CHAPTER II

COMPUTERS IN EDUCATION
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CHAPTER II
COMPUTERS IN EDUCATION

INTRODUCTION

The increasing importance of informatics in day to day life has resulted in the emergence of computers in education at the international level. The worldwide recognition gained for the importance of the computer compelled the educationists to revise the existing curricula to include informatics components. Computers are being used in education to prepare the children for the "informatics future" by training them in programming and related skills for work in the informatics industry. They are also used as educational aids to improve children's skills in academic subjects at all levels of education. Introduction of computers in education brought out the changes in the content and methods of education.

HISTORY OF COMPUTERS IN EDUCATION

In the later part of 1950s, the second-generation computers were introduced and by this time the computers were being used by educational institutions. During this period, large universities began using computers for administrative purposes such as accounting, payroll and student record keeping. In early 1960s, the research on programmed learning showed the value of highly structured instructional sequences with appropriate feedback. By the development of computer technology, the micro-computers were introduced. The micro-computer was recognized as a medium for providing the feedback control and branching characteristics of a good programmed instruction, but found to be too difficult and expensive than book format. In U.S.A., Suppes (1968) working at Stanford University, demonstrated the instructional capabilities of the computer. They tested and found to be a promising, if not powerful, alternative to traditional instruction. In this period, PLATO project was introduced involving the design of a complete system of hardware and software for instruction. Over the past 20 years, the PLATO project has developed into the largest collection of computer assisted material available.
In early 1970s, Seymour paper at the Massachusetts Institute of Technology began research on teaching children by having them program computers (Papert, 1971). Papert following the educational theory of Jean Piaget (Bybee, 1982; Flavell 1963) maintained that students can learn many problem-solving skills on their own, given the correct educational environment, which he claimed to be an easily programmed computer. Two major developments of Papert’s projects were LOGO, a powerful but easily learnable programming language and the turtle, a small robot that children could control using LOGO. Between 1970 and 1975, Bukoski and Korotkin pointed out that the percentage of secondary schools using computer for instruction increased from 12.9 to 27.7 percent. In this period, third generation computers became available in increasing numbers and at low cost. More number of schools and colleges began to use computer for administrative functions. But the instructional use of computers was still largely the domain of universities, with only a few private corporations and the military taking an interest. In this decade the MITRE Corporation and Brigham Young University (1972) started development of the TICCIT (Time - shared Interactive Computer Controlled Instructional Television) system (Merrill, Schneider & Cletterer 1980). With TICCIT students studied lessons presented on standard color televisions and interacted through modified typewriter and keyboards, all of which were controlled by a mini-computer.

Between 1975 – ‘80, the situation began to change with the introduction of personal computers. It became possible now for the individual university researcher, the small public school, and even the individual public school teacher to buy one and to start using it for educational purposes. Within a short period, the market place showed the potential for micro-computers, and in 1977 three companies marked micro computers – Tandy Radio Shack, Commodore International and Apple – and although originally not intended for the K-12 environment, they quickly found their way into the schools.

Between 1981-'90, the role of the computer in the classroom was probably best clarified by Taylor (1980) who proposed a taxonomy of educational uses. A computer may function as a tutor, a tool; or a tutee. Romiszowski (1986) divided educational computing into just two major categories: informatics as an
instrument of education or as the content of education. Taylor's tutor and tool roles roughly parallel Romiszowski's instrument of education category; the tutee role is like his content category. Taylor's (1980) three roles of computer are stated as follows: Firstly a computer as a tutor, is an active part of the learning process. It is the deliverer of instruction, the patient drillmaster, the guide through a simulated world. Secondly, a computer as a tool, is to offer the potential of serving as many other tools that extend human mental capacity, all in a single device. Finally, a computer as a tutee, refers to the creation of software - programs that instruct and guide the computer to carry out some desired task.

During this periods of the research on computer applications in the Education, there was a promise for CAI in schools. In this decade of research and evaluation, computers in education have been shown repeatedly to provide more and more efficient and effective means of delivering instruction. Therefore, Kearsley, Hunder and Seidel (1983) have concluded that the CBI has not lost its validity. They said that, "Computers can make learning experience much more exciting, satisfying and rewarding for the learner and the teacher. Hence it is clear that computers do not stifle the creative process, do not dehumanize and do not faster antisocial development".

From 1990 to 1999, the number of micro-computers in American schools went up from 25 million to almost saturated level. But in our country, the number of micro-computers used in our schools went up from a few thousand to almost few lakhs; in Tamilnadu state it went up to the maximum level in all Higher Secondary Schools and Universities. Despite early concerns about cost and continuing scepticism about effectiveness, computers have become a part of almost every child's education. Hence today, the computer has become a part and parcel of our daily life. According to the recent research on computer in education, as technique wise or application wise or in the sense of the other useful way, findings have revealed that the computer takes change of all the fields of education and their system. Their evaluation indicated the effectiveness and efficiency of the computer in education to promote and improve the education system and their applications such as multimedia, multimedia projector, internet, information technology, etc. These recent developments of computer in education bring
education to our home and the education is the pivot around the computer and its applications. However, in the recent years, computer is widely used and is bringing some exciting innovations in education. For present and future, the computer is a part and parcel of our work. The computers are helping the teachers and students in the following areas.

1. Computers take over the most of the drudgery of schooling like classifying students according to abilities, preparing time table, schedules etc.,
2. Computers allocate learning resources to students as a group.
3. Computers fulfil the students interest in learning and encourage some creativity.
4. Computers maintain progress cards and preserve them confidentially.
5. Computers give immediate and positive feedback to the students.
6. Computers provide easy access to files of information.
7. Computers do not restrict the time of learning.
8. Computers provide direct (face to face) interaction between student and subject matter to be learned.
9. Computers engage the student in tutorial interaction and dialogue.
10. Computers master the student in their subject matter.
11. Computers provide natural and real situations of subject matter to student.

COMPUTER IN SCIENCE EDUCATION

Seymour Papert (1980) says, “True computer literacy is not just knowing how to make use of computers and computational ideas. It is knowing when it is appropriate to do so”.

Many science teachers are hesitant to change their instructional strategies to incorporate the new technology, but its potential has steadily become more apparent. But the new technology viz. the computer can be used by almost all the teachers to enhance instruction in significant ways. Micro-computers have a unique place in the hands of science teachers because they can be used with laboratory equipment and measurement devices to produce efficient, and
sometimes, cost effective ways of providing laboratory experience. A science
teacher should understand that while the micro-computer is a very powerful tool,
the decision to use it in the most beneficial way will be made by science teachers.

