CHAPTER II

COMPUTER SIMULATION AND EDUCATION
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2.0 INTRODUCTION

As mentioned in earlier chapter among all powerful and important uses of computer simulation one of it's use is for educational purpose. Simulation enables a teacher to present artificial versions of real life situations that are too costly, time consuming, dangerous, or complicated to recreate in a classroom. In this sort of instruction the computer is able to simulate the conditions of an experiment or situation.

Illustration of chemistry, biology, or physics experiments, the prediction of outcomes of sports events, recreation of historical events, cooking and meal planning, social science experiments all are the applications of computer simulation, which can help to convey the idea better with simulation.

2.1 EDUCATION AND THE MICROCOMPUTERS

During 1960s computers were believed to have significant potential for education. In fact, tremendous growth in the use of computers for direct instruction was expected. But conditions were not yet right. The computers of that day were huge, costly machines, usable and affordable only by large corporations, government agencies, universities, and research centers. Large, highly trained staffs were required to operate, maintain and program these computers. Therefore, educational uses of computers were expensive to develop and even more expensive to implement. Further the design of the learning activities were based primarily on the programmed instruction approach, in which students progress through highly structured steps toward clearly specified behavioural goals /1/.

The more recent history of computers in education is quite different. The small computer- the microcomputer- is being touted as a potentially revolutionary tool for the modern educator because in addition to its low cost, it is generally designed to be easier to use than
larger machines. In fact, to use most microcomputers, the educator does not have to be a computer expert or even to know anything about programming. A few days of training will usually enable a complete neophyte to benefit from the exciting new technology. The low cost and case of operation of the microcomputer have allowed classroom teachers, counsellors, librarians, resource teachers, school administrators, and other educators to make immediate and successful use of this powerful tool.

Universities and research centers were largely caught unprepared as this revolution in the use of computers began. They were lulled by the belief that computers had been found impractical and too costly for use in education. Further, the universities were beset by a myriad of problems of their own, ranging from inability to compete with industry for computer experts to inability to maintain their existing programs in the face of dwindling funds. As a result, universities, and training institutions have been slow to respond to the demands of educators for more training in instructional computing. Nowadays, educators at all levels are showing interest in learning about computers in education.

Staudemaier, described /2/ several courses in which the computer plays a central role in the simultaneous teaching in physics and computer sciences, computer simulation in theoretical physics and also laboratory in which the computers (or microcomputers) are used on-line in physics experiments, which are performed by students.

The idea of using computers in teaching is hardly new. Almost since the dawn of computing efforts have been made to apply this technology to the education process, and early attempt in the USA and elsewhere have been written in to the folklore of computer based teaching and learning.

In Britain responsibility for the development of IT (Information technology) in the universities was placed in the hands of the computer
board for universities and research councils when it was founded in 1976. Originally the computer board saw its remit as providing computer to support research with no mention made of teaching, although this oversight was later recognized by Barnayard /3/ and rectified. Following the publication of Barnayard report, the first initiative aimed at developing the use of computers in education was launched in the shape of the national development program for computer Assisted learning (NDPCAL) /4/. In 1983 the computer board commissioned a review of computing facilities for teaching in universities which led to the publication of the Nelson resort /5/. One of the fundamental recommendations of the nelson report was the setting of a target of one computer workstation per five undergraduate students by 1990. Another survey of the provision of computing facilities for teaching was carried out by the inter university committee on computing (IUCC) in 1991 /6/.

In the field of electronics, the electronic design education consortium (EDEC) is dedicated to the production of computer based teaching and learning to support the education of electronics engineers and computer scientists. It is one of the projects being funded under the teaching and learning technology program (TLTP), a major initiative of the UK higher education funding councils aimed at making teaching and learning more productive and efficient by harnessing modern technology. EDEC achieved its stated goals of producing 160 hours of courseware during the 3-year duration of project /7/.

2.2 THE ROLE OF COMPUTERS IN THE CLASSROOM

Most important applications of computers in education are in problem solving. Computers were developed to help solve a diverse range of complex problems. Some computers are capable of making calculations with such speed and accuracy that they can solve in a matter of seconds problems which might require a lifetime to work out
by hand. When used as tool for problem solving, the computer can serve as an extension of the human mind but not as a replica of it.

The role computers can play in the classroom depend upon the curriculum and how that curriculum is put into practice. The following steps are useful in examining a curriculum to determine the best role for computers /1/.

