
Computers are magnificent tools for the realization of our dreams, but no machine can replace the human spark of spirit, compassion, love, and understanding.

- Louis Gerstner

This chapter has been divided into seven subsections to have a brief outline of the numerous researches done in this area of Computer Assisted Learning. These subsections gradually build up the idea of using Computer Assisted learning in addressing Alternative Frameworks. The first subsection introduces the area and the second section builds up a context as an indicative examination. The third subsection starts from the simple application of providing Audio-Visual Aids, something that had been historically tried as the most basic initiative in the area of the use of Computer Assisted Learning and builds upon other areas such as using computers for delivering coursework. A contrasting perspective to the previous non-interactive interface is the interactive interface, which has been discussed in the fourth subsection. It includes researches such as those related to use of models and simulations and using computers for manipulation of variables etc. The fifth subsection is related to researches on comparison of computer assisted learning with traditional teaching, its effects on learners’ performance, teachers’ and learners’ outlook towards computers. The sixth subsection has been titled ‘Computer Assisted Learning and construction/reconstruction of concepts’ and is related to developing an understanding of conceptual changes. In all the subsections, an attempt has been made to include researches done both in abroad and in the Indian contexts. Relevant conclusions have been drawn and reflected upon in the last subsection of this chapter.
3.1 Introduction

Computer assisted learning is seen as an extension of technological development in different areas of science and technology. ‘How can technology can assist or support learning?’ is a spontaneous question that emerges. (McCombs, 2000) builds up the suggestion that technology can support learning in five ways. First, To bring exciting curricula into the classroom that is based on real-world problems; Second, To provide tools and scaffolds that enhance learning and are a part of a coherent and systemic educational approach; Third, To give learners and teachers more opportunities for feedback, reflection, and revision; Fourth, To build local and global communities that are inclusive of teachers, administrators, parents, learners, practicing scientists, and other interested community people and Fifth, To expand opportunities for teacher learning that include helping teachers to think differently about learners and learning.

With the technological advancements in place, innovative pedagogies can be expected as a consequence of their applications in education. “Technological development has led us to develop different modernized techniques for innovative pedagogies in various technical fields may be education, business or distant learning. With the modernization of societies, people have become more concerned about the systematized teaching-learning techniques and training about different topics in different fields (Barik & Mondal, 2010).

3.2 Building up a Context for Computer Assisted Learning

In developing countries, conditions, constraints, and resources differ sharply from industrialized nations, creating special challenges for the technical and educational study communities (Jaimes & Sow, 2003). This challenge gets commuted with the challenge of providing education to all. Technology interventions can probably assist in be providing elementary learning for all. But there is a problem in its use. “Technology is not used properly in education, so the ability of individualizing education and personalizing it to the needs and problems of each learner has been lost. We propose a learning system in which the computer plays the role of a tutor providing better interaction between the learner and the computer” (Bork, 2003).
The results of a qualitative study by (Pal, Lakshmanan, & Toyama, 2007) on computer-aided learning centres reveals a range of voices of parents on hopes for the next generation. For parents, the computer has an immense symbolic value which is separate from its functional value. An environment of great fear about the future of agriculture has been located, because of which computer-aided learning centres have become symbols of future aspirations of jobs for their children. The study also reveals varied related concerns of parents from the dowry implications of having computer-trained daughters to the relative value of English versus computer literacy as the key to social mobility.

The constraints that include the current financial crisis and the increasing pressure to deliver more from less, has been reflected upon in the study by (Chandra & Borah, 2012). This study suggests that both public as well as private institutions can use the potential benefit of cloud computing to deliver better services even with fewer resources. The study mentions that “Government of India is having the ambitious plan to raise the present 16 million enrolments in higher education to 42 million by 2020 as well as interconnect electronically India's 572 universities, 25,000 colleges and at least 2,000 polytechnics for enabling e-learning and content sharing across country” (Chandra & Borah, 2012). This ambitious plan can be supported with the use of technology in education.