Today the learners being more sophisticated, science teachers can deal
with more technical information than the other teachers. It should also be
understood that teachers having access to single computer can make a significant
impact on the teaching of science. But having a computer in a class room, or even
access to one, will have no effect on the quality of a science teacher's instruction,
unless the teacher has an understanding of the potentials and pitfalls of the
machine. Having knowledge about the computer and their functions, their
classroom and laboratory become lively when they use computer along with their
teaching.

For this, a science teacher would be interested in some of the peripherals
that have become useful components of a microcomputer system. Science teachers
often have some special needs when it comes to data entry. Ideally a computer
should be capable of having direct input from laboratory equipment without
requiring keyboard input. Devices which sense or count information when passed
directly to the computer are referred to as “probes”. In most of the micro­
computer systems there are a variety of probes available that measure qualities
like light-intensity, pressure and temperature. Science teachers would also be
interested in the variety of output devices like printer, a large television screen or
a device, called “Liquid Crystal Display” (LCD), which utilizes an overhead
projector to project a large screen image. In U.S.A., the National Science Teachers
Association has recommended that every science classroom should have a
minimum of one dedicated microcomputer, one large-screen display (LCD) for
overhead projector and one printer.

How a science teacher might use the computer in the classroom or in the
production of instructional materials for the class room, depends to a large extent
on his goals, objectives and needs.

According to Taylor (1980-81) a computer, as a science tutor takes an
active part in the learning process i.e., deliverer of science text and laboratory
instruction like an apparatus or physical model used to demonstrate the molecular motion of a gas.

Taylor (1977) noted, "Teachers are plainly of critical important in caring for and about children; the inspiration, encouragement, control, guidance they provide matter profoundly. Further, no one but the teacher on the spot can perceive and supply the particular needs of a particular child at a particular moment. Neither the teacher's pastoral nor his tutorial functions can be replaced. When we talk about alternative systems of learning, then we are asking only where, principally, the burden of instruction should rest".

Becker suggested that teachers are becoming more aware of the variety of applications for computer in education.

A computer, as a science tool, is a device that measure pressure, kinetic energy of a gas molecules, number of impacts of gas molecules per seconds, etc.

A computer, as a science tutee, is creation of software-programs that instruct and guide the computer to carry out some desired science lessons and experiments.

Seymour Papert (1980), one of the most well-known advocates of using the computer as tutee has said: "When a learner programs the computer she/he acquires a sense of mastery over a piece of the most modern and powerful technology and establish an intimate contact with some of the deepest ideas from science, from mathematics, and from the art of intellectual building".

It is this challenge, the challenge of providing access and understanding of machine that can be transformed into a tool to solve problems and extend the power of man that is the special challenge of computer science and computer science teacher.

Many of the original applications utilizing computers in the science classroom were characterized by the development of programs dealing with rote memory. Using drill and practice strategies in which memory was the key element, science students were taught simple academic skill like science fact, principles, chemical formulae, etc. Although the science teacher may be interested in taking advantage of the efficiency of computerized exercises, the computer is not limited to teaching rote memory skills. It can challenge the student to
reflective thought and to develop complex problem-solving strategies. Nevertheless, a science teacher with access to sufficient computer power can provide a more responsive range of instructional options, than has been the case in the past.

A Physics teacher in a remote school could provide a talented or exceptional student with access to a program like interactive physics, which could be more challenging than the regular curriculum without taking time from his regular teaching assignment. When physics teachers use computer in the physics class, the computer provides an intellectually rich environment which is both responsive and adaptive. Physics students can develop scenarios that simulate complex interactions which would be impossible using the equipments that might commonly found in the schools. For example, an apparatus or physical model is used to demonstrate the kinetic energy of gasses, discharge tube, etc.

Hence the computer as simulator, whether it be simulating a microcosm or global environmental model, can – lead science students from the realm of factual learning into the real world of problem – solving and integrative skills. Perhaps the most significant application of the computer for achieving science educational goals is its ability to present intellectual challenges to science students in a responsive environment where solutions can be explored and evaluated without risk.

THE USAGE OF COMPUTERS IN SCHOOL CURRICULUM

Recent revolutions in the field of information brought about by advances in the computer technology, has created an information society, in which majority of labor force are expected to hold information related jobs. Ignorance about computers will render people functionally illiterate as does ignorance of 3R as reading, writing and arithmetic. This shows that our society heavily depends upon information technology in many aspects of work, personal life and hence, it will expect our schools to familiarize students with applications of computers during their schooling. The familiarity will involve an understanding of the use of facilities such as word-processing, modelling, screen reading and the effective use of files and data. Further, the students learn “Basic” language during their
schooling. It will also demand a limited range of keyboard skills, program writing and execution. To sum up, computers are an integral part of everyday life. Their impact is felt at every age level and in economic level too. Being able to deal with computers in a non-threatening manner is a necessary life skill. Hence, to be a computer literate is as important as a literate in the more traditional sense. In addition to acquiring three basic skills in 3Rs such reading, writing, and arithmetic, one should have proficiency in the fourth R viz. computer. Therefore the computer literacy gives 4R basic skills. Without this, one may be excluded from many experiences and events. Hence, familiarity with both the theory and potential applications of computers is absolutely essential.

In this context, many countries have introduced computer literacy in school curriculum. For example, in Britain, the Department of Education and science developed what is known as Microelectronics Education Project (MEP). The aim of the project was “to help schools to prepare children in a society in which devices and systems based on microelectronics are common place and pervasive. These technologies are likely to alter the relationships between one individual and another and between individuals and their work; and people will need to be aware that the speed of change is accelerating and that future carriers may well include many retraining stages as they adjust to new technological developments”. (Adams and Jones, 1983). In U.S.A., the Minnesota Educational Computing Consortium conducted a study in 1979, to explore the impact of pre-college educational programs designed to increase computer literacy and the effects of human-computer interaction within the context of instructional computing environments. In 1982, microcomputers were introduced into secondary school in the People Republic of China to prepare students for widespread use of computers in all aspects of society (Chen Qi, 1988). In our country a pilot project on computer literacy was launched by the Government of India in 1984.
COMPUTER LITERACY

Definitions

Lindelow (1983) suggests that computer literacy should emphasize programming skills. On the other hand, Seedily (1982) advocates the use of computer as a tool in many ways, such as “Information handling”.