1. **Specify the goals and objectives of the curriculum.**
2. **Examine the curriculum to determine where and how computers might be effectively used** :-

Unfortunately, since 1985, there has been very little research on the unique capabilities of computers to support certain kind, of learning /8/. However, on the basis of logic and experience, some educated guesses about the match between what must be learned and computers can be proposed Fig. 2.1 shows one approach to this kind of analysis /9/. In Fig. 2.1 the cognitive levels of objectives from knowledge (simple) to evaluation (complex) from the horizontal rows objectives at the simple end of the scale are typically facilitated by such instructional computing activities as drill and practice, tutorials, and some educational games. Objectives that involve higher levels skills can be supported by games, demonstrations, and **Simulation.** Finally, objectives at the highest levels can be addressed by rather sophisticated simulations, problem-solving situations, programming, and other creative applications. Generally speaking, more complex instructional computing activities tend to be more costly. They can require greater skill from the software developers to produce and more sophistication on the part of teachers and students to use. These more costly and so sophisticated techniques should be reserved for situations where they are really needed. Drill & practice would be an effective way to help students learn to recite the names of state capitals when given the name of a state; more sophisticated technique would not be necessary. On the other hand, an objective that requires
the student to interpret a set of population statistics for the India would be at a higher level comprehension, perhaps. Tutorials would seen to be a more promising approach. Educational games can be sometimes effective in increasing student motivation /10/.

![Diagram of Cognitive levels of instructional computer activities]

**Fig. 2.1 : Cognitive levels of instructional computer activities**

3. **Evaluate the existing curriculum to determine where computers weight be applied to increase the degree of attainment of goals and objectives :־**

In the classroom, a teacher can look through records students record of performance and add general impressions about which techniques have worked and where. For example, an individual teacher may feel that too much class time is being consumed by instruction on lower-level objectives and may want to have more available for higher-level objectives. In that case, the teacher might spend less time on simple kinds of learning that computers can teach well, and instead concentrate on facilitating social development, motivating further learning, or teaching more complex material. Analysis of the match between potential computer
activities and instructional objectives may suggest areas in which instructional computer may help.

4. Evaluate the existing curriculum in term of how it might be or updated to utilize computers more effectively.

   For universities/colleges or schools classroom, it is necessary to literate about computer.

   Compute literacy can provide better integrated program for students.

5. Planning of curriculum and its operation according to the information, accumulated.

   Course definitions, goals, objectives, sequence are clarified. Then, the clear results would come that what is expected in the classroom curriculum.

   Teachers need to be involved in the teaching planning and to do their own planning for using computers in the curriculum. Since computers are better at some instructional tasks than others, teachers can bring their knowledge of instructional strategies and learning in to good use during the planning stage.

   A good number of publications on the use and effectiveness of modern computers in education exists /11-19/. S. Robertson, J.calder et al /11/ presents the use and effectiveness of palmtop computer in education, and this paper report how palmtop computer were used in school over the course of years. Continuing work is described that is aimed at developing a model and computer based simulation of a student learning to model which has the potential for providing better computer based support in the future—both in respect of providing improved quality dialogues and in terms of comprehending the students activities /12/. Teacher and student of the physics department of FURG (Funda ção universidade do Rio Grande) are developing a project that aim to improve the standard of science education in primary public
schools through computer assisted learning /13/. Appropriate training in hardware and software operation, in service teachers can better utilize these technologies to serve their instructional needs a number of well-designed software packages used included tutorial of Microsoft word (for simple word processing skills), Excel (for working with spreadsheet) and Tool Book (for understanding how hypermedia works) in windows /16/.

The recent proliferation of science simulation software presents philosophy of science instructions with a viable means to reaching greater number of students in both science and non-science majors. Conclusion stated that, while computer simulation are extremely useful pedagogical tools, they are not experiments, and are thus of only limited utility as a substitutes for actual laboratories /17/.

A report on a survey of the use of video as a teaching resources within on British university, presented by Jane Barford and Colin Waston /18/, drawing on evidence gathered during 1995 from fourteen schools within its four faculties. It identifies the factors and issues which influence the use of video in teaching, including management of video resources within the schools; how video is used to support teaching strategies; and its perceived usefulness as a teaching resources.

Although video is clearly an established and frequently used resource in the university. Staff who understand the importance of visual images are well placed to exploit the potential of multimedia technology; utilizing that technology to support their teaching, rather allowing their teaching to be technology driven /19/.

Jane & Colin /18/ research about visualization of problems and experiments for teaching doe not seek to suggest that video is the optimum educational resource. Problems with poor subject material, particularly when used without the backup of resources packs or follow-up exercise; and the perceived lack of inter activity for students,
are just two of the immediate disadvantages of this medium. Nevertheless there are clear indications from the finding that the participant staff do see video as having an important pedagogical role to play, even though they are more immediately concerned with the practical considerations relating to its use. Such findings are supported by the recent launch of the Educational Broadcasting services trust shot list project, funded by Higher Educational funding council to provide subject based videos for the HE sector, particularly in science. In addition, Viscom The Rebert Garden University's own production company, is developing a teaching program of subject based videos for the school of Applied science which will provide tailored subject material; ".... Presented in a manner that lends itself to the lecturing environment." [18].

2.3 COMPUTER AS A PROBLEM SOLVING IN EDUCATION

As mentioned, most important applications of computers in education are in problem solving. To solve the problem, programming is necessary & problem must provide step by step instructions for the computer. Thus, strategies for solutions must first be derived, and then programmed into the computer. Further, in order to create such sets of instructions, one must understand key elements of the problem and the nature of solution.