The study by (Gopal, 2011) reflects on the status of the use of computers in teacher education. This study highlights that in the field of education, computers have become an important metaphor to denote technology in the classroom. Keeping this in mind, most teacher education institutes in India have introduced a course in Computers in Education, but due to the paucity of time in the academic year, many teacher education institutes briefly cover the aspects of technology education in their classroom. As an intervention, this study discussed adapting an Interactive Video Based Self Learning Module on Open Office Impress in the Dimensions of the Cognitive Apprenticeship Framework. The results of the study showed that this material augmented the Pre-service teachers' technology skills in directly using, applying and learning technology (Gopal, 2011).

(Pawar, Pal, & Toyama, 2006) made many observations in Indian context like, a distinct feature observed in computer use in schools or rural kiosks in developing
countries is the high learner-to-computer ratio. A common issue related to more than five children crowding around a single display has been raised. This issue is related to the problem of funding the computers in schools as schools are rarely funded to afford one PC per child in a classroom. “To our surprise, both the concept and the implementation appear to be unique to date, for the specific application to computers in education in resource-strapped communities, with previous work restricting studies to two mice, or for largely non-educational applications. We have developed software that allows multiple coloured cursors to co-exist on the monitor, along with two sample games with some educational content” (Pawar et al., 2006). Initial trials with both single-mouse and multiple-mice scenarios in this study suggest that children are more engaged when they are in control (of a mouse), and that more mice increases overall engagement of the learners.

3.3 Using Computer in Non-Interactive Instructional Mode

Computer as visual aid supplier

“The use of video and films as ‘visual aids’ in Physics education dates back to the 1950’s when the American Association of Physics teachers sponsored a set of films to bring together current film technology, the expertise of the film producer and the knowledge and experience of outstanding Physics teachers. These were followed in the 1960’s by the well known Physical Science Study Committee (PSSC) series of films, parts of which survive today in the videodisc series Physics Cinema Classics” (Fuller, R. & Lang, 1992). However these films and many similar Physics films produced in the following years had a major limitation: the control exercised by the classroom teacher or learner is limited to turning the videotape on or off. Thus an important pedagogical consideration is severely limited during such passive viewing of these films: the ability of the teacher to respond immediately and appropriately to the needs of the learners (Zollman & Fuller, 1994).

In India even this form of non-interactive use of technology has been found to be inadequate. The study by (Anuradha & Tai, 2010) was undertaken in twenty-one higher secondary schools of Nellore town of Nellore district, Andhra Pradesh, India. This study attempted to look at the availability of audio visual equipment and materials in the schools and their effective use in classroom teaching. Data shows that
the position of audio visual equipment was poor. Computers, television, tape recorder, public address equipment were possessed by only 47.62 per cent of the schools. 90.4 per cent of schools have effectively used the audio visual equipment. The school administration is not taking any effort to procure and utilize the audio-visual equipment and materials in a right manner as it is difficult for the managements to meet the maintenance cost of audio-visual equipments as the schools are poor.

**Non interactive computer use in classroom**

(Susskind, 2005) studied the effects of non-interactive Computer Assisted Instruction on learners' performance, self-efficacy, motivation and attitudes. The results imply that accompanying lectures with PowerPoint presentations does not significantly affect learners' achievement. The study further reveals that learners who received traditional instructions first and then received lectures with PowerPoint did not experience a change in classroom motivation. However, learners who were initially taught with PowerPoint and then received traditional lectures became less motivated during the traditional lecture format.

Other studies related to the use of PowerPoint presentations in classrooms reveal differences in different types of population in using PowerPoint. (Shankar & Subasri, 2006) analyzes accessibility of PowerPoint presentations among the high and higher secondary school teachers in classroom teaching-learning in selected schools of Pondicherry state. Findings of the study reveal that more than 68% of the respondents lack the fundamental working knowledge of computers. Among the remaining 32% of teachers, 12% of teachers are fluent in utilizing the computer in preparing and projecting the PowerPoint presentations and these teachers further utilize the system in preparing self-learning materials using internet. Regarding the skills of teachers the study reveals that 20% of the teachers possess good skills. Urban teachers are found to utilize PowerPoint presentations more effectively in classroom teaching-learning when compared with the rural teachers. There exists no significant difference between the male and female teachers with respect to their accessibility of PowerPoint presentations in classroom teaching-learning. Private school teachers are found to use PowerPoint presentations comparatively more than the government school teachers. Attitude of private school teachers in using the PowerPoint presentations in classroom teaching-learning seems to differ significantly than the
government school teachers. There is no significant difference between the high school teachers and higher secondary school teachers in using the PowerPoint presentations in classroom teaching-learning.

