
Desirable	4	8	3	5	0
Questionable	4	3	6	5	0
Undesirable	0	0	3	1	0

---

Question 3 is concerned with the changes introduced in the biological sciences curriculum as a result of computer use. Table 7 shows that we have 8 favorable



responses in column a, new approaches to science; 7 in column b, new in-service teacher model; 2 in the column c, redefinition of the major goals of science; and 5 in column d, new rationale and purpose relating to societal and technological problems. Most of the respondents indicated that changes such as redefinition of the major goals of science and a new rationale to relate science to societal and technological problems are questionable and undesirable.

#### Majority Teacher Opinions

For actual practice, the majority indicated that computers have encouraged changes in the curriculum by introducing new approaches to science and new in-service teacher models. However, most reported that it has not been a redefinition of major goals in science or new rationale and purpose relating to societal and technological problems as a result of computer usage. For desirable practice, most teachers believe that new approaches to science, new in-service teacher models, and new rationale and purpose relating to societal problems are essential or desirable, but the majority reported that a redefinition of major goals in science as a result of using computers in teaching is questionable and undesirable.

The fourth item in this questionnaire concerns itself with the teaching methods emphasized in the participating classrooms. All of the respondents indicated textbooks and laboratory methods; and 7, the computer (see Table 8). Almost all of the teachers indicated that the computer can not replace textbooks or other instructional strategies used in the classroom. Most of the participating teachers that the computer is just a good supplement device in teaching because of the teacher's lack of familiarity with the computerized system and the quality of the software available. The textbook is still very important for the majority of teachers. They indicated that students should learn reading, writing, analysis and synthesis skills through the textbook. Most believe that the computer is an additional tool, one of the most powerful, but it can not replace the textbook nor the teacher because students need direction and supervision. One of the participating teacher interviewed commented that the computer can help individualize work for gifted students, but individualization for average high school students is not practical unless there is a spectacular software program.

Table 8

Question 4: The following methods of teaching are emphasized in your classroom

- a. Textbooks
- b. Laboratory methods
- c. Computer programmed instruction
- d. Other; please identify

---

Actual Practice

	a	b	c	d
Yes	9	11	2	2
Partially	6	4	5	0
No	0	0	8	0
Don't know	0	0	0	0

Desirable Practice

Essential	11	13	2	2
Desirable	4	2	11	0
Questionable	0	0	2	0
Undesirable	0	0	0	0

---

### Majority Teacher Opinions

For actual practice, laboratory methods and textbooks are the most emphasized methods of teaching in biological sciences by the respondents. Eight teachers mentioned that the computer programmed instruction is not stressed in the classroom because of lack of computer hardware, skills, and expertise. For desirable practice, just 2 respondents indicated that the use of computers in teaching is questionable. The others reported that all the methods of teaching mentioned above are essential or desirable.

One of the teachers interviewed reported that he is still basically a lecture type teacher who uses lab activities to supplement the lecture. This shows that textbooks in teaching still the major instructional device in the classroom. Previously in chapter II, the review of literature has shown also that the lecture type lesson is more popular than any other teaching method in the classroom.

Table 9

Question 5: Has the biological sciences curriculum changed?

---

Responses

a. Has changed a lot	2
b. Has been replaced by a new curriculum	0
c. Has stayed the same	7
d. Other; please identify	6

---

The fifth item in this questionnaire is about the effects of computer use on biological sciences curricula. 7 respondents indicated that the curriculum has stayed the same, 6 reported that the curriculum has changed a little, just 2 mentioned that the curriculum has changed a lot as a result of using computers. No one of the interviewees indicated that the curriculum has been replaced by a new one since the introduction of computers (see Table 9).

### Majority Teacher Opinions

The majority of participating teachers indicated that the biological sciences curriculum has stayed the same or changed little as a result of using computers in teaching. Although in a previous question ( item 3 ), the majority of the teacher participants indicated that using computers in teaching science has encouraged changes in the curriculum such as new approaches to science, here in answering this question most of the teachers reported that the science curriculum has changed a little or stayed the same as a result of this use. It seems that most of the respondents believe that the introduction of computers in teaching biological sciences has not caused major changes in the curricula.

### Summary of Research Question 2

The purpose of this research question was to determine the influence and changes the computer has had on biological sciences curricula. It was found that computer software has been used mostly for demonstration. All the respondents believed that using the computer for demonstration is an essential and desirable practice. Some have used the computer for drill and practice, but most of the teachers interviewed thought that computers should be used for higher levels of thinking, to learn

new skills and solve problems. The majority of interviewees complained of the lack of good software in biological sciences. They also indicated that most of the available commercial software is for drill and practice which deals with low levels of cognitive thinking. Most of the participants expressed that they do not have the time nor the necessary skills to write their own programs.

Using computers in teaching biological sciences has introduced new approaches to science and in-service teacher models in some of the participating schools, but few mentioned a redefinition of the major goals of sciences in their programs. No one indicated that the biological sciences curriculum has been replaced by a new one, and most of the teachers stated that their curriculum has stayed the same or changed a little.

### Research Question 3

What is the attitude of teachers who are presently using the computer in teaching biological sciences towards this device?

This research question was intended to determine the teacher's attitude towards the computer as a teaching aid in the classroom, and find out the extent to which the

participating teacher strongly agree, disagree, or strongly disagree with the addition of the computer in teaching biology. To answer this research study, the second part of the computer user questionnaire was constructed. It consists of the following 10 items :

6. Biology content can be taught better with a computerized system rather than a textbook.
7. Addition of the computer in teaching biology, provide more accurate and updated information.
8. The computer has many benefits in teaching biological sciences.
9. The computer is used to give positive feedback to students.
10. Using computers helps students think scientifically and understand new technology.
11. The addition of the computer in teaching decreases our work load in the classroom.
12. I like using the computer in teaching science.
13. I would like to learn more about computers and their applications in teaching.
14. The computer is my favorite teaching device.
15. Computer technology is an integral part of biological sciences education.



In addition, interviews were conducted with the participants.

Question 6 asks if the biology content can be taught better with a computerized system rather than a textbook. 12 respondents disagree, 2 strongly disagree, and only one strongly agrees and supports this concept. It seems that the participants still believe that the textbook is very important in teaching and is the best way to teaching biology content. The teachers' opinions are shown in Table 10.

Table 10

Question 6: Biology content can be taught better with a computerized system rather than a textbook.