Perhaps, a better definition of computer literacy is given by Moursund (1983). According to him, “all students should become computer literate. This means that they should gain a substantial level of computer awareness and develop a functional level of skill in using computers as an aid to problem solving in a variety of disciplines”.

O’Donnell (see Majundar, 1987) states that, “Computer literacy is an awareness and understanding of the computer, its role in society, and its impact on education”.

Computer Literacy in India

The computer literacy in schools was introduced in our country through a pilot project, called CLASS (Computer Literacy And Studies in Schools) in 1984, by the Government of India as a joint venture of the Ministry of Human Resource Development and the Department of Electronics. The main objectives of the project are (NCERT, 1984):

1. to provide students with a broad understanding of computers and their uses;
2. to provide hands-on experience;
3. to familiarize the students with the range of computer applications in all walks of human activity and the computer’s potential as a controlling and information processing tool; and
4. to demystify computers and to develop degree of ease and familiarity with computers which would be conducive to develop individual creativity in identifying and developing application relevant to their immediate environment.
The major emphasis in this project is on manipulative skills rather than on teaching the principles of computer science. Further, the basic features of the projects are:

i) Computer Education should be introduced at the secondary and the higher secondary stages at the outset, to be followed by computer literacy programs at the middle and primary schools stages.

ii) Computer education would be a part of the curriculum of every student, irrespective of eventual branching into science, humanities or arts, as a tool with application in all aspects of human endeavour.

In the first phase of the CLASS project during 1984-85, 250 schools were selected for participation. A comprehensive evaluation of the pilot stage of this project was undertaken by the Indian Space Research Organization (ISRO), Ahmedabad. The aim of this study was to analyze and understand various components of the project in its totality (Agarwal 1987).

The evaluation report was encouraging in the sense, that students were found to be enthusiastic in learning about computers and to use them for learning other subjects. Until the end of 1993 nearly 2800 schools have been covered under CLASS project. In our country there are more than 60,000 high/higher secondary schools and many of them are Government/Government aided institutions. To introduce CLASS project in all these schools needs careful planning. However, there are a number of private schools where computer studies have been introduced for the benefit of their student. But, unfortunately computers are used in these schools to do some specific tasks, such as, word processing, manipulating a database, programming, etc. Computers are not used by teachers as a medium for the teaching-learning process or by students to develop a function level of skill for problem solving in various disciplines. These activities should form a part of any computer literacy program in schools as per the definition of computer literacy (Moursund, 1983).
ROLE OF COMPUTERS IN CLASSROOM

From research finding, Robyler (1985) noted that, “Computer applications have an undeniable value and an important role to play in classrooms of the future”.

For a great number of years in the history of universal education children/students used slates and the teacher used the blackboard. If we consider current practice, then the blackboard is still the main aid for learning true, they have other aids such as slide projectors, film projectors, tape recorders, television and lately video recorders, but these have not had the impact they perhaps could have had. Innovations in the use of aids for learning have not been effective for the way they have affected methods of teaching, or the curriculum as a whole. Possibly the main reason for this is that they are all passive aids. If the teacher uses a tape recorder student has to intervene in the process at many points since students want perhaps to emphasize a particular aspect of the learning.

With the introduction of computer, this defect has been rectified. The computer is fundamentally different from any other teaching aid that has come into our classroom. Since the universal education was established, teachers have used different aids to enable them to provide the best learning environment for the children / students in their charge. Two main pressures have been applied to these aids, firstly economic and secondly availability. The computer can make choices, able to limited at present and under the control of a program, but choice none the less, this makes it different from other forms of teaching aids previously used. For instance, a student/child having difficulties with a piece of work from a work card must refer to the teacher to adjust the level of difficulty being worked at. The computer can be programmed to detect the children’s / student’s difficulties, and automatically adjust the questions being asked. In fact in all this discussion one must bear in mind this stipulation that, most importantly, the computer is INTERACTIVE – something that no other aids have been to date.

The two aspects involved in the learning through computers are: 1. Creativity, and 2. Cognitive development. The student’s/ children’s creativity has been described as the development of something novel due to the introduction of computer in our classrooms. It adds to the society whereby intellects can
flourish. The second aspect involves children’s/student’s cognitive development. The prime purpose of this aspect is to introduce children/student’s to the skill of 3R viz.: reading writing and arithmetic. These three skills are important, but to some extent they have prevented the cognitive development of the student. Piaget suggested that student may never come across a mathematical brain, and the student that was good at mathematics was the student who responded well to the instruction given.

Computers in classroom have certain values as they affect learning positively. It may be useful to view computers from the perspective of learning. Student may learn the following:

*About computers* – what they are, when they can do, where we encounter them daily, how to control them. Although this aspect crosses all three (Taylor, 1980) role of a computer, it is especially relevant to that of tutee;

Computers functioning as instructors – classic CAI the tutor role; Computers – finding information in databases; manipulating numbers; improving written communication skills with a word processor, spelling checker, or style and grammar analyst-the computer as tool.

This puts the computer into proper perspective as an integral tool in the learning process.

When microcomputers first entered the schools many teachers who had access to them also felt considerable pressure to put them to use somehow. Some of the arguments for teaching programming seem to reflect a desperation to justify having the machines in the schools. For instance, there is the argument of mental discipline. It is good to develop the logical powers of the mind by giving students problems to solve by writing programs. This argument is an updated version of teaching Latin to exercise the mind. Still, the underlying concern that computers to be used for something worthwhile is valid.

**COMPUTER-ASSISTED INSTRUCTION**

Not so long ago, the micro-computer was a rare and exotic sight in Indian classrooms. During 1990s many schools began acquiring microcomputers and
putting them to use for instruction, drill and practice, record keeping, and other applications.

The use of microcomputers expanded rapidly during the 1990s and between 1991 and end of the present decade.

- Indian schools acquired over few lakh computers.
- The number of schools owning computers increased from approximately 25% to virtually 50% but in our Tamilnadu it is 100%.
- More than half the states began requiring – or – at least recording – preserve technology programs for all prospective teachers.

Many educators, legislators, parents and researchers have expressed concern about the educational effectiveness of using microcomputers in schools. Because the acquisition of computer hardware and educational software programs involves a considerable monetary investment, these groups want assurance that computers in the schools are more expensive and entertaining toys; they desire evidence that educational microcomputer use truly enhances learning in demonstrable ways.