For example, to calculate the distance of a star from the earth, one obviously does not simply ask the machine a question like, How far is Alpha Century from the earth?. The programming necessary to solve this problem: instructions are used in the from of precise mathematical statements, to determine the measurements for solution & finally the detailed programming instructions provided to the computer.

The use of computers graphics for problem solving as investigated during use by individual learners and by distant pair collaborating by interaction through the screen. In both investigations learner had to correct computer graphics representing population
models either by graphical manipulation or by with written explanation. In both situations positive effects of manipulable graphics on problem solving performance were found. However, a detailed analysis of the interaction process in the collaborative situation showed that, comparing both experimental conditions, static graphics led to a higher proportion of correct content related statements and explanation of system relations result suggest that for the effective use of graphics in computer supported collaborative learning, structural support devices that encourage adequate processing and focus learners on the problem solving process seem to be necessary /20/.

A working prototype of the mobile classroom of the Philippines Department of Science and Technology (DOST) is exported to be completed soon. This is an idea which the department of electronics could take up in India to benefit schools that do not have Information Technology (IT) Infrastructure /21/.

2.4 WHY IS COMPUTER LITERACY IMPORTANT?

In recent years the prevalence of computers, increased dramatically in society. Computers are no longer limited to universities, research laboratories and large corporations, as they were until the early 1970’s but are now routinely found in elementary school classroom and every day life. Computer literacy does not have a long history.

In the 1970’s most writers trace the beginning of interest in education for computer literacy to statements by various mathematics and science education groups /1/.

Two events appear to have made computer literacy imperative. (i) Easy access to computing was made possible by advances in microprocessor and silicon chip technology. By the late 1970’s, computers had become so responsible in price that many people began to buy them for home use. The impressive capabilities and
low prices of these machines hastened their introduction into classroom.

(ii) To control may process in manufacturing, science, frame and industry, computers have used large-scale data storage devices and in electronic message transmission computer aided design and computer aided manufacturing (CAD/CIM) have revolutionized engineering. The printing publishing and communications fields have also been profoundly affected. Business and industry need workers who are able to use these new technologies /22/.

These social changes are placing pressure on the schools to produce technology oriented cultured people.

2.5 APPROACHES TOWARDS COMPUTER LITERACY

The role of education is crucial for development of universal computer literacy and technological skills. New patterns of thinking will probably emerge as emphasis on technological education increases. Evidence of new ideas being effort to undergraduates; several colleges are beginning to emphasize on new technology oriented culture rather than traditional approaches.

The idea of education for computer literacy has not been widespread vocal opposition. However, there is debate over the best way to approach the teaching of technology and computing. Some people argue that the most essential part of education about computers is awareness of technology, it sues, and its impact on society. This is called Computer awareness. Other argue that students should learn that they can control computers rather than that computers can control them. According to this view, the relationship between communication and traditional literacy has a direct counter part in computer literacy. There are two view within computer literate program one has emphasized programming skills /23/. The other would be satisfied if student could use applications software to do meaningful data processing and problem solving /24/.
A third way to approach this problem is to focus on needs and to consider the computer literacy curriculum as part of an integrated overall school program. Students might pursue information about computers in a science or mathematics course. Programming would be taught in the context of problem solving. This integrated approach tends to soften the distinction between programming and using applications packages. Fig (2.2) summarizes the different approaches. One of such is problem solving & Simulation. Simulation program helps student to teach highly dangerous and time consuming experiments. Its provide the real like situation but without real implements. /1 /

Fig. 2.2: Different views of the contents of computer literacy and computer awareness curricula.
2.6 COMPUTER AIDED LEARNING

At one time, people involved in instructional computing tended to group educational computer applications into two main categories: computer assisted instruction (CAI) and computer managed instruction (CMI). Historically, CAI consisted of drill and practice or tutorial presentations. Drill and practice involves the repeated presentation of questions, checking of answers, and provision of feedback on the correctness or incorrectness of the responses. Its purpose is to reinforce and aid in the memorization of facts and concepts. Tutorial sessions sometimes contain question and answer segments; but they are designed more to present and illustrate material. Thus tutorial sessions present, explain, and introduce concepts; in drill and practice, on the other hand, instruction is generally provided by repetition and reinforcement /25/.

In CMI, students do not necessarily receive direct instruction from the computer. Rather, the computers function to keep records of students' progress, provide prescriptions and schedules for instructional activities, and perhaps provide testing and diagnosis of learning problems /26/.

During 1985's the distinction between CAI and CMI is probably not as useful as it once was. That is, some drill and practice or tutorial software may incorporate aspects of CMI functions. Such as keeping track of the student 'Progress'. Usually the term computer aided learning' is used to refer to any and all uses of computers for instruction. Some other proposed similar terms are computer based education (CBE), computer based instruction (CBI) computer aided design (CAD), computer aided manufacturing (CAM), computer engineering (CAE). Compute integrated manufacturing. (CIM).
2.6.1 WHAT IS CAD/CAM/CIM

Our brain resembles the halves of a walnut, with the left half controlling the right side of our body and right half controlling the left side of our body. And it seems that our creative, or visual, side is controlled by our right brain; the verbal or written, by our left brain. Studies suggest we do not use the right half of our brain as much as we should; we use only half the brain power given to use /27/.