---

Responses

Strongly agree	1
Agree	0
Disagree	12
Strongly disagree	2

Majority Teacher Opinions

Only one of the participating teachers indicated that a computerized system is the best way to teach biological sciences.

---

Question 7 asks if the addition of the computer in teaching biological sciences provides accurate and updated information: 2 strongly agree, 5 agree, 6 disagree, and 2 strongly disagree with this concept. Table 11 represents the responses for this question.

Table 11

Question 7: Addition of the computer in teaching biological sciences provides more accurate and updated information.

---

Responses

Strongly agree	2
Agree	5
Disagree	6
Strongly disagree	2

Majority Teacher Opinions

Almost half of the participating teachers indicated that the addition of computers both improves and updates the biological sciences program.

---

In question 8 the biological sciences teachers were asked if they believed that the computer has many benefits in teaching. All but one agree or strongly agrees with this concept (see Table 12).

Table 12

Question 8: The computer has many benefits in teaching biological sciences.

---

Responses

Strongly agree	6
Agree	8
Disagree	1
Strongly disagree	0

Majority Teacher Opinions

Most of the respondents believe that the computer has many benefits for teaching.

---

Question 9 asks if the computer is used by the participants to give positive feedback to students. The responses were positive: 13 strongly agree, and 2 agree with this concept. No one selected disagree or strongly disagree (see Table 13).

Table 13

Question 9: The computer is used to give positive feedback to students.

---

Responses

Strongly agree	13
Agree	2
Disagree	0
Strongly disagree	0

Majority Teacher Opinions

The majority of teachers believe that the computer gives positive feedback to students.

---

Question 10 asks if use of the computer helps students understand new technology: 4 strongly agree , 11 agree, and only 1 disagrees. This indicate that teachers believe that computers can enhance scientific thinking of student and help introduce new technology in the classroom in a meaningful and attractive way. Results are presented in Table 14.

Table 14

Question 10: Using computers helps students think scientifically and understand new technology.

---

Responses

Strongly agree	4
Agree	11
Disagree	1
Strongly disagree	0

Majority Teacher Opinions

The majority indicated that the computer helps students think scientifically and understand new technology.

---

Question 11 asks if addition of the computer will decrease teacher work load in the classroom. The majority believe that the computer will increase their work load because they will need more time to become familiar with the software available and then teach the students how to use it. On the other hand, 4 respondents indicate that the computer has definitely decreased their work in the classroom, especially in practice and drill. Teachers do not have to devote their time to review of the same material. Table 15 illustrates these findings.

Table 15

Question 11: The addition of the computer in teaching would decrease your work load in the classroom.

---

Responses

Strongly agree	1
Agree	3
Disagree	6
Strongly disagree	5

Majority Teacher Opinions

Most of the science teachers indicated that using the computer in teaching would decrease their work load.

Question 12 asks if the teachers like using computers: 7 strongly agree, 8 agree, and none disagree or strongly disagree. This indicates that teachers accept the introduction of computer in teaching biological sciences (see Table 16).

Table 16

Question 12: I like using the computer in teaching science.

---

Responses

Strongly agree	7
Agree	8
Disagree	0
Strongly disagree	0

Majority Teacher Opinions

All science teachers indicated that they like to use computers in teaching.

---

Question 13 asks if the teachers/participants would like to learn more about the computer and its applications in teaching. Here again, there is a willingness from all the interviewees to learn more about this tool and its applications in teaching: 6 strongly agree and 9 disagree. This indicates that teachers would like to see and experience new and interactive ways of using computers in biological sciences (see Table 17).

Table 17

Question 13: I would like to learn more about computers, and its applications in teaching.

---

Responses

Strongly agree	6
Agree	9
disagree	0
Strongly disagree	0

Majority Teacher Opinions

All of the respondents indicated that they like to learn more about computer applications in teaching.



Question 14 asks if the computer is the teacher's favorite teaching device in the classroom: 1 strongly agrees, 2 agree, 11 disagree, and 1 strongly disagrees. The majority rejected this concept. This indicates that teachers using the computer are still unfamiliar with all the capabilities of this novel teaching device. Most of the teachers interviewed thought that the computer is useful to some extent in teaching, but it can not replace the textbook, at least for the time being (see Table 18).

Table 18

Question 14: The computer is my favorite teaching device.

---

Responses

Strongly agree	1
Agree	2
Disagree	11
Strongly disagree	1

Majority Teacher Opinions

Most biological sciences teachers indicated that the computer is not their favorite teaching device.

---

Question 15 asks if computer technology is an integral part of biological sciences education: 9 strongly agree and 6 agree (see Table 19). It is interesting to note that although interviewees insisted that computer technology plays an important role in biological sciences education, most of the teachers reported that the computer is not their favorite device.

Table 19

Question 15: Computer technology is an integral part of biological sciences education.

---

Responses

Strongly agree	9
Agree	6
Disagree	0
Strongly disagree	0

Majority Teacher Opinions

All of the respondents believe that computer technology is an integral part of biological sciences education.

### Summary of Research Question 3

The majority of the respondents indicated that they like using the computer and learning more about it. They believe that it has many benefits in teaching biological sciences and that computer technology is an integral part of science education in general. They indicated that computers give positive feedback to students and helps them think more scientifically and understand new technology. Interestingly, the majority also reported that the computer is not their favorite teaching device in the classroom. The textbook is still the principal teaching tool.

Most interviewees rejected the concept that biology content can be taught better with a computer than a textbook. Most considered the computer a supplement to the textbook which is their first source of information in teaching. In addition, most believe that using computers will increase their work load in the classroom.

#### Research Question 4

What is the actual practice versus the desirable practice related to introduction of the computer to teach biological sciences at schools which have not yet used this device?

The purpose of this research study was to find out if the biological science department at the schools visited have established specific objectives for encouraging computers usage, and determine the reasons for lack of this use at these schools. The first part of the questionnaire for the teachers who did not use computers in teaching biological sciences was constructed to answer this research question. This part includes seven questions. The first 5 items ask the participants to answer each item in this section for actual and desirable practice by circling one of the answers. The sixth and seventh questions ask the participants to circle one of the related answers. The items are the following:

1. The biological sciences division has established specific objectives for encouraging computers usage.
2. Computers are available for teaching.
3. The biological sciences department is in the

process of introducing computers to the classroom.