Taylor (1971) stated that, “Learning systems long before computers were economically viable for schools”. Also, he noted that all such systems presumed the presence of teacher.

“Teachers are plainly of critical importance in carrying for and about children; the inspiration, encouragement, control, guidance they provide matters profoundly. Further, no one but the teacher on the spot can perceive and supply the particular needs of a particular child at a particular moment. Neither the teacher’s pastoral nor his tutorial functions can be replaced. When we talk about alternative systems of learning, then, we are asking only where, principally, the burden of instruction should rest”. (Romiszowski, 1986)

The crucial characteristic of learning system is to redirect attention from the act of teaching to the process of learning. The microcomputer in the learning process is termed as Computer-assisted instruction (CAI), computer-based instruction (CBI), Computer-assisted learning (CAL), Computer-based training (CBT), Computer-based education (CBE), Computer-enriched instruction (CEI), Computer-managed instruction (CMI) and so forth.
Definitions

As Kulik Kulik and Bangert-Drowns point out in their 1985 research summary “the terminology in the area is open to dispute”. This is putting it mildly. The following definitions are a synthesis of those offered by Bangert-Drowns (1985), Bately (1987), Grimes (1977), Samson (1986) and Stennett (1985) and represent commonly accepted definitions of these terms:

- **Computer-based education (CBE) and computer-based instruction (CBI)** are broadest terms and can refer to virtually any kind of computer use in educational settings, including drill and practice, tutorials, simulations, instructional management, supplementary exercises, programming, database development, writing using word processors, and other applications. These terms may refer either to stand-alone computer learning activities or to computer activities which reinforce material introduced and taught by teachers.

- **Computer-assisted instruction (CAI)** is narrower term and most often refers to drill-and-practice, tutorial, or simulation activities offered either by themselves or as supplements to traditional, teacher direct instruction.

- **Computer-managed instruction (CMI)** can refer either to the use of computers by school staff to organize student data and make instruction decisions or to activities in which the computer evaluates student’s test performance, guides them to appropriate instructional resources, and keeps records of their progress.

- **Computer-enriched instruction (CEI)** is defined as learning activities in which computers (1) generate data at the students’ respect to illustrate relationships in models of social or physical reality. (2) Execute programs developed by the students or (3) provide general enrichment in relatively unstructured exercises designed to simulate and motivate students.

Taylor’s three modes of computer use are computer-assisted instruction (CAI), use of application software, and software creation or programming. For the direct application of these three modes, designing and developing interactive
instruction, the type of tutoring is being done by the computer does very well. To develop CAI, the computer is to be instructed as what is to be done. The computer becomes the tutee so that it can, also, function as the tutor. The roles of the tutor and tutee are closely linked, whether referring to the teacher and a student or to the process of creating interactive instruction.

**Why do students like CAI?**

CAI enhances students attitudes towards several aspects of schooling. The following is a list of reasons given by students for liking CAI activities and or favouring them over traditional learning. These students’ preferences also contribute to our understanding of the fact that why CAI enhances achievement.

Students say they like working with computer because computers:-

- Are infinitely patient
- Never get tired
- Never get frustrated or angry
- Allow students to work privately
- Never forget to correct or praise
- Are fun and entertaining
- Individualize learning
- Are self-paced
- Do not embarrass students who make mistakes
- Make it possible to experiment with different options
- Give immediate feedback
- Are more objective than teachers
- Free teachers for more meaningful contact with students.
- Are impartial to race or ethnicity.
- Are great motivators.
- Give a sense of control over learning.
- Are excellent for drill and practice.
- Call for using sight, hearing and touch
- Teach in small increments
- Helps students to improve their spelling
> Build proficiency in computer use, which will be valuable in later life.
> Eliminate the drudgery of doing certain learning activities by hand (e.g. drawing graphs).
> Work rapidly-closer to the rate of human thought.

(Bialo and Sivin 1990; Braun 1990; Lawton and Gerschner 1982; Mohros and Tinker 1987; Robertson 1987; Rupe 1986; Schmidt 1985-86; Weprer 1990).

Many of these items point to student's appreciation of the immediate, objective and positive feedback provided by computer learning activities in comparison with teacher directed activities. As Robertson (1987) points out “This reduction in negative reinforcement allows the student to learn through trial and error at his or her own pace. Therefore, positive attitudes can be protected and enhanced”.

The Tutor role could not develop until some quantity of CAI software existed to support it. Although growth seemed slow initially, today there are literally thousands of CAI packages available in the market. However, complaints about the quality of many of these products are been found to be common. Observers saw in early software the heavy hand of the computer programmer with hardly a sign of an educator. Software was technically adequate, even excellent but educationally deficient. Though there is much improvement, we have not achieved the potential use of the computer medium. The computer as tutor is widely accepted and such use will continue to grow as software justifies it, until the computer becomes truly every teacher's aid. In the research conducted in the beginning of the 18th century, Kulak; Bangert; and Williams (1983), observed that across grade and content areas, students who had traditional instruction scored 50th percentile on objective test, whereas students who learned with CAI scores 63rd percentile on the average and also found that CAI yielded greater retention over time ranging from two to six months. Other studies of Fisher (1983) and Bozeman indicated either achievements gains favouring CAI or insignificant difference between CAI and traditional instructions. But later on in 1988, Roblyer; Castine; and King examined 85 studies and noted that the only difference was the lack of further research in retention and learning time. They also suggested that reduced time may be of little concern in K-12 education
because the school calendar is fixed. Further they concluded that there are no studies that could be useful for the study of the computer as a total replacement for the teacher, so they concluded in favor of the issue of supplement versus substitute moot. Roblyer (1985) observed that CAI was more effective as a supplement to regular instruction than a replacement. Achievement was often greater with CAI than traditional instruction. Retention was not significantly enhanced but learning time did decrease. Effectiveness was not uniform across grade levels and content, but rather effective in lower ability students and lower grade levels. Mathematics learning increased significantly more than did reading language arts. Clearly indications were quite positive but not broadly conclusive.

Kathleen Cotton (1997) analyzed 59 research reports. These reports and documents have some relationship(s) between computer-based learning and learning outcome of students. But of these, 28 are research studies, 22 are reviews, and 9 are meta-analyses of research studies. 12 of the documents focus on elementary students, 19 are concerned with secondary students, 7 cover the elementary-secondary range, 5 involve subjects spanning the elementary-post secondary range, and the age/grade levels of subjects are not specified in 16 of the reports.