Using the right/left brain relationship as an analogy, a computer function like the left half of our brain. For years computers have been pumping out reams of paper which have been routinely passed from accountant to accountant, from engineer to engineer, and from manager to manager, because it was the thing to do.

CAD/CAM, and in particular the computer graphics era, allows us to condense tons of printouts into neat little pictures that can be easily understood and then acted upon. The decision makers can get the picture and decide what to do. In essence, graphics and CAD/CAM offers an engineer the chance to use the results of the right side of his or her brain.

Although many people apply the name CAD/CAM/CIM to a graphics workstation, the name itself is an acronym meaning Computer Added Design, Computer Aided Manufacturing Computer integrated manufacturing and they have separate disciplines. In reality CAD/CIM is a marriage of many engineering and manufacturing disciplines. In its simplest form, it is a computerized communication and design function within and between design engineering and manufacturing design. If we take it to the extreme, we can include almost any phase of the business and manufacturing cycle. This would include marketing, office automation, accounting, quality control, and almost anything else that could attach itself to a central data base. In general, we can look at the CA in any of the acronyms as being computer. Aided and being synonymous, with automation /27/.
Computer integrated manufacturing (CIM) is a term to describe complete automation with all process functioning under computer control. It uses the database and communication technologies to integrate the design, manufacturing and business functions that combine the automated sequence of factory or facility. CIM reduces the human component of manufacturing and thereby relieves the process of its most expensive and error prone ingredient. CIM stands for a global methodological approach in the enterprise in order to improve the industrial performance /28/.

2.6.2 USE OF COMPUTER AS INSTRUCTIONS

Table 2.1 /1/ present eight instructional uses of computers. In each instance, the primary purpose of each use is denoted by an X in the appropriate column of the table. An application may primarily benefit the teacher, students engaged in group learning, or students engaged in individual educational activities often of course, an application will have benefits in two or three areas; but here only the primary benefit for each type of application has been indicated.

Table 2.1 : Benefit of using computers in various instructional applications.

<table>
<thead>
<tr>
<th>No.</th>
<th>Computer Application</th>
<th>Aid to teacher</th>
<th>Individual instruction</th>
<th>Group instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Development of instructional materials</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Maintaining students' records, administering and scoring</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>tests, designing, learning experiences for individual</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>students.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Group presentation and demonstrations.</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reinforcement of learning through drill and practice.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>---</td>
<td>----------------------------------------------------</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Computerized games, simulation and problem solving.</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Instruction in computer and programming</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Creative and occupational uses of the computer e.g.</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>music, art, writing, business.</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The first three applications used in table 2.1 primarily benefit the classroom teacher. Computers can be used to develop instructional, puzzles, handouts and so forth. These can be used by teacher to test students, to keep records, and learning activities for individual students. The computer can be used to demonstrate calculations, graphics and displays to a group or an entire class. In group applications however, special equipment may be necessary. For example, large projection screens would enable a group of students to see the visual output better than a small CRT; Similarly, audio output may have to be amplified to a greater degree than is necessary for a single user. Further a computer network might be set up in a classroom so that students can communicate with each other and with the teacher certain adaptation in software design are necessary for group instruction. These are courseware developers who specialize in courseware for group use /29/.  

Individual instruction may be enhanced by introduction of facts and principles during computerized tutorial sessions. Facts and principles can be reinforced through repeated exposure during computerized drill and practice sessions. Individual learning can also be facilitated by computer simulations and problem solving in
producing computer programming and in creative applications of computers.

Table 2.1 suggests that the computer can also facilitate group instruction by providing group presentation of tutorial instruction, problem solving activities. Simulations and activities in which group design creative applications of computers involving graphics, art engineering etc.

Simulation, games, and problem solving are three different kinds of computerized instructional activities. However although they are distinct in design and operation, they do share several traits; accordingly, they are often grouped together. For example, they use more of the power and capacity of computers than tutorials or drill and practice further, they are more obviously suitable to instruction in cognitive tasks on a higher level than knowledge of facts and definitions or simple understanding or concepts and principles /30/. Simulations, games, and problem solving give greater opportunities for introducing affective objectives and, if properly designed, can provide intrinsic motivation for learning.

These type of applications can be more difficult and costly to keep develop than drill and practice. The teacher must be sophisticated in using problem solving activities that involve the computer. Moreover, knowledge about how to develop these type of applications is not well established till 1985. However, these approaches have the potential to significantly alter educational practices /1/.

Nowadays these approaches of simulating the problem become very powerful and indispensable tool, to study the complex and large problems and experiments.
2.7 WHY TO CONSIDER SIMULATION IN EDUCATION?

Educators use computers in various ways. Computers were portrayed as tireless and patient workers, able to free educators from repetitious tasks. Different types of computer activity engage students in different kind of learning.

Besides all activities of computer, Simulation on the other hand, concerned primarily with representing real situations. The purpose of conducting simulation studies is to learn the most about the behaviour of system being simulated for the lowest possible cost.