4. In-service computer training is provided for science teachers.
5. Our biological sciences curriculum has implemented innovations to meet the demands of new technology.
6. How do you rate the biological sciences curriculum at your school as related to new discoveries and technology?
  - a. Up-to-date
  - b. Good
  - c. Out-dated
  - d. Poor
  - e. Other; please identify.
7. Why doesn't your school use computers in teaching biological sciences?
  - a. Lack of funds
  - b. Lack of training
  - c. Lack of expertise
  - d. Lack of interest
  - e. Other; please identify.

Question 1 asks if the biological sciences division has established specific objectives for encouraging computer usage: 1 answered yes, 4 partially, 17 no, and 2 don't know for actual practices (see Table 20). This indicates that at least at the present time this school sample was not being encouraging the computer use in teaching biology in the near future. On the other hand,

the answers obtained for desirable practices are: 2 essential, 20 desirable, and 3 questionable. these show that teachers support this concept and believe that action should be taken to integrate computers in teaching.

Table 20

Question 1: The biological sciences division has established specific objectives for encouraging computers usage.

---

Actual Practice

Yes	1
Partially	4
No	17
Don't know	2

Desirable Practice

Essential	2
Desirable	20
Questionable	2
Undesirable	0

Majority Teacher Opinions

The majority of the respondents indicated that their school has not established specific objectives for encouraging use of the computer in teaching biological sciences.

---

Question 2 asks if computers are available for teaching. All but one respondent indicated that they have access to computers in their schools, and most commented that they lack knowledge in using computers and time to learn about using this device in the classroom (see Table 21).

Table 21

Question 2: Computers are available for teaching.

---

Actual Practice

Yes	14
Partially	9
No	0
Don't know	1

Desirable Practice

Essential	8
Desirable	14
Questionable	2
Undesirable	0

Majority Teacher Opinions

The majority of teachers indicated that computers are available for teaching.



Question 3 asks if the biological sciences department of the participant is in the process of introducing computers to the classroom: 4 answered yes, 6 partially, 13 no, and 1 don't know (see Table 22). This shows that some schools are going to use computers while others are not, at least for the time being, due mostly to financial reasons.

Table 22

Question 3: The biological sciences department at your school is in the process of introducing computers to the classroom.

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Actual Practice

Yes	4
Partially	6
No	13
Don't know	1

Desirable Practice

Essential	5
Desirable	15
Questionable	3
Undesirable	1

### Majority Teacher Opinions

Most of the respondents indicated that there is no intention of science departments to introduce computers in the classroom.

Question 4 asks if in-service computer training is provided for science teachers. For actual practice 5, respondents answered no; 2, don't know; 10, yes; and 7, partially. For desirable practice, 11 answered essential; 11, desirable; and 2, questionable (see Table 23).

Table 23

Question 4: In-service computer training is provided for science teachers.

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#### Actual Practice

Yes	10
Partially	7
No	5
Don't know	2

#### Desirable Practice

Essential	11
Desirable	11
Questionable	2
Undesirable	0
	107

Majority Teacher Opinions

The majority indicated that in-service training for computer use is provided for them.

Question 5 asks if innovations have been implemented in the biological sciences curriculum to meet the demands of new technology. The answers are 1 yes, 9 partially, 11 no, and 3 don't know. This indicates that, in most cases few schools have introduced innovations in the biological sciences curriculum (see Table 24).

Table 24

Question 5: Our biological sciences curriculum has implemented innovations to meet the demands of new technology.

---

Actual Practice

Yes	1
Partially	9
No	11
Don't know	3

Desirable Practice

Essential	7
Desirable	13
Questionable	4
Undesirable	0
	108

### Majority Teacher Opinions

Most of the respondents indicated that no innovations have been implemented in their curriculum as an actual practice even though innovations are a desirable and essential practice.

Question 6 asks the participants to rate the biological sciences curriculum at their school as related to new discoveries and technology. The majority described the curriculum as good, some as out-dated, and only few teachers indicated that they have an up-to-date curriculum (see Table 25).

Table 25

Question 6: How do you rate the biological sciences curriculum at your school as related to new discoveries and technology.

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a. Up-to-date	4
b. Good	14
c. Out-dated	6
d. Poor	0
e. Other; please identify	0

### Majority Teacher Opinions

Although all the respondents have not yet used computers in teaching biological sciences, the majority indicated that the curriculum is good. Other responses were divided between out-dated and up-to-date curriculum.

Question 7 was concerned with the causes related to lack of computer use in biological sciences. The responses are: 9 for lack of funds, 6 for lack of training, and 6 for lack of interest (see Table 26). Some of the interviewees believe that lack of computer usage is caused not only by lack of money but also because teachers have other priorities in teaching, like laboratory work.

Table 26

Question 7: Why doesn't your school use computers in teaching biological sciences.

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a. Lack of funds	13
b. Lack of training	3
c. Lack of expertise	2
d. Lack of interest	6
e. Other; please specify.	0

### Majority Teacher Opinions

Lack of funds and lack of interest were the main reasons given for lack of computer uses.

### Summary of Research Question 4

Most of this school sample has computers and in-service computer training available for teaching, but the majority of these schools have not established goals or specific objectives to use computers in teaching biological sciences.

The participating teachers in this study, who are not currently using the computer in biological sciences, indicated that lack of hardware, time, money, training, and interest are the eminent reasons for lack of use of this tool. Some believe that lack of good software is part of the problem. One science chairman during the interview, indicated that students who use the computer become dependent on this device for learning. Another science chairman said that the science faculty does not use the computer, even though the software and the hardware are available, because there is no interest at the time being. She added that there is always a danger that the science teacher can become too involved with

this tool and less interested in science material itself. In this case, the computer becomes more fascinating than the subject of science. Most reported that lack of time prevents the use of the computer in the classroom.

#### Research Question 5

What is the attitude of teachers who are not using the computer in teaching biological sciences towards this device?

To answer this research study question, the second part of the non user questionnaire, which includes 5 questions, was constructed to determine the teacher's attitude who is not presently using the computer in teaching biology towards the use of this device in the classroom and its effects and applications in instruction. In this regard, the participants were asked to indicate the extent to which they agree or disagree with the following statements:

8. Computer use in teaching biological sciences should be encouraged.
9. I would like to use computers in teaching.
10. I don't really see how using computers in the classroom will improve student's achievements.

11. I could ever learn to accept the introduction of teaching machine in the classroom.
12. I frequently have to deal with more discipline problems when we are having a process type lesson than when we are having a textbook type lesson.