3.4 Enabling Interactive Learning Using Computers

The previous subsection showed how computers can assist the teacher in providing/supplying visual aids, for which the criticism lies in it not being interactive in nature. Use of the interactive nature of computer technology can support learners in carrying out inquiry-based activities, using topics, questions, and even theories that they themselves define and develop. The interactive technology can be used to do away with the traditional and the associated passivity, in which the learner is usually considered to be an empty vessel that can be filled with knowledge. “Furthermore, learners who are permitted to use their own resources in developing, implementing and evaluating projects are likely to find, with little doubt, need for considerable revision. This, in turn, illustrates that the possibility always may exist for critique (scepticism) of methods associated with all scientific conclusions” (Bencze, J.L, Bowen, G.M., & Oostveen, 2003). Some studies that support the above cited claims have been referred to in the coming discussion.

Study by (Crosby & Iding, 1997) examines high school learners' performance on an interactive multimedia tutorial for learning physics concepts in conjunction with their individual differences. Results showed that learners in general performed better on the knowledge acquisition than knowledge application phases of the tutorial and differences emerge between learners with left and right hemispheric preferences on performance at different stages of knowledge acquisition. The results indicated that learners with right hemispheric preferences might benefit more from instructional strategies typically employed in tutorials for learning science, such as the inclusion of illustrations, analogies, and animation.

(Ronen, 1993) describes the designing and using of an open graphic interface called RAY, for instruction in geometrical optics. The RAY program offers a learning and a problem solving environment in which the learner can actively provide his/her own feedback without any kind of hesitation. However, a problem witnessed with this program is that learners cannot make a distinction between the representations of physical entities (light rays) and a geometrical construction (for
instance, the continuation of a ray behind the mirror) since both are represented in a ray diagram by lines. A research conducted on its effectiveness reveals that it can indeed contribute to overcoming some learning difficulties, which learners have.

(Matsuda, 2006) describes the effectiveness of two kinds of education system, one is a Cyber Assistant Professor (CAP) and another is a Cyber Theatre (CT). CAP has been designed for a self-learning system, which enables interactive communication between virtual teacher and learner. The study claims that the production of interactive actual videos taken on location as teaching-learning materials is difficult in some cases, but the production of interactive 3D animation teaching-learning materials in CAP is not that difficult. They also argue that this technology would make learners aware about the computer that it is not only a tool for browsing information, but also a tool for creating information.

The study by (Young, 2003) revealed that a computer mediated communication environment could lower learners' psychological barriers to enable them to express their opinions freely and to communicate actively on the Internet and that it could also enhance their critical thinking, problem solving and communication skills through online activities or class homepage construction. Computer access was also a concern of those learners who did not have computers at home.

(Mas, Mesquida, & Gilabert, 2011) have developed a tool called MiProJOC gameplay. The tool can also be used to assess knowledge in scholarship and learner independent work. MiProJOC is designed to facilitate the maintenance of a repository of questions from different areas, different game modes to define and present the statistical results from the use of the game. The study contends that a combination of traditional teaching methods with innovative teaching mechanisms generates a positive effect on learning of any subject.

(Gupta, Tejovanth, & Murthy, 2012) find that the introduction of logic programming and computer-hardware interfacing at the high school level is advantageous in terms of creating an interactive environment fostering learning and creativity.

(Blake & Scanlon, 2007) proposes a reconsideration of use of computer simulations in science education. Study discusses three studies of the use of science simulations for
undergraduate distance learning learners have been discussed. The first one, The Driven Pendulum simulation is a computer-based experiment on the behaviour of a pendulum. The second simulation, Evolve is concerned with natural selection in a hypothetical species of a flowering plant. The third simulation, The Double Slit Experiment deals with electron diffraction and learners are provided with an experimental setup to investigate electron diffraction for double and single slit arrangements. Study involved evaluation of each simulation, with 30 learners each for The Driven Pendulum and Evolve simulations and about 100 learners for The Double Slit Experiment. From these evaluations study has developed a set of features for the effective use of simulations in distance learning have been developed. The features include learner support, multiple representations, and tailorability.