Most of the studies involved American students but Israeli and Canadian subjects are also represented. Other specific populations serving as subjects in the documents include economically disadvantaged students (4), special education students (5) remedial students (2) and Hispanic students (2). The rest of the documents either concerned general student populations or did not specify characteristics of their subjects.

The 59 reports were concerned with the effects based on one or more of the following types of educational computer used on students learning outcome: CAI (35), CBE in general (15), the use of word processors for return composition (5), computer-managed instruction (3) programming (2) and simulations (4).

The effects of computer use on a large number of outcome area were examined, including academic achievement in general (30), in mathematics (13), in language arts (8), in reading (3), in science (2), in problem-solving skills (2), and in health and social studies (1 each). Studies also focused on student's
attitudes towards the content of courses in which computers were used (21), towards computers themselves (19), towards school in general (6), toward the quality of instruction in courses with computer activities (4), and toward themselves as learners (4). Other outcome areas include learning are rote (10), learning retention (9), locus of control and motivation, computer literacy, and co-operation/helping (4 each).

Thus from the above studies the main features of CAI are noted as follows:-

➤ The use of CAI as supplement to conventional instruction produces higher achievement than the use of conventional instruction alone.

➤ Research is inconclusive regarding the comparative effectiveness of conventional instruction and CAI separately.

➤ Computer – based education (CAI and other computer applications) produce higher achievement than conventional instruction.

➤ The use of word processors by students develop writing skills that leads to high-quality written work compared to other writing methods (paper and pencil, conventional typewriters).

➤ Students learn material faster with CAI than with conventional instruction.

➤ Student retain what they have learned better with CAI than with conventional instruction. The use of CAI leads to more positive attitude toward computers, course content, Quality of instruction, school in general, and self – as – learner than the use of conventional instruction.

➤ The use of CAI is associated with other beneficial outcomes which includes greater internal locus of control, school attendance, motivation/time-on-task, and co-operation among students which are not to be found in the use of conventional instruction.

➤ CAI is more beneficial for younger students than older ones.

➤ CAI is more beneficial with low-achieving students than with high-achieving ones.

➤ Economically disadvantaged students benefit more “from CAI than students from higher socioeconomic backgrounds.

➤ CAI is more effective for teaching lower – cognitive material than higher–cognitive method.
Most handicapped students, including learning disabled, mentally retarded, hearing impaired, emotionally disturbed, and language disordered, achieve at higher levels with CAI than with conventional instruction alone.

There are no significant differences in the effectiveness of CAI with male and female students.

Students' fondness for CAI activities centers around the immediate, objective, and positive feedback provided by the activities.

CAI activities appear to be at least as cost effective as and sometimes more cost effective than the other instructions such as teacher directed instructions and tutoring.

FUNDAMENTALS OF THE CAI TECHNIQUE

In the early 1960s when the mainframe computers first appeared in schools, the psychologist B.F. Skinner developed the teaching machine. The first teaching machines were mechanically operated devices which presented a student with a question or statement and invited a response. If the student's response was correct the machine organized the presentation of the next question or response. Teaching machines were helpful for collecting many responses, perhaps the most fundamental of notion of this programmed instruction, presented by teaching machines, is the natural end product of a behavioural approach to learning. In programmed instruction, material is broken down into small steps which are called frames. The instruction which is presented in a frame can be thought of as the stimulus, the action of choice of a student, the response, and the recognition of a correct response by the presentation of the next stimulus as reinforcement. The programmed instruction, as an instructional technique, was first presented through machines. It can also be presented through texts. Nowadays teaching machines are of the clunk-click type that hold historical interest only. But today there are thousands of programmed text available which cover topics from pre-reading skills to college-level mathematics.

Programmed instruction is presented by two basic types i.e., linear and branched. Linear programs demand the reading of text sequentially from the first frame to the last where as branching deals with different learning patterns.
Programmed instruction was the organizational base supporting the first programs which attempted to use the computer to teach students CAI mode some 10 – 15 years ago. This was not surprising as about this time because

1. The hardware was relatively unsophisticated unlike today and
2. It was difficult to write programs then because higher-level languages were not as advanced as that of today.

Both (1) and (2) mitigated against the development of complex and accurate simulations. It was not surprising then that the concepts behind the nation of a machine actually teaching, i.e., creating gain in attainment without teacher involvement was quickly applied to the more flexible and powerful medium of computer.

Teachers tended to be sympathetic to computer use for this type (Siann and Macleod, 1986). To be successful, behavioural based software needs to pedagogically sound and capable of providing opportunities for learning which are not available through traditional methods of instruction, i.e., individualized teaching, individualized work cards etc. Siann and Macleod (1986) reports on a recent survey of 600 behavioral type software packages with only 5 percent as “first rate” and the rest ‘simply depressing’. They also reports that those which were acceptable lacked flexibility and failed to provide important insights into the subject material which might be obtained when a teacher works with a student and investigates the reasons which are given when a student makes a particular choice.

CAI as a better tool of instruction

According to Taylor’s (1980) third aspect, the computer as a teacher (or) learning with computer where the action of programming the computer constitutes the main learning situation. Therefore the program that controls the action of the computer is called as software. The appropriate software(s) are to be selected for students. First determine the objective or use intended for software. The software is based totally on the nature of the instructional process that is being followed in developing the tool. The outward appearance matters little since CAI is an instructional tool. The software can be classified according to its intended use. There are many classification schemes. The classification scheme to be used here
is not unique, but it serves the purpose of focusing on the possible uses of computer in education settings.

When working with computer software on networks or minicomputers, students are likely to find that rather than a series of individual programs, there are modules or units dealing with individual concepts or ideas, and that these molecules, rather than the program as a total instructional unit, might be more usefully categorized according to use.

The researchers who design and develop the computer software(s) do not set upon the task of writing a software program by deciding the purpose and usage. Rather they have an objective in mind, and it is viewed with a particular set of students in mind. Any piece of software can include a variety of strategies incorporating elements from each of the uses we can anticipate and it might be used for different students with different objective in mind.

According to a comprehensive taxonomy of CAI software packages would be classified as following: by subject; by the nature of the skill-orientated task that they teach; and by the instructional strategy that they implement. Further then the classifications are divided into categories or modes according to their usage to the students.