Question 8 asks if computer use in teaching biological sciences should be encouraged: 14 strongly agree, 7 agree, and 3 disagree. The answers show that the majority of teachers believe that computer use should be encouraged in teaching (see Table 27).

Table 27

Question 8: Computer use in teaching biological sciences should be encouraged.

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Responses

Strongly Agree	14
Agree	7
Disagree	3
Strongly Disagree	0

Majority Teacher Opinions

The majority indicated that the computer should be encouraged in teaching biological sciences.



Question 9 asks if the participants would like to use computers. Even though they are not using computers in teaching in the time being, most reported they would like to. In response to this question, we have 11 who strongly agree, 10 who agree, and just 3 who disagree (see Table 28).

Table 28

Question 9: I would like to use computers in teaching.

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Responses

Strongly Agree	11
Agree	10
Disagree	3
Strongly Agree	0

Majority Teacher Opinions

The majority indicated that they like to use computers in teaching.

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Question 10 asks if computer use in the classroom will improve student achievements. Most respondents agree with this concept. Only 2 teachers disagreed, and thought that the computer would distract students' attention (see Table 29).

Table 29

Question 10: I don't really see how using computers in the classroom will improve student's achievements.

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Responses

Strongly Agree	0
Agree	2
Disagree	14
Strongly Disagree	8

Majority Teacher Opinions

The majority believe that computers help improve student achievement.

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Question 11 was concerned with the introduction of teaching machines to the classroom. All but one indicated that they will accept computers and other teaching devices in the classroom and believe that they can enhance students' understanding (see Table 30).

Table 30

Question 11: I could ever learn to accept the introduction of teaching machines in the classroom.

---

Responses

Strongly Agree	0
Agree	1
Disagree	10
Strongly Disagree	13

Majority Teacher Opinions

The majority indicated that they accept the introduction of teaching machines in the classroom.

---

Question 12 asks the participants if they have more discipline problems when they have a process type lesson than a textbook type lesson. The majority of the interviewees reported that hands-on experiences or process type lessons do not cause discipline problems for them in the classroom (see Table 31).

Table 31

Question 12: I frequently have to deal with more discipline problems when we are having a process type lesson than when we are having a textbook type lesson.

---

Responses

Strongly Agree	0
Agree	3
Disagree	16
Strongly disagree	5

Majority Teacher Opinions

The majority indicated that they did not have to deal with more discipline problems than usual in a process type lesson.

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#### Summary of Research Question 5

It was found that teacher attitude was mostly positive towards the concept of using computers in the classroom. The majority of the respondents like using computers and indicated that its use in teaching biological sciences should be encouraged. They are willing to accept the computer in the classroom and try it in teaching, and believe that it can improve student achievement.

### Research Question 6

what influence does use of the computer have on student achievement and attitude from the teacher's perception?

During the interviews conducted with teachers who are presently using computers in teaching biological sciences, the interviewer (the researcher herself) asked them their opinions concerning student achievement and attitude as a result of using the computer in the classroom.

The majority of interviewees believe that the computer has a positive influence on student attitude and achievement, and helps them learn about and understand computer technology. Most indicated that their students like computers and learn by its use. They believe that the computer is going to increase student achievement and helps to communicate a model in teaching, while the other methods of teaching like demonstration and formal lecture, fail in this regard.

Most teachers reported that students are open to computers and not inhibited by them at all. One of the science chairpersons indicated during an interview that the interest that the students show, probably stimulates them to study, read a little more, and gain some factual

information. He added that the computer's use in teaching can reflect on students' overall performance and gives them immediate feedback. Some participating teachers believe that drawing on the board is very static, but visualization offered by the computer can motivate students to learn. One teacher mentioned that it is too early to tell the impact of computers on student achievement, however, it is certain that some students are so excited by this device that they become interested in school. She added that using computers in demonstration, simulation, and drill helps increase the student understanding.

Another teacher indicated that students like computers, but he did not notice any increase in achievement because few computers are available to give students the opportunity to use them.

#### Summary of Research Question 6

It was found that the majority of teachers believe that students enjoy using the computer. It is a change of pace and allows the student to review questions he is asked to contemplate. Most indicated that both student achievement and interest levels in learning biological sciences have increased, and their vocabulary and understanding are better after using the computer.

### Research Question 7

What are the advantages and disadvantages of using the computer in teaching biological sciences from the teacher's perception?

The computer's advantages and disadvantages in teaching was one of the subjects discussed during the interview with the teacher sample that has have used the computer.

#### Advantages of the computer in Teaching

Most of the interviewees indicated many advantages of the computer and reported that it has wide applications in data collection, simulation, direct practice, make-up work, and cognitive development. Teachers believe that the computer helps the student progress at his/her own rate, with a clearer understanding. It is very useful in individualized learning, feedback, and remediation. One teacher interviewed reported that in the near future, all schools and every department will be using computers.

Most of the interviewees described the computer as a clinical assistant for teachers and students. The computer allows number punching and graphing which are especially helpful in the laboratory. As one participating teacher indicated, the use of computers



in biology will force the biology teacher to be more quantitative in the laboratory work.

The computer can enhance teaching and reduce some of the teaching load (mostly bureaucratic) as the majority of teachers indicated. They believe that it is another way to present a modern, technological concept and helps prepare students in this competitive world which is now based on computer knowledge and applications.

The computer can be an enriching device in the classroom. One of the interviewee indicated that the computer can do the actual lab work without the problem of missing equipment and allows students to participate in up-to the minute technology, especially if they are interested in research.

#### Disadvantages of the Computer in Teaching

Most of the interviewees complained of too few computers and not enough software. Some of the them pointed out that the computer can be a burden for over-worked teachers. Others were not satisfied with the ways the computer has been used. They indicated that it should be used in higher levels of teaching. One teacher interviewed commented that that the proper use of computers in science is a laboratory tool. Drill and

practice, and computer assisted instruction are not as high a priority.

Another teacher felt the opposite way, that the computer should not be used in laboratory work because it takes away from hands-on experience. He indicated that that actual labs should be done by students. Lab computer simulations do not give students a proper understanding of actual work in the lab area.

A few others thought that the computer causes loss of personal contact and changes teaching style. Most indicated only advantages of computers and wished to have more computers and appropriate software. One teacher reported in this regard that there is nothing but advantages when it comes to students and their being able to learn. They would be really self-motivated by the computer.