Simulation programs represent particularly promising uses of computers in education because of their potential for increasing motivation and bringing realism into educational experiences. They tend to make use of the ability of computers to control many interrelated variables simultaneously. Color graphics and sound may be available to increase clarity, dramatic impact, and realism. With simulation, students can be involved in complex learning activities. When simulations are well designed, they promote active involvement in learning, and this leads to greater comprehension of material for example, with a simulation of a nuclear power plan the student may actually experience the operation of the plant while learning about the complex relationships involved.

Educational instructional programs are significantly enhanced with simulation. Effective instruction simulations require consideration of the cognitive level of the tasks in the learning activities. The questions which will be addressed, while considering the use of an educational simulation are:

(i) *Is the microcomputer based game or simulation appropriate for the educational objective?*

(ii) *Does the software packages support the objective?*
(iii) *Where is the appropriate point in the curriculum to introduce the simulation?*

Simulations work best when they are integrated into a planned sequence of learning. Computerized simulations must into the larger educational program, which includes textbooks, writing exercise, various media, costly and dangerous experiments and teaching strategies. Computerized simulations of an experiments should be considered one more tool for the teacher. /1/.

2.8 **GRAPHICAL REPRESENTATION**

Like any language, graphical or pictorial presentation of any problem or experimentation play an important role. Well trained engineer or a well trained scientist should be proficient in the use of the languages of his profession the English language in both its written and oral forms; the language of symbol as used in mathematics, physics and chemistry; and the pictorial languages, graphics. These are the principle means of communication for scientist and engineers. In the classroom teaching also these languages are as useful with the help of these languages. Thinking should embrace both the symbolic and graphic modes of expression.

Combined power of symbolic and graphical languages find by scientist and engineers; advantageous in many instance to solve technical and scientific problems /31/. Problems, experiments and ideas expressed by graphics, should be more effective. Learner and students also catch the idea quickly with these language of graphics.

There is some recent research on the impact of using graphics in collaborative learning and problem solving in face to face situations: /32,33/. It has been shown that graphics are symbolic vehicles for externalizing student conjuration for peers and teachers as well as means for negotiating group and individual understanding in a domain. Student engage in appropriate conversations about the conceptual content they are investigating. They can point at the graphically
represented entities, talk about what is meant, about describe how these are connected to other things. In this way graphics provide indexical support for meaning negotiation and for agreement on the solving progress.

Recent research has also demonstrated how graphical representation affect the case of problem solving in various domains /34-38/. Graphics serve as external representations which are very effective for making inferences, finding salient characteristics and structuring the course of problem solving dependent on the content. Besides this effect of facilitating problem solving processes, graphics can display salient features of a problem space and allow the visualization of parts of the goal structure in the form of intermediate nodes. Making goals explicit helps learners to concentrate on the structure of the solution. Merrill and Reiser /39/ have shown that external representation reminds learners of their current position in their solution plans. Therefore, graphics representation can have a highly supportive function in the problem solving process.

The constructive aspects of graphics for problem solving are especially evident in manipulable graphics where learners can change features of graphics directly. Recent research has shown how actively constructed and interactive graphics affect learning and problem solving. Activity drawing graphics can lead to deeper processing in problem solving than a merely passive relation of pre-drawn graphics. Grossen and Carmine /40/ illustrated how user constructed graphics were much more effective in support of problem solving performance and retention than the passive use of pre-drawn graphics in the domain of graphical reasoning. In agreement with these finding Cox and Brna /35/ pointed out that external representation, such as graphics should be actively constructed by the user in order to be of maximum benefit. By means of direct manipulation, learners will obtain a direct feeling for the underlying structure of the represented content that is often hard to achieve with conceptual reasoning /34/.
In using manipulable graphics application of knowledge to problem solving is helped by the fact that changes can not only be carried out, but also made directly visible, thus relieving the limited capacity of working memory.

Now a days, in the place of paper, and pencil the computer evaluation make graphical language so easy and so more effective. Specially in the field of science education, language of graphics should help great to impress ideas, and hypothesis and experiments in the classroom teaching.

2.9 SIMULATION IN RESEARCH AND INSTRUCTION

In research, modelling means the creation adoption or choice of a model to correspond with a natural phenomenon of man-made system. Simulation means the purpose oriented work with a model of a system. In a computer simulation the model is defined as an algorithm and programmed to a computer language to be run on a computer.

2.9.1 SCIENCE EDUCATION, EXPERIMENTS & SIMULATION & MODELLING

Modelling and simulation is a special scientific method to study natural phenomena and to develop, to create and to test a new theory, Fig. 2.3 tells the story of modelling and simulation in research and instruction /41/. In an idealized case the scientist studies a natural phenomenon by observing it in reality; he performs experiments in real life or in the laboratory. For better understanding and communications to other scientists he performs a model of the real system. The formulation of the model is seldom done in one step. In most cases the scientist has to undergo a long, hard construction process with many revision cycles. In case the scientist has described the model in a computer language, he will run it on the computer and study its behaviour in simulations. The revision of the model could be influenced
by either the outcome of the real life and laboratory experiments or by
the simulation experiments.