Firstly, the simplest classification method applied to be subject category. Availability of one form or another of CAI packages benefited a variety of subject disciplines. Some of the earliest application area for which CAI materials were developed includes the science based subjects; the engineering disciplines and medicine.

The second method of classifying the types of CAI software packages that currently exist is by means of the nature of the task that the package is designed for its user. Some of the CAI software packages were designed to teach basic reading and writing skills; spelling; word usage, numeracy skills and a variety of more practically orientated subjects.

The third method of classification is important and widely used for CAI software packages based upon the mode of CAI that they implement. But many large CAI systems adopt a mixture of different instructional modes. Under this
classification scheme, CAI software packages are categorized into six modes, as detailed below:


MODES OF COMPUTER-ASSISTED INSTRUCTIONS

The different modes of CAI has been described as follows:

1. **Tutor Mode**

   In the Tutor mode of computer program the computer assumes the responsibility for the instruction by entering into a dialogue with the student.

   Tutorials are used in almost every subject area from the humanities to the social and physical sciences. They are appropriate for presenting factual information, for learning rules and principles, and for learning problem-solving strategies (Gagne, wager and Rajas, 1981). There are many instructional factors relevant to tutorial instruction which are:

   **A. Introduction**

   If related to the following factors:

   **The title page**: All the tutorials begin with a title page to attract the student’s attention, and to create a receptive attitude. They also indicate in a general way what the lesson is about. Gagne and Briggs (1979) indicate that doing something more to motivate the student is important.

   **Presentation of objectives**: A statement of the lesson’s objectives frequently follows the title page. The behavioral psychology school of thought, which spawned the instructional systems design model of instruction, encourages the use of behavioral objectives (Myer, 1962; Anderson & Faust, 1973).

   **Direction**: This is essential to the effectiveness of any computer-based lesson.

   **Stimulating prior knowledge**: Research on human learning indicates that the students will learn more if they can relate new information to what they already know (R.C. Anderson, 1977; Adons and Bruce, 180; Rumelhart and Ortony, 1977).
Initial student control: A tutorial frequently has more than one part. If a tutorial gives the students a menu for choosing topics, the student will return to the menu whenever finishing a topic, and

Presenting: Some tutorials give it in the introductory part. This is a short diagnostic test to ascertain if the lesson is appropriate for the student.

B. Presentation of information

The following are the main relevant aspects:

Mode of presentation: It means whether information is presented to the student as text, graphics, sound or a combination of these. Research on human learning (Fleming and Levie, 1978) indicates that dual modalities tend to enhance learning. Fleming and Levie were referring primarily to dual sensory modalities (Visual auditory and tactile), but other research evidence (Rigney & Lutz, 1976) indicates that combined visual modalities also enhance learning.

Length of text presentations: A critical factor affecting the quality of a tutorial is the length of information presentations.

Layout of text: Proponents of varying layout (Minestota Educational Computing Consortium, 1981) argue that it makes a lesson more interesting and increases the students attention.

Graphics and Animation: Dwyer (1978) presents considerable evidence that, when properly used pictorial information enhances the learning. However, if used improperly, it can actually be detrimental, Fleming and Levie (1978) point out that because the student generally attends to something, a principle of good instruction necessary is to keep attention focused on the important information in a lesson and to avoid focusing attention on unimportant information.

Color and its use: The use of color is closely akin to that of graphics, like graphics there is an evidence that color can be used effectively to enhance learning (Dwyer, 1978). Some colors especially yellow and green are easier to perceive than others (Duret & Tnezona).

Focusing attention: An essential aspect of good attention is to ensure that the student attends to important information.
Text quality: Burke (1982) uses the term leanness to describe an important quality of a tutorial. Reder and Anderson (1980), demonstrated that students learn the main points of a text book better from summaries of the main points than the text itself.

Types of information: There are four types of information. They are: Verbal information; Concepts; Rules and Principles; and Skills.

The rules and principles, which play an important role in the mathematical, physical and social sciences, is thought in either of two ways. One is Rule-Example method and another one is Example-Rule method. Research evidence appears to support the rule-example method (Klausmeier, Ghatala and Prayer, 1974; Klausmeier and Feldman 1975; Koran, 1971; Merrill, 1974); although there is some contrary evidence (Lahey, 1981).

Instructional prompts: It is used to guide the student and to give hints. Students should be able to get help when using a lesson.

C. Question and Responses

In tutorials, the most common method of interaction is to pose questions and the student must answer. A sizable amount of research supports the facilitative effect of questions in instruction (Anderson & Biddle, 1975). Questions should occur frequently and lengthy information presentations are best divided with interspersed questions. Questions can be categorized into two basic types. Alternative – response questions are those in which the student chooses the correct response or responses from a list. These include true/false questions, matching questions, multiple choice questions and making questions constructed response questions require the student to produce rather than select a response.

D. Judgement

It is produced by searching the student’s response for a correct answer and optionally for an incorrect answer. The six major answer types are:-

- A single selection, such as a multiple choice question.
- Multiple sections, such as a marking question.
- A numeric answer, such as for an arithmetic problem.
E. Feedback

It is the reaction of a program to the student's response and may take many forms including text messages and graphic illustrations. Following correct responses, it may also provide reinforcement for the student. Following incorrect responses, it should provide correction, with the purpose of improving future performance.

F. Remidiation

It refers to more extensive presentation of information for the student who is not learning material.

G. Sequencing lesson segments

There are two types in the tutorial, one is linear and another one is branching and

H. Closing

It is a final one. Temporarily and permanently, a lesson should always make clear that the student is leaving the program.

This in the tutor made present information, the questions are put up to students and decisions made based on the students comprehension whether to move on to new information or to engage in review and remidiation.

In their simplest form, tutorial programs comprise a linear series of factual statements interspersed with predetermined questions and responses. In their next form which is complex one, tutor mode packages are composed of parallel sequences of different levels of difficulty. In some cases programs are structured into three levels and the student can move from the mainstream of instruction to branching path for remedial or enrichment material. Other programs have a series
of instructional loops to which the student can branch briefly for remedial or supplemental study and then return to the main sequence of the program. Tutorial packages are designed to run on a computer permit, a more complex branching structure than either programmed texts or conventional teaching machines. The focus of the instruction is on the subject material and on the student’s mastery on it.