#### Summary of Research Question 7

The participants indicated many advantages of the computer in teaching biological sciences. They have used it most in demonstration, laboratory simulations, data compilation and information processing. Also, they believe that the computer helps students understand the importance of educational technology in teaching.

Some teachers criticized the ways the computer has been used in teaching. They suggested that it should not be used for drill and practice, but for more stimulating practices like simulations and new concepts. Almost all teachers asked for more computers and better software quality to satisfy their students' needs in the classroom.

### Summary of Findings

The following paragraphs contain the principal study findings:

#### The Extent of Using Computers in Teaching Biological Sciences

The survey study shows that the computer has been used more often in teaching computer skills, math, business, English, physics, chemistry, and less in the biological sciences (Table 1). It was found that only in some schools do teachers use computers regularly in biological sciences (Table 2), and in some others they use it occasionally (Table 3). Most of the teachers interviewed complained of lack of hardware and good software in biological sciences. Some indicated that it was hard to write their own software due to their lack of expertise in programming.

The Actual Practice Versus the Desirable Practice Related to Curriculum as a Result of the Computer Use in Teaching Biological Sciences

The teacher sample reported that the computer has been used for demonstration, information processing, tutoring, drill, and practice in the classroom (Table 5 ) and (Table 6). Most indicated that computers should be used for more advanced thought processes, to learn new skills and solve problems. New approaches in science and in-service teacher training have been introduced in the curriculum as a result of using the computer, but the majority reported that the computer has not caused a redefinition of the major goals of science (Table 7). The findings indicate that the curriculum has stayed the same or changed a little as a result of using computers in biological sciences (Table 9).

The Attitude of Teachers Who Are Currently Using the Computer in Teaching Biological Sciences Towards this Device

It was found that the majority of the teacher sample believed that biology content can best be taught with a textbook rather than a computerized system (Table 10). On the other hand, teachers reported that the computer

has many benefits in teaching biological sciences (Table 12). It can be used to give positive feedback to students (Table 13) and help them to think scientifically and understand new technology (Table 14).

The majority thought that the work load in the classroom increased after the addition of the computer (Table 15), but all indicated that they like using the computer (Table 16) and learn more about its applications when teaching (Table 17). Most reported that the computer is not their favorite teaching instrument (Table 18), even though they all believe that computer technology is an integral part of biological sciences education (Table 19).

The Actual Practice Versus the Desirable  
Practice of Introducing the Computer in Teaching  
Biological Sciences at Schools Not Presently  
Using This Device

It was found that most of the biological sciences departments in the school sample have not yet established specific objectives for encouraging computer usage (Table 20). Even though the majority of these schools have computers available for teaching (Table 21), they are not yet in the process of introducing computers to the classrooms (Table 22).

In-service computer training is provided for science teachers in most of the school sample (Table 23). However, over half of the teachers reported that their biological sciences curriculum has not yet implemented innovations to meet the demands of new technology (Table 24). The majority indicated that lack of funds is the major cause of the lack of computer use in teaching biological sciences (Table 26).

The Attitude of Teachers Who Are not  
Presently Using the Computer in Teaching  
Biological Sciences Towards this Device

The majority of teachers believed that use of the computer in teaching biological sciences should be encouraged (Table 27) and reported they would like to use computers (Table 28). Most have positive attitudes towards the computer and feel that using this tool in the classroom will improve student achievement (Table 29).

It was found that the introduction of teaching machines in the classroom is welcome by almost all the teachers in the sample (Table 30). The majority indicated that they do not have to deal with discipline problems when they are having a process type lesson (Table 31).

What Influence Does Use of the Computer Have  
on Student Achievement and Attitude  
From the Teacher's Perception

Findings from the interviews with teachers who are using computers in teaching indicate that the computer has a positive influence on student attitude and achievement. The teachers reported that the computer stimulates learning and increases student understanding and interest in the material studied.

Advantages and Disadvantages of Using  
Computers in Teaching Biological Sciences  
From the Teacher's Perception

Most of the teachers who are using computers reported a lot of advantages of this device in teaching biological sciences. They indicated many applications in which the computer could be used, including individualized learning, feedback, and remediation. They described the computer as a clinical assistant for teachers and students and an effective tool to prepare students for the competitive world.

At the same time, most teachers complained of a lack of computer hardware and software to cover all the subjects. Some criticized the use of the computer in

drill and practice and suggested that it should be used for more stimulating practices.



## CHAPTER V

### SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

#### Summary

For many years there has been a rapid decline in science education programs at the secondary school, especially in the biological sciences. Many studies show that science courses are not related to new technology and societal problems and the predominant method of teaching is recitation and lecturing. Using computer technology in teaching in biological sciences has the potential to solve current problems and advance learning in this subject. The computer has been used in biology classes of some secondary schools for data accumulation, lab simulation, demonstration, drill, practice, tutoring, and other teaching methods. The computer is very important in biological sciences since it can simulate experiments which would otherwise be unavailable to students because of lack of time, money and equipment or danger.

The study problem was to : 1) determine the present extent of computer use in teaching biological sciences at selected public high schools in Los Angeles County; 2) investigate the effects and the changes, if any, that

have taken place in the related curricula as a result of using computer technology instruction; and 3) analyze and study the attitude of teachers towards the integration of this use.

The purpose of this study was to determine the extended use and the impact of computers in teaching biological sciences at the high school level and report the relative curriculum changes and teachers' attitudes as a result of this use.

In response to the purpose of this study, seven research questions concerning computer use at the secondary school in Los Angeles County were posed:

1. To what extent has the computer been used in teaching biological sciences?
2. What is the actual practice versus the desirable practice related to curriculum as a result of computer use in teaching biological sciences?
3. What is the attitude of teachers who are presently using the computer in teaching biological sciences towards this device?
4. What is the actual practice versus the desirable practice related to introduction of the computer to teach biological sciences at

- schools which have not yet used this device?
5. What is the attitude of teachers who are not using the computer in teaching biological sciences towards this device?
  6. What influence does use of the computer have on student achievement and attitude from the teacher's perception?
  7. What are the advantages and disadvantages of using the computer in teaching biological sciences from the teacher's perception?

As stated in chapter I, the study was important for the following three reasons:

1. It provided information about changes, if any, which have been brought into the biological science curriculum to meet the demands of new technology.

2. It provided information regarding the congruence between actual and desirable practices related to curriculum as a result of computer use in biological sciences.