Models and Simulations

Models are the important tools used in science investigations, and are a valuable means of expressing an understanding of a process and of constructing knowledge. (Raghavan, 1995), (R. Driver, 1986), and (Gilbert, 1998), report that models and model-based reasoning have been found to be important in the development of science concepts and the development of learners' understanding of the processes of science (Thomas, 2001). Using computer simulations and modelling, learners tend to develop new strategies for solving problems, complete tasks of greater cognitive complexity, test personal hypotheses by making predictions, develop higher-order thinking skills, and engage in complex causal reasoning (Cox, 2000).

(Stratford, 1997) reviewed Computer-Based Model Studying Precollege Science Classrooms in nineties showing that studying the field is not new. On the other hand we need to acknowledge the changes in the hardware and software settings. The summary is presented in the form of a table organized into three categories: running simulations, modelling, and writing simulation programs. The table contains, for each study, the name of the software, the main purpose of the study, and its contribution to the literature.
<table>
<thead>
<tr>
<th>Software: Reference</th>
<th>Study Purpose/Theory</th>
<th>Study Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Running Simulations</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brna (1987, 1991): DYNLAB</td>
<td>Software presented a variety of situations which were expected to cause learner to confront discrepancies between their beliefs about motion and the behaviour of their model</td>
<td>The simulation provided opportunities for learners to change their conceptual understanding and to articulate their new beliefs.</td>
</tr>
<tr>
<td>Gorsky &amp; Finegold (1992): 5 force simulations</td>
<td>Investigated the use of computer simulations to help restructure learners' conceptions of force</td>
<td>Simulations led to varying degrees of cognitive dissonance and were effective in eliciting learners' beliefs about forces acting on objects at rest and in motion. Learners who directly experienced the outcomes of their own Alternative Frameworks apparently rejected their incorrect views and accepted the scientific ones, at least in the context of the simulation.</td>
</tr>
<tr>
<td>(White, 1993): ThinkerTools</td>
<td>Described a physics motion simulation used in an inquiry curriculum, designed to help learners develop conceptual knowledge</td>
<td>Sixth graders performed much better on classic force &amp; motion problems than high school learners in traditional physics classes.</td>
</tr>
<tr>
<td>Slack &amp; Stewart (1990): GCK</td>
<td>Explored individual learners' problem-solving strategies and developed a model of learner performance; GCK genetics simulation was used to present problems and data to learners</td>
<td>Learners followed these strategies: unplanned approach (lack of hypotheses &amp; testing strategy); working backward (explaining rather than predicting); and emphasizing quantitative counting and ratios. Learners lacked problem-solving abilities and skills such as genotypic thinking and generational thinking.</td>
</tr>
<tr>
<td>Hafner (1991); Stewart, Hafner, Johnson, &amp; Finkel (1992): GCK</td>
<td>Used GCK to investigate individual learners’ model-revising processes, general and domain-specific heuristics, and criteria for model acceptance</td>
<td>Learners engaged in model-revising problem-solving successfully, and were able to produce revisions which were generally compatible with accepted scientific theory. The simulation allowed learners to engage in knowledge production, and significantly increased the amount of “research” they could do.</td>
</tr>
<tr>
<td>Finkel (1993, 1994): Finkel &amp; Stewart (1994): GCK</td>
<td>Studied how model-revision strategies and knowledge were used as learners worked in groups to solve genetics problems using the GCK simulation</td>
<td>Learners' strategies for model revision included a variety of actions such as recognizing anomalous aspects of the data, making crosses, and developing, assessing and accepting multiple alternative models. Learners used their understanding of genetics, of the process of model revision, and of their own problem-solving strategies during model revision.</td>
</tr>
<tr>
<td>Simmons &amp; Lunetta (1993): CATLAB</td>
<td>Explored general patterns of problem-solving behaviours and genetics conceptual organizers in experts and novices interacting with a genetics simulation</td>
<td>Successful expert and novice problem solvers employed the most complex patterns of problem-solving behaviours, mainly using description problem-solving sequences; least successful employed random patterns of behaviours.</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Ronen, Langley, and Ganiel (1992): STEP simulations</td>
<td>Reported and analyzed a large scale integration of computerized simulations into the present structure of Israeli high schools</td>
<td>Researchers speculated that problems encountered were symptoms of problems which occur in systems in transition. They also suggested that real change can only occur after teachers experience the advantages offered by computer simulations.</td>
</tr>
<tr>
<td>Kruper &amp; Nelson (1991): Biota</td>
<td>The software allowed learners to construct meaning by providing opportunities to define problems, construct and test alternative hypotheses, and communicate subsequent evaluation of these hypotheses to peers</td>
<td>They reported no significant differences on pre- and post-test between treatment and control groups on tests of science reasoning skills, however, there were differences between learning processes. They concluded that strategic simulations can offer learners’ valuable experiences which help develop deeper content understanding.</td>
</tr>
<tr>
<td>Feurzeig (1992): Cardio</td>
<td>Provided an interactive visual environment for investigating the physiological behaviour of the heart. The simulation incorporates process visualization aids in the introduction of model-based inquiry skills, and supports advanced work in science research</td>
<td>Learners were able to explain nonlinear dynamical behaviour and to solve heart repair problems.</td>
</tr>
<tr>
<td>Richards, Barowy &amp; Levin (1992): Explorer Science</td>
<td>Provided learners with a coherent set of experiences that challenge the way they think about the world; provided opportunities to construct and test explanations for phenomena</td>
<td>Learners developed a sense of how scientists use models. Researchers reported that learner interaction with simulated models facilitated analysis and conceptual understanding of physical phenomena.</td>
</tr>
</tbody>
</table>