Fig. 2.3: Modelling and simulation in research and instruction.

In science instruction at the universities the students learn in a
very different way. In laboratory courses they get a feeling of how to
define special conditions for the experiment, how to measure the
important variable, and how to evaluate the outcomes. But most areas
of discipline are learned in a very abstract, theoretical manner by
reading books or hearing lecturers. They always learn facts and results
out of the work of famous researchers very seldomly they are taught
also about difficult problem solving process, there researchers had to
go through for finding their results. Students do not learn much on the
methods of asking scientific questions, developing and test them.

Using modelling and computer simulation in science instruction
could be an alternative way to teach the science. Student could work
for some time in the role of a researcher, when they are allowed or
even trained to create, adapt and revise models and test them in
simulation runs for finding answers to scientific questions. Computer
simulation could be a medium or instructional method for learning
science by doing. These methods provide an important extension of
student activities to more explorative, activating and motivating work.
2.10 LEARNING FROM SIMULATION PROGRAMS

One of the features of computer assisted learning projects has been the variety of simulation programs which they have produced and used in the physical science, engineering, mathematics, medicine, and social studies. Many of the concepts in these subjects are difficult to illustrate, either because data cannot be produced readily in the lecture room, or because the concepts themselves and the relations between them are represented in formal and symbolic terms which seem remote from everyday experience. However, computer programs which use these equations or quantitative data bases to provide a model of the system can help to build up a student's knowledge structures. In general, the student cannot attend the programs themselves but can manipulate input values of variables which describe the system and observe their effects on output displays. In this way the properties of the underlying model can be appreciated and hypotheses and ideas about them tested. Thus the students understanding can be elaborated. Simulation packages of particular value for topic which are mathematically complicated and for which it is difficult for a student to comprehend the full range of behaviour just from the mathematical formalism. The computer can thus be used to deepen insight into a physical phenomenon. Packages or simulation programs have also been developed to simulate laboratory situations where real experiments would be dangerous time consuming, expansive or technically difficult [42].

For these reasons, providing exercises through computer programs has proved a popular and useful development in science teaching. For example, Roos has a series of programs which simulate the human menstrual cycle [43]. The output shows the time of ovulation and the time and duration of menstruation. The user can substitute hormone treatments and observe the suppression effects on ovulation, uterine developed and/or menstruation. Again Dehner & Norcoss [44] have developed a simple program which allows students to simulate
acid base titration for a variety of weak acid and turbo diametric titration to obtain solubility product information for a number of slightly soluble salts. Although this type of program does not provide experience with the laboratory technique, the student can perform his titration more cheaply and quickly than might be possible in the laboratory, and these illustrations will help him to grasp the basic concepts which are involved in titrimetric analysis. Standard has also developed a dry physics laboratory in which the user chooses apparatus and programs allow him to perform experiment with it /45/. For example, in dynamics the student can operate masses at speeds beyond anything that could reasonably be achieved in the laboratory.

Engineering is another useful area for simulation, particularly as many real systems, e.g. Nuclear reactor are too expensive or dangerous to be made available to the student. A multi institutional Engineering project directed from Queen Mary college, London has derived over seventy packages in electrical, nuclear, aeronautical and mechanical engineering /46/. Almost all of these science based simulations translate the output into visual display. So that the student can more easily see the effects of decisions.

An example of teaching through simulation, which shows many of the advantages and difficulties of the technique, is the emergency patient program which has been implemented by Taylor and Scott of the Glasgow bases Medical project /47/. The patient is represented at any current time as the state values of a set of vital signs, such as temperature, pulse rate, respiration, coma and cyanosis, which are appropriate to the working context. Functions act on these values and so govern their change through time. At the terminal, detail of situation are printed out e.g. a car accident victim with fractures and airway blockage. The student can ask for investigations and test do not affect the patients state directly, but they have a time penalty and during this time the condition could deteriorate. The user can monitor changes and the rates of change in the values of the vital signs and the results are
shown graphically. To improve the patient's condition, the student can propose treatments. To each of these a time increment simulates its administration, after which functions attached to that treatment alter the patient condition values. Fig. 2.4 shows the command which are used in the medical simulation program. If threshold values are exceeded, the patient dies. The treatment can be classified in those which have good or bad effect in the short and in the long term. The aim of course, is to hasten the patient's improvement and achieve a stable condition and this is the sole feedback given to the user through the changing sign values.

An advantage of using this simulation exercise is that the learner can operate with a simpler system than would be encountered in reality. Greater control is possible and so it is easier to appreciate the relationship i.e., the patient's requirements and the effects of treatments. Building simulators to serve as teaching device is not an easy task and require careful analysis. Even when the equations or the date bases which describe the system are known, it is not always easy to decide the task which should be given to the learner, i.e. what combination of variable should be manipulated, or what type of instructions should be allowed at the terminal. The feedback message and the form of the output displays are also important influences on learning and should derive from the educational objectives.

A number of simulation packages have been developed by the physics Department at survey covering such topics as the transmission of electron through a potential barrier, the conductivity of semiconductor materials and radioactive decay chains. A full list is available and some example are given below which illustrate various facilities and techniques that are available using VDU (Video Display Unit) terminals.