3. It provided information about teachers' perception and attitudes regarding the use of computers to teach biological sciences.

A descriptive survey study was chosen to gather necessary data for the study from a school sample in Los

Angeles County in 1985-1986. Data were derived from four sources: 1) phone survey to the school sample, 2) responses to a computer user questionnaire, 3) responses to a non user questionnaire, and 4) interviews with the teacher sample. A pilot study was conducted to determine the validity and relevancy of the two questionnaires.

The Science Education Office, Division of Curriculum and Instruction Programs provided a list of Los Angeles County high schools from which a possible sample could be drawn. Also, the same office furnished a list of the principals, science chairs, and people to contact regarding the biological sciences programs in the high schools.

Permission was granted by 100 high schools in 50 school district to conduct the phone survey inquiring into the extent of computer use in teaching science. Also, permission to administer the questionnaires was obtained from 20 high schools in 10 Los Angeles County districts. The teacher sample was limited to those who were willing to participate in this study and grouped as follows: a) 11 teachers and 4 science chair from 11 public high schools who are currently using computers in teaching biological sciences; and b) 16 biological sciences teachers and 8 science chair from 10 public high

schools who are not yet using computers in teaching.

The computer user questionnaire consists of three parts constructed by the investigator. The first part includes five questions. The first 4 items have 2 sections related to the actual and desirable practices of using computers in biological sciences. The second part consists of 10 Likert-type items to solicit teacher attitude towards using computers in teaching biological sciences. In the third part of this instrument, general demographic information and background of the participating teachers were requested.

The questionnaire for the non user of computers in teaching biological sciences also consisted of three parts which were constructed by the researcher. The first part of this questionnaire included 7 questions. The first 5 items have 2 sections related to the actual and desirable practices of implementing computers into biological sciences.

The second part of this instrument consisted of 6 Likert-type items to study teacher attitude towards using computers teaching in biological sciences. In the third part of this instrument, general demographic and background of participating teachers were requested.

The phone survey was done in December 1985. The

remainder of the data were collected during January and February 1986. Both of the questionnaires were submitted personally by the researcher to the teacher sample during the interviews.

There were 6 delimitations imposed on this study:

1. The study was delimited to biological sciences in expectation of curriculum practices and teachers' attitudes related to computer use in teaching. Thus, data generated from this study should not be generalized to any other subject matter.
2. The study was delimited to selected high schools in Los Angeles County; therefore, the findings may not be generalized nationwide.
3. The study was completed between the years of 1985 and 1986.
4. The phone survey was delimited to 100 secondary schools in Los Angeles County.
5. The number of schools visited was delimited to 20 secondary school in Los Angeles County.
6. The grades of participating classes in this study were delimited to 9th, 10th, 11th, and 12th grades.

Also, this study was limited to the following factors:

1. The number of schools visited was limited by budget and transportation constraints of the researcher.

2. The interview process conducted by the investigator could have altered the normal behavior of the teachers interviewed.

3. The study was limited by the openness and cooperation of the participants in this study.

4. The total sample was limited by the time constraints, school year 1985 - 1986.

The review of the literature included 6 sections.

The first section dealt with the review of literature pertinent to the history and nature of science teaching at the secondary school. It pointed out the need for changes in the biological sciences curriculum. Science programs at the secondary school are out-dated and lack relationship with new technology and lecture is more emphasized than inquiry learning in the classroom. Also, there is a shortage of qualified science teachers due to lack of training, expertise, and interest in teaching this subject. Teaching biological sciences at the secondary school has been neglected as other science subject. Biology curricular at most secondary schools need to be improved and updated to suit student's life in this century.

The second section of this chapter included a review of technology use in science. It emphasized the

importance of teaching science and computer technology daily in the secondary school. Computer use in teaching biological sciences was found in computation, gathering information, drill and practice, simulation learning, and teaching new skills. Lack of money, expertise, training and interest are the major reasons for lack of computer use in the secondary schools.

The third section of this chapter contained a review of the computer simulation uses in teaching biological sciences which have been used in different areas in this subject, especially in laboratory experiments in case of lack of equipment or for safety reasons.

The fourth section of this chapter reviewed some of the educational software available in biological sciences. It focuses on the importance of highly prepared computer programs in teaching science and criticizes some of the commercial software as being dull and superficial.

The fifth section included a review of the attitudes of biological sciences teachers towards the computer in teaching. It indicates that some of the teachers have negative attitudes towards computer use because they feel that computer does not have the ability to communicate with students. Most believe that lack of funds,



training, and interest are the principals reasons for lack of computer use in the classroom.

The last section reviewed the teacher's attitudes towards innovations and changes in the curriculum, and the new role for the teacher in today's life. Also, this section includes several studies which show the resistance of the teachers towards changes in the curriculum. Generally, the innovators have different concerns and expectation than the teachers. Today's teacher has very important role to play in planning and implementing any changes in the classroom. Biology teachers have the responsibility to update and improve their science programs to keep them related to new technology and societal needs.

Chapter IV included the findings of the study which present the data related to each of the seven study questions. It contains 7 sections:

The first section focused on the extent of computer use in teaching biological sciences.

All of the 100 secondary schools that participated in this study indicated that they have used computers in teaching one subject or another. All of them reported that they teach computer skills which include programming, word processing, and computer languages.

Sixty two percent of the schools have used computers in math, 52 percent in business, 47 percent in physics, 42 percent in chemistry, 35 percent in biological sciences, 37 percent in English, 16 percent in reading, 6 percent in journalism, 5 percent in special education, 5 percent in bilingual program, and 4 percent in industrial educational arts, social studies, and library science.

Most the teachers who participated in this study commented that they like and encourage the use of computers in teaching biological sciences, but the majority complained that they are not enough computers accessible, and expressed dissatisfaction with the available commercial software as not being creative and stimulating for science education. In addition, science teachers indicated that better software and good computer in-service training will enhance the use of computers in the classroom.

The second section in this chapter focused on the actual practice versus the desirable practice related to curriculum as a result of computer use in teaching biological sciences.

It was found that computer software has been used mostly for demonstration. All the respondents believed that using the computer for demonstration is an essential

and desirable practice. Some have used the computer for drill and practice, but most of the teacher interviewed thought that computers should be used for higher levels of thinking, to learn new skills and solve problems. The majority of interviewees complained of the lack of good software in biological sciences. They also indicated that most of the available commercial software is for drill and practice which deals with low levels of cognitive thinking. Most of the participants expressed that they did not have the time nor the necessary skills to write their own programs.