### Creating Models

<table>
<thead>
<tr>
<th>Jackson, Stratford, Krajcik, and Soloway (1995): Model-It</th>
<th>Described intentional scaffolding strategies designed to make system dynamics modelling accessible to pre-college learners</th>
<th>Learners built reasonable models; software strategies made modelling accessible; building models allowed learners to refine and articulate their understanding of complex systems.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandinach (1988): STELLA</td>
<td>Investigated the effectiveness of using STELLA in the systems-thinking curricula</td>
<td>Learners tested well on their knowledge of STELLA, but were less able to translate knowledge and skills to more general problems.</td>
</tr>
<tr>
<td>Mandinach (1989): STELLA</td>
<td>Tested the potentials and effects of using STELLA to teach content-specific knowledge as well as general problem solving skills</td>
<td>Learners acquired knowledge of systems concepts and applied them to scientific problems at varying levels of complexity and sophistication.</td>
</tr>
<tr>
<td>Authors (Year)</td>
<td>STELLA/Software</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>-----------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Mandinach &amp; Cline (1992): STELLA</td>
<td>Examined the impact of learning from a systems thinking approach to instruction and from using simulation-modelling software</td>
<td>The researchers concluded from their experiences and observations that gaining a working knowledge of system dynamics, STELLA software, and the Macintosh is substantially different from acquiring information within a content area of expertise.</td>
</tr>
<tr>
<td>Miller, Ogborn, Briggs, Brough, Bliss, Boohan, Brosnan, Mellar, and Sakonidis (1993): IQON</td>
<td>Researchers described the design of and rationale for modelling tools that are claimed to be simple enough for young teenaged learners (grade 8) to learn</td>
<td>Pupils built meaningful models of considerable complexity and contributed ideas about the relation of IQON models to reality. Researchers observed that learners began to understand complex models as interconnected systems. Pupils constructing models saw their models as fallible, tended to consider revisions, and made more interesting modifications than those who were simply exploring pre-defined models.</td>
</tr>
<tr>
<td>Schecker (1993): STELLA</td>
<td>Research focused on having learners develop and test models with STELLA; researcher suggested that modelling can help to accentuate the conceptual structure of a physical domain and help clarify the qualitative meaning of physical concepts</td>
<td>It took about 2 instructional units for learners to become familiar with software to make models on their own, after which they were able to work out model structures themselves in classroom discussions or work groups.</td>
</tr>
</tbody>
</table>

**Creating Simulation Programs**

<table>
<thead>
<tr>
<th>Authors (Year)</th>
<th>STELLA/Software</th>
<th>Description</th>
<th>Concluding Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>diSessa (1991): Boxer</td>
<td>Investigated ways in which sixth grade learners invented ways of working on difficult problems