Numerous tools or higher level programming languages, like BASIC; C; C++; Visual C; Visual Basic; Visual Java, etc., are being developed to assist the teacher in the teaching of tutor mode programs, and the results so far have generally been promising. The microcomputers first used in schools had limited capacities for storing information and alternative responses to student input. The physical limitations of the machines restricted the programmer’s ability to plan for the wide range of possible student inputs. The present capabilities of the computers are only beginning to be tapped with respect to using the machines as instructional sources. With the use of smart systems and the integration of visual images stored on external devices, instructional programs in which the computer acts as tutor will surely become an instructional device worth considering.

2. Drill & Practice Mode

Among all the methods “drill & practice” is the earliest form of CAI to develop and use. In “drill & practice”, it is assumed that the student arrives at the computer with some prior training. Drill and Practice type software is available in many, if not all subject areas. While students can practice diagramming sentences, computing square roots or solving algebraic equations, they can also learn the mechanics of the task most probably through teacher-centered instruction. ‘Drill & Practice’ programs get mixed reviews from both computer educators and others. To sum, this type of approach is seen as a throwback to the concept of mental exercises; others argue that the rote-learning of pedagogical practices is useless, and argue that students must develop cognitive understanding and discover things for themselves, if true learning is to take place. The perspective of Gagne (1965) incorporates both behavioural and cognitive theories into a workable description of learning.
In drill & practice a selection of question or problem is presented repeatedly until the student answers or solves them all at some predetermined level of proficiency. Computer programs can considerably enhance the effectiveness / efficiency and can make the drill & practices. Most common use of computers in educational field is to provide drill & practice through the usage of software designed. A good drill & practice program can be very effective and efficient in providing elaborate topics already learned or partially understand. Moreover, the computer can do these things in an innovative and self – motivating fashion. A good drill & practice program will be (1) easy to use (2) adaptable to a variety of uses (3) interesting to the learner and, of course (4) educationally valid.

A paired associate is any pair of related words or events. The English word ‘dog’ and the Spanish word ‘perro’ are paired associates. In translation drill, the response to ‘dog’ would be ‘perro’ and the response to ‘perro’ would be ‘dog’. Other paired associates are a musical tone and its name (c-sharp, for instance), or a musical tone and its pictorial representation on a musical scale. Pictures of objects and English words identifying them, the names of chemical elements and their abbreviations, a spoken word and its spelling, countries and their capitals, and numbers and their square roots are all examples of paired associates.

A science teacher with access to a computer would find a wide assortment of programs that could be used by students to learn simple facts or statements of concepts. A flashcard approach which merely shows an example or a definition for the statement to respond to, and then respond to the student input to more complex software which analyses student responses in drill & practice sequence, and then provide specific reinforcement or remedial work.

Presently there are hundreds if not thousands of ‘drill & practice’ type programs available to teachers in all subject areas. Acorsofti markets ‘Number Balance’ which gives practice in adding or subtracting two numbers, and / or in multiplying or dividing. Chalksoft market ‘Angle’ which gives practice in the use of protractors and in measuring angles; Dr. Oaines market ‘Counting’ which is a practice program for counting shapes up to nine.
3. **Simulation Mode**

Although direct experience is usually the best form of instruction, reality in education must often to be sacrificed to factors of time, cost, safety and equipment availability. Simulation program provides the student with artificial experience of a static-or-dynamic real-world environment. The student is usually called upon to take actions that affect the modelled situation. Thus the instructional simulations are computer programs that imitate a phenomenon in order to teach the student about it. Simulations represent one of the more creative and interesting approaches to computer based instruction.

*Edwards* (1978) define the simulation mode of the computer as one in which the real world is represented by a model which is believed to behave like some portion of the real world.

When 50 pence is dropped into an arcade game and control is taken of an interstellar fighter with laser guns and force field shields, money is being spent on a computer simulation. Simulations are static-or-dynamic models or descriptions often of complex events or conditions. They are the naturally occurring at the end product of a model of learning which is more complex than that from which individual 'drill and practice' emanates. Simulations provide opportunities for the student to explore and gain understanding rather than learn in accord with a stimulus-response approach.

They are divided into four categories as mentioned below:-

**A. Physical simulations**

A physical object is displayed on the screen, giving the student an opportunity to use it or learn about it. They are very common and play secondary role to the coming one.

**B. Procedural simulations**

They play a primary role in most lessons and its purpose is to teach the sequence of actions that constitute a procedure. Physical and procedural simulations are inter related to each other.
C. Situational simulations

It deals with the attitudes and behaviors of people in different situations, rather than with skilled performance. Unlike procedure simulations which teach sets of rules, situational simulations usually allow the student to explore the effects of different approaches to a situation, or to play different roles in it.

D. Process simulations

They are different from other simulations in several important ways. The student neither participates in the simulation as with situational simulations, nor constantly manipulates it as in physical or procedural simulations.

There are several advantages in simulations. Simulations are attractive and interesting to students, probably more so than any other form of instruction presented by computer. It is well known that they enhance motivation. Although the 'learning by doing' philosophy has long been advocated (Brainer, 1973; Papert, 1972; 1980, for example), the introduction of computers into the educational field is likely to make its implementation more widespread. However, if the lecture series took ten hours, and the average time to complete the simulations was only five hours, teacher would have to say that the simulation was more efficient. That is, more transfer occurred per unit of learning time with the simulation than with the lecturer (Roscoe, 1971, 1972; Povenmine & Roscoe, 1973).

They are cheaper than allowing students to learn in the 'real world' and often the capacity of the computer to manipulate more than one variable simultaneously, and project the simulation in living color with associated sound out, allows for a simulation which could not be presented by traditional teaching methods. Also they are safe in as much as students can gain experience in areas which might, in the 'real world' be dangerous. Skills and understanding gained from participation in a simulation transfer easily to other situations.

The power and flexibility of current hardware in combination with the flexibility of languages viz.; Visual C; Visual Java; Visual Basic; etc may complex simulations easier to prepare. Simulation type software is increasing in complexity, realism and scope, over many subject areas, at a speed not matched
by any other type of software. Thus computer simulations can be as simple as the
development of mathematical problems that represent simple physical phenomena
such as object that more under applied forces, or as complex ecosystems or as
model environmental and population effects due to variations in system
parameters. In some cases, computers can be used to simulate, or replace standard
laboratory equipment which might otherwise be too expensive to purchase or
maintain.