Using computers in teaching biological sciences has introduced new approaches to science and in-service teacher models in some of the participating schools, but few mentioned a redefinition of the major goals of sciences in their programs. No one indicated that the biological sciences curriculum has been replaced by a new one, and most of the teachers stated that their curriculum has stayed the same or changed a little.

The third section dealt with the attitude of teachers who are presently using the computer in teaching biological sciences towards this device.

The majority of the respondents indicated that they like using the computer and learning more about it. They

believe that it has many benefits in teaching biological sciences and that computer technology is an integral part of science education in general. They indicated that computers give positive feedback to students and helps them think more scientifically and understand new technology. Interestingly, the majority also reported that the computer is not their favorite teaching device in the classroom. The textbook is still the principal teaching tool.

Most interviewees rejected the concept that biology content can be taught better with a computer than a textbook. Most considered the computer a supplement to the textbook which is their first source of information in teaching. In addition, most believe that using computers will increase their work load in the classroom.

The fourth section focused on the actual practice versus the desirable practice related to introduction of the computer to teach biological sciences at schools which have not yet used this device.

It was found that most of this school sample has computers and in-service computer training available for teaching, but the majority of these schools have not established goals or specific objectives to use computers in teaching biological sciences.

The participating teachers in this study, who are not currently using the computer in biological sciences, indicated that lack of hardware, time, money, training, and interest are the eminent reasons for lack of use of this tool. Some believe that lack of good software is part of the problem.

The fifth section dealt with the attitude of teachers who are not using the computer in teaching biological sciences towards this device.

It was found that teacher attitude was mostly positive towards the concept of using computers in the classroom. The majority of the respondents like using computers and indicated that its use in teaching biological sciences should be encouraged. They are willing to accept the computer in the classroom and try it in teaching, and believe that it can improve student achievement.

The sixth section focused on the influence of computer use on student achievement and attitude from the teacher's perception.

It was found that the majority of teachers believe that students enjoy using the computer. It is a change of pace and allows the student to review questions he is asked to contemplate. Most indicated that both student

achievement and interest levels in learning biological sciences have increased, and their vocabulary and understanding are better after using the computer.

The last section in the findings dealt with the advantages and disadvantages of using the computer in teaching biological sciences from the teacher's perception.

The participants indicated many advantages of the computer in teaching biological sciences. They have used it most in demonstration, laboratory simulations, data compilation and information processing. Also, they believe that the computer helps students understand the importance of educational technology in teaching.

Some teachers criticized the ways the computer had been used in teaching. They suggested that it should not be used for drill and practice, but for more stimulating practices such as simulations and new concepts. Almost all teachers asked for more computers and better software quality to satisfy their students' needs in the classroom.

## Selected Findings

These are the most important findings from the study:

1. Most of the school sample had used the computer more in teaching computer skills, math, business, English, physics, and chemistry than in biological sciences. The majority of the teacher sample interviewed reported that it was harder to use the computer in biological sciences than in other subjects because it is descriptive and relies on concepts and principles more than numbers and graphs.

2. The biological sciences curriculum has stayed the same or changed little as a result of using computers.

3. Most of the teachers/interviewees rejected the need for a redefinition of the major goals of science in the school program.

4. The majority of the teacher sample criticized the use of computers in drill, practice, and tutoring and reported that they would like to have better computer software which teach students new skill, and promote higher levels of thinking and problem solving.

5. All in the teacher sample who have used the computer reported that it had many benefits for teaching

biological sciences, including encouraging students to think more scientifically and understand new technology. However, they still believed that biology content can best be taught with a textbook.

6. Most of the school sample which had not yet used the computer in teaching biological sciences reported that specific objectives for its use have not yet been established at their schools.

7. Lack of money and interest are the principal reasons for lack of computer usage in the participating school.

8. The teacher sample that was not yet using the computer in teaching biological sciences primarily has a positive attitude towards this use and would like to use this machine in the classroom.

9. All the teachers who were using computers reported that the computer stimulates the students to study and increases their understanding. Most indicated that the computer has many applications in individualized learning, feedback, and remediation.

10. The review of the literature and the findings of the survey study show that most of the biology educators believe that computer can not replace the teacher or the textbook in the classroom.



## Conclusions

The following conclusions were derived from the findings of the study:

1. Use of the computer in teaching biological sciences at the secondary school sample in Los Angeles County was limited to some extent because of lack of hardware and good software in this subject, and partly because of the lack of interest of some teachers.

2. All of the teacher sample reported that the computer is not going to replace the textbook nor the teacher (probably until good varieties of software will be available in all of the areas of biological sciences). The teachers indicated that the textbook and laboratory methods are the major devices used in teaching.

3. The computer has not caused a redefinition of the major goals of science, but it has introduced new approaches to in-service computer training in the classroom.

4. In general, teachers have a positive attitude towards the computer, but most indicated that it increases their work load in the classroom.

5. Most of the school sample, which has not used the computer yet in biological sciences, reported no intentions of introducing this device in the near future

nor implementing new innovations related to science and technology in the curriculum. Most of the time, resistance to change from the school faculty is the reason. The majority of the teacher sample had more than 10 years of experience and have used textbooks, lecturing, and recitation as a major methods in teaching. They were not been exposed to computers while they were achieving their degree. On the contrary, younger teachers in the sample were more enthusiastic about computer usage and more open to accept changes in teaching.

6. All of the teachers reported that the computer has a positive influence on student attitude and achievement. It seems that, in general, students have fewer fears and are less intimidated by the computer than the teachers.

7. The majority of interviewees rejected the use of computers in tutoring, drill and practice and believe that it should be used in more creative and stimulating ways.

## Recommendations

The following recommendations are made as a result of the study:

1. Secondary schools should adopt the computer in teaching biological sciences, and given a priority in the curriculum as are the textbooks and laboratory experiments. In-service computer training should be available to teachers to eliminate their fears and expose them to computer applications in teaching.

2. Teachers should have specific times within their schedule to try new ideas in teaching and to be open to new innovations and discoveries in science.

3. Teachers who are using computer technology, putting time and effort into writing their software programs for specific objectives, should be rewarded for their contributions.

4. Efforts should be made by the State Board of Education to attract young people who have degrees in science to teach at the high school. This could bring new ideas and updated information to the classroom. In addition, young teachers are more willing to change and try new methods and strategies in teaching than teachers who have had more years of experience.