An example of the simulation of a process that is mathematically complicated and that could not be demonstrated in a laboratory is that
Fig. 2.4: Commands used in the Medical Simulation program.
of the transmission of electrons through a potential barrier. A program called TRANS calculate transmission coefficient for an electron incident upon the potential barrier. The effect of varying the electron energy and the barrier width is determined and the output date is presented in tabular form. Package Mocoil, which simulates a moving coil meter and calculates the displacement when a current passes by solving the appropriate differential equation. /42/. Another example of the simulation of an experiment occurs called Counters, simulates a radiation experiment enables optimization of the experimental arrangement of detectors, source and geometry. The objective is for the student to gain skill in experimental strategy and familiarity with the significance of various counting techniques A large number of simulated experiments can be carried out in an hour which would in the real laboratory takes many days. Laboratory experiment, using simulation have been reported by Masterton /48/.

One of the key experiments for the teaching of modern physics is the double slit experiment, but it is impossible to realize it at school using low intensity of light. The constructions of a simulation model of this experiment could be of help. The computer simulation serves for probability interpretation of the interference pattern on the screen by single portion in the experimental device. By pressing the button on the keyboard simulates the light source, the terminal display simulates the screen with multipliers in the experiment /49/.

The Physics simulation program Particals and fields has been equipped with a powerful dialogue system, which minimizes the amount of work for defining or changing the input data and for selecting the most useful parameters for displaying the results. The entire program is in segmented from fit in to 70K bytes of main memory. This program is on of a series of physics simulation programs developed in a joint project by the Institute for Hochenergiephysik der universität Heidelberg and by Ges mthochschule siegen under the name Interactive physics course on computers /50/.

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Computer simulation in quantum mechanics is very useful because it helps to overcome two problems particular to the teaching and learning of the subject. Firstly, quantum mechanics more than fields of physics make use of abstract concepts (Like wave function, effective potential, Scattering phase) which are not measurable or at least inaccessible by student's experiment but can be easily calculated and displayed by computer. Secondly, only rather few quantum mechanical problems can be solved in closed form whereas most require numerical methods. Program SQUASH (Stationary Quantum Mechanics in Schrödinger and Heisenberg formulation) fulfills all the functions in accompanying a quantum mechanics lecture as a laboratory course /51/.

To teach physics in an exact and at the same time non-mathematical way, computergenerated movies can help and such type of movies was made at the university of karlsruhe by H. Gentz /52/. About this motives, it was argued that, if for educational purpose the corresponding real experiment is not possible, computergenerated movies are particularly valuable in teaching physics to people with poor mathematical background. Just as real experiments, computer generated movies can demonstrate the behaviour of physical systems according to the laws of physics under various initial conditions. In the course of making computer generated movies, a three dimensional problems movies are also developed /53/.

In the early eighty's digital simulation of dynamical processes has become a very important tool in various fields. During this time the available simulation systems become more and more user-oriented for they thus become also more and more suitable for educational purpose. The simulation system KISS (Kinetic Simulation System) is used both in research and educational areas. KISS is written in general purpose programming language and is thus to a great extent portable /54/.
Wedekind /155/ reported a work, which carried out in a project Computer-aided simulation in university science teaching at the university of Tubingen from 1975 to 1979. It was the task of the project to develop computer simulation programs for university instruction in subjects of Biology and Physics, the application of these programs in regular courses, the analysis of the possible educational functions, and the evaluation of the necessary educational context.

Simulation of the kinetic Alfven wave which has many applications in space and fusion plasma, has been performed by using macro scale magneto-hydrodynamic particle simulation code. Dispersion properties and wave particle interactions of the kinetic Alfven wave are successfully obtained in the simulation /156/.

A fast simulation model for the dynamic process of traffic flow through urban network is presented by M. Cremer and J. Luduing in 1986 /157/. The model simulates the progression of cars on a street by moving 1 bit variables through binary position of bytes in the storage which are arranged to copy the topology of a specified network. The model simulates accurately macroscopic phenomena of traffic flow while at the same time producing the mechanisms of microscopic model and it is also possible to simulate this model on PC.

In order to develop new semiconductor devices and study different kinds of semiconductor device, two-dimensional device simulation has become an important tool for Computer-Aided Design of LSI circuits, specially for MOS devices. And in the investigation of electrical characteristics of devices e.g. the study of bipolar transistors with complex structure. Several approaches have been taken to simulate these type of devices. Such as BAMBl program and another powerful software system i.e. Ellipack. E Cell e and al. /158/ analyzed the effectiveness of this, powerful software tool kit, Ellipack with a special propose program written by them.
The article by G Addie, explains how the graphics calculator can be used in simulations of physics experiments and also how its use for plotting graphs requires a shift in emphasis from obtaining an experimental result to evaluating it. The graphic calculator takes over the computer in the lab, and is an inexpensive alternative that that is accessible for all students. It is concluded by Addie that, these are the main four areas, in which the graphics calculator is making an impact:

(i) Simulation of physics experiments.