The following are a few of the many programs available. Concepts of
geography can be taught by simulating an airline flight from London to Los
Angeles or to Adelaide, or, by having those who survived an airplane crash trek
out of an uninhabited area and by so doing understand the logic of contour lines.
Students studying environmental science or biology can assume the role, and be
presented with the problems of a fox living in a city. Students analyse data on a
variety of organic substances, from melting point through NMR or Mass
spectroscopy.

The increase in the ease of programming, as a consequence of the use of
more powerful languages in conjunction with the increasing memory space of
desktop computers, is seen in the production of simulation which are much more
realistic. Colorful and meaningful even though they were developed a few years
ago. e.g. Mary Rose, Saququara.

Hence, a subset of simulations is the demonstration program. This a
program that does not really teach in the way of tutorial program, by both
presenting information and requiring student activity, but simply shows the
student something else. It may be a useful classroom demonstration for a teacher
to use. Simulations provide the student with an opportunity to expose their own
answers and even explore the logic or method utilized to arrive at those answers,
rather than having to accept teacher dictate. Simulations can also be effective in
teaching simple facts.
4. Problem Solving

A computer program which possesses one or more problems may require the application of a process or procedure for resolution. It is important to recognize the difference between a simulation and a problem-solving program. In simulation, there is no prescribed outcome. The program merely provides a responsive environment for the testing of a hypothesis. On the other hand, a problem-solving program has a focus on coming to a particular answer or conclusion. Problem-solving on the computer would require cognitive skills beyond the application level, and more often than not, a part of the solution process will require the learning of procedures necessary to resolve the problem.

5. Instructional Games

A computer program requires the application of one or more skills or concepts to a problem in which competition, strategy and random events are significant factors. Many students / people are more familiar with the use of computers as a game rather than its use in instruction. The student is required to learn the rules, through experience with the package, and then apply them to achieve particular pre-defined objectives. The following few are well-known student oriented games which are Decimal Parts is an elementary school arithmetic games; How the west was one + Three x Four is a board game depicting a race between a stagecoach and a railroad engine; Ordeal of the Hangman is a guessing game with a difference; Rocky’s Boots is one of the series of program designed to teach logical reasoning to young children. Archeology search is a game whose purpose is to teach elements of the scientific method of inquiry, four-letter words is a vocabulary game asks the player to create as many four letter words as possible from given letters.

All the games mentioned above are intended to be instructional. The common features are present to varying degrees viz. Goals, Rules, Competition, Challenge, Fantasy, Safety and Entertainment. There have been many attempts to classify games (Abt, 1968; Ellington, Adinall & Percival, 1982). They can be classified by an overall generic description such as combat games, adventure games, card, board, or logic games, role-playing games and psychomotor games.
In the course of time, it is likely that science educators will design games in which the objects simulated will have the same physical characteristics as their real life counterparts, and winning strategies will require the knowledge and application of basic laws of chemistry or physics. It is considerable that the laws will be learned through the same trial and error procedures that often are used to master the present games. A student’s ability to play a sophisticated video game should infer that this same student could, under proper instruction, be taught to appreciate and understand equally complex scientific concepts.

6. Instructional Support

A computer program is used by an instructor or student to produce non-computer instructional materials that facilitate class-room learning. As long as a computer is a limited resource, possibly the most efficient use of a computer is to place it in the hands of the teachers who could use it to prepare other materials for instruction. It is called as material production. Another most efficient use of a computer is to place it in the hands of the teacher who could use it to manage the learning environment. It is called as Computer Managed Instruction. Thus there are two categories of the instructional support. In the former category it would be word processing programs which can be used by the teacher to facilitate all forms of written communications, while the later category might be a grade-book program which would be used for storing student records.

A. Material production

It is hard to project how much written and visual material is prepared by the ‘typical’ science teacher. But when resources are available there is no doubt that preparing materials for instructional purposes can be a major task for an instructor. The computer can make this task much more manageable and professional.

Science teachers feel that using a computer for writing a whole spectrum of papers is a great help. Although only a limited amount of time is saved in preparing the original documents, significant time is saved when a document is edited or updated. It is almost certain that the time a teacher takes to learn about
the usage of word processor will be compensated in a short period. In addition to this science teachers can make use of graphic and formatting programs which are designed for educators and in some cases for specific subjects instructors or teachers. Some science teachers will find that there are programs which can generate worksheets which are of specific use to their own courses. For example a teacher can choose a program and construct crossword puzzles with vocabulary alone and can give specific clues according to this choice.

In terms of software that are subject specific, there are files of pictures on various topics from which a teacher can select appropriate pictures to illustrate concepts and add them to visuals or make them part of papers for providing students. For example, there is a file of pictures for the Macintosh which includes images of the various pieces of laboratory equipment found in almost many laboratories. The teacher can ‘cut-and-paste’ the pictures from templates to a laboratory exercise sheet with the minimum effort and can present a professional looking image for the students. Digitized templates and images are available for wide range of topics and experiments.

B. Computer Managed Instruction

Computer managed instruction is distinguished from computer aided instruction by the fact that in computer aided instruction, the student interacts directly with the computer which responds in some way to the student input. The mode of response might be a drill & practice program, tutorial, problem solving or simulations. When a computer manages instruction, it functions in a very different role. The computer is used to take information about a student and to use the information to plan or recommend for future instruction. It is anticipated that in the near future, computers will be sophisticated enough to combine their record keeping capabilities and a variety of instructional strategies to prepare instructional programs to meet the individual student’s requirements.

Nowadays most of the computer managed instructions are implemented by the students who feed the information directly into the computer and the computer responds directly to the student. The management of instruction can be an integral part of the computer aided instructional program. A computer on a teacher’s desk
can reduce the amount of paper work needed to keep a class running smoothly and effectively. With a more extensive computer network the system not only keeps track of the students work, but incorporates analysis and strategies into the system in order to recommend programs for students which would lead to highly individualized instruction.

CONCLUSION

The computer uses in education is directly related to the development of the skills needed for national development. The interactive computer-based instruction changes the human thought structure for children learn differently with computers when compared to teacher based instruction. The systematically and the potential multidimensionally of the computers as instructive, individualized tutors facilitate the learners learn effectively. However, the teacher being central to any scheme of education cannot be supplemented by the technology. Technology is a tool and a servant within the control of the teacher. But, if the teacher does not know how to handle the servant, the latter will take over the former.