5. Further research studies should be undertaken to investigate the extent of using computers in biological sciences at the university level and to study the attitude of teachers and students towards this use.

6. Survey studies should also be conducted to study the extent of computer usage in different subject matter areas and its effects on curriculum as well as the achievement of students.

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**APPENDIXES**

Computer User Questionnaire

A. Practices related to curriculum

Please circle one of the numbers to the left of each item for actual practice and to the right for desirable practice.

Actual practice

- 4. Yes
- 3. Partially
- 2. No
- 1. Don't know

Desirable practice

- 4. Essential
- 3. Desirable
- 2. Questionable
- 1. undesirable

1. Computer software has been used in our biological sciences program for:

- 4 3 2 1 a. Tutoring.....4 3 2 1
- 4 3 2 1 b. Drill and practice.....4 3 2 1
- 4 3 2 1 c. Demonstration.....4 3 2 1
- 4 3 2 1 d. Simulation games.....4 3 2 1
- 4 3 2 1 e. Learning new skills.....4 3 2 1
- 4 3 2 1 f. Other; please identify.....4 3 2 1

2. Computers have many applications in our biological sciences curriculum, such as:

- 4 3 2 1 a. Computation.....4 3 2 1
- 4 3 2 1 b. Data gathering.....4 3 2 1
- 4 3 2 1 c. Information processing.....4 3 2 1
- 4 3 2 1 d. Model testing.....4 3 2 1
- 4 3 2 1 e. Other; please identify.....4 3 2 1

3. Computers have encouraged changes in our curriculum, such as:

- 4 3 2 1 a. New approaches to science.....4 3 2 1
- 4 3 2 1 b. New in-service teacher models.....4 3 2 1
- 4 3 2 1 c. Redefinition of major goals in science.....4 3 2 1
- 4 3 2 1 d. New rationale and purpose relating to societal and technological problems.....4 3 2 1
- 4 3 2 1 e. Other; please identify.....4 3 2 1

4. The following methods of teaching are emphasized in our classrooms:

- 4 3 2 1 a. Textbooks.....4 3 2 1
- 4 3 2 1 b. Laboratory methods.....4 3 2 1
- 4 3 2 1 c. Computer programmed instruction.....4 3 2 1
- 4 3 2 1 d. Other; please identify.....4 3 2 1

5. Has the biological sciences curriculum changed?

APPENDIX A  
COMPUTER USER QUESTIONNAIRE

- a. Has changed a lot
- b. Has been replaced by a new curriculum
- c. Has changed a little
- d. Has stayed the same
- e. Other; please identify \_\_\_\_\_

B. Teacher's attitudes

Please indicate the extent to which you agree with the following statements:

Strongly Agree (SA), Agree (A), Disagree (D), or Strongly Disagree (SD).	SA	A	D	SD
6. Biology content can be taught better with a computerized system rather than a textbook.	--	--	--	--
7. Addition of the computer in teaching biology, provide more accurate and updated information.	--	--	--	--
8. The computer has many benefits in teaching biological sciences.	--	--	--	--
9. The computer is used to give positive feedback to students.	--	--	--	--
10. Using computers helps students think scientifically and understand new technology.	--	--	--	--
11. The addition of the computer in teaching decreases our work load in the classroom.	--	--	--	--
12. I like using the computer in teaching science.	--	--	--	--
13. I would like to learn more about computers and their applications in teaching.	--	--	--	--
14. The computer is my favorite teaching device.	--	--	--	--
15. Computer technology is an integral part of biological sciences education.	--	--	--	--

Please complete

- 1. School: \_\_\_\_\_
- 2. Sex: Male ( ) Female ( )
- 3. Highest degree earned: BS ( ) BA ( ) MB ( ) MA ( ) Other ( )
- 4. Major field of study: \_\_\_\_\_
- 5. Total years in staff in your school: \_\_\_\_\_
- 6. Title: \_\_\_\_\_ Total years you have held this position: \_\_\_\_\_

**APPENDIX B**  
**COMPUTER NON USER QUESTIONNAIRE**

Computer Non User Questionnaire

A. Practice related to curriculum

Please rate each practice to the degree it applies to your school. Circle one of the numbers to the left of each item for actual practice and to the right for desirable practice.

Actual practice

- 4. Yes
- 3. Partially
- 2. No
- 1. Don't know

Desirable practice

- 4. Essential
- 3. Desirable
- 2. Questionable
- 1. Undesirable

- 4 3 2 1      1. The biological sciences division has established specific objectives for encouraging computers usage.....4 3 2 1
- 4 3 2 1      2. Computers are available for teaching.....4 3 2 1
- 4 3 2 1      3. The biological sciences department is in the process of introducing computers to the classroom.....4 3 2 1
- 4 3 2 1      4. In-service computer training is provided for science teachers.....4 3 2 1
- 4 3 2 1      5. Our biological sciences curriculum has implemented innovations to meet the demands of new technology.....4 3 2 1

Please circle the answer you prefer.

6. How do you rate the biological sciences curriculum at your school as related to new discoveries and technology?

- a. Up-to-date
- b. Good
- c. Out-dated
- d. Poor
- e. Other; Please identify.....

7. Why doesn't your school use computers in teaching biological sciences?

- a. Lack of funds
- b. Lack of training
- c. Lack of expertise
- d. Lack of interest
- e. Other; Please specify.....



B. Teacher's attitudes

Please indicated the extent to which you agree with the following statements:

Strongly Agree (SA), Agree (A), Disagree (D), or Strongly Disagree (SD).

	SA	A	D	SD
8. Computer use in teaching biological sciences should be encouraged.	--	--	--	--
9. I would like to use computers in teaching.	--	--	--	--
10. I don't really see how using computers in the classroom will improve student's achievements.	--	--	--	--
11. I could ever learn to accept the introduction of teaching machines in the classroom.	--	--	--	--
12. I frequently have to deal with more discipline problems when we are having a process type lesson than when we are having a textbook type lesson.	--	--	--	--

Please complete

1. School: \_\_\_\_\_
2. Sex: Male ( ) Female ( )
3. Highest degree earned: \_\_\_\_\_
4. Major field of study: \_\_\_\_\_
5. Total years on staff in your school: \_\_\_\_\_
6. Title: \_\_\_\_\_
7. Total years you have held this position: \_\_\_\_\_