(ii) Graph plotting and analysis of experimental results.

(iii) References

(iv) Acquisition of experimental results.

Computer simulation studies in condensed matter physics represent a rapidly changing field, making significant contribution in techniques and in new results to important physical problems. The workshop on recent development in computer simulation studies in condensed matter physics, held at the center for simulation physics at the university of Georgia, February 14-26, 1988, was an attempt to bring together some of the practitioners in this field and to provide a forum for the presentation and exchange of new ideas and recent developments. These proceedings are a record of the workshops and are published with the goal of timely dissemination of the papers to a wider audience /60/. Another workshop held on Banas in 1992, Proceeded the topic simulation based experiments /61/.

The computer program 'solid state simulations', provide to learn solid state physics with a working model to play with it. This simulation packages are core material for a course in solid state physics for advanced undergraduates and graduates students in physical sciences and engineering /62/.
For, High school or introductory undergraduates students who do not have a background in higher level mathematics or quantum physics, the Visual Quantum Mechanics /63,64/, project has developed materials to help students learn quantum physics.

The compute program presented by Rebello, Ravipati et al., /65/ simulates the working of three p-n junction devices: the light-emitting diode, the solar cell, and the tunnel diode. This program enables students to create the device starting with two pieces of intrinsic semiconductor material, and doping them appropriately to create a p-n junction device of these choice and can observe the changes in the energy bands and fermi-level as a response to doping. No prior knowledge of higher level mathematics is required to use the program and it is available for windows and Mancitosh platforms. This program is so flexible that it can be used by students over a range of academic levels. This program is tested in both high school and university environments and modifications based on the test, in the current versions of the program are going on.

2.11 Software Class

For high school students, to get to know more about human body, the CD-ROM inside story 1992 edition has a title A.D.A.M. Which acquaints the student with the various organ system of the body, through two model, ADAM and EVA. The organ system are depicted through line drawings that 3D image of different images of the heart, lungs and skulls are included. Through this package student can explore each organ system through a variety of options. The requirements for to know the bare bone facts are a 486/33 MHz. Processor or higher, window 3.1 X or window 95; 8 MB RAM ; 10 MB hard disk space; SVGA Color Monitor, 12X CD-ROM drive; MPC-2 Compatible sound card, a mouse /66/.

A software title Atoms, Elements and Compounds, developed by NIIT Leda Home learning, NIIT Ltd., can make formulae and equation
of chemistry intelligible and enjoyable & learning enjoyable for the student. The minimum requirements for this package are 486 DX2/66 MHz PC with 4 MB of RAM, 1.5 MB hard disk, SVGA monitor. 16-bit Sound Blaster, Dos 5.0 and windows 3.1 /67/.

For chemistry student in high schools who are not too sure of their way around the lab. Corel Corp's Corel Chem. Lab. is a good instruction, and a guide. Not just to the experiments but also to relevant facts that students are expected at their fingertips-elements, atomic weights, molecular structure and formulae. Inside the package there is an introductory experiment which familiarizes the students which the equipment in the lab and there use. Through this the student can practice an experiment on the PC before performing it in school. System requirement for this windows (3.1 x / 95) title are a PC 486DX 33, 8 MB RAM (12 MB recommended), SVGA card, 640 x 480 resolution, 256 colors, windows-compatible, sound cord and 2X CD-drive /68/.

Computer based simulation of practice laboratory experiments are developed by Edword /69/. He takes the view that the aim of computer based simulation is to provide a learning experience as close to that of the lab as possible.

Anatomy practicals are usually onetime exercises. For medical students to practice what they have learnt, Adam software Inc. Offers A.D.A.M practice practical two sections: a review section, and a test section, offer students the opportunity to familiarize themselves with the anatomical structures of the different regions of the body: head and neck, upper limb, body wall and back, thorax, abdomen, pelvis and perineum, and lower limb. Minimum system requirements are a 486/33 MHz PC with 8MB RAM. 640 x480 resolution, SVGA color monitor, 2 x CD ROM drive, windows 3.1X windows 95. The title is available from Sarathena, New Delhi /70/
The title developed by sanctuary woods multimedia, San Mateo, California, USA /71/ is one that really does provide edutainment. With this software, pronunciation and simultaneously how to spell the word also one learns. This software claims to teach the 4 to 7 years olds word recognition and spelling, build up their vocabulary, and test their reading comprehension. Title 'Franklin Learns Maths' make simple and enjoyable the arithmetic.

One of the latest CD-ROM title from Innoserve system developed by the technology mission New Delhi helps the student of class IX. In understanding the confounding concepts of physics. This package presents apparently difficult concepts effectively, despite its text book format. In this package the basics of physics are discussed, which closely simulate the class room condition. Visually simulating but simple graphs have been used where it is possible to discuss various concepts. System requirement for running this title are a 486 processor, with minimum 8 MB RAM, Color monitor, sound card, speakers, CD-ROM drive, mouse and windows 3.1/95. The title is available from Innoserv Systems Pt. Ltd. New Delhi /72/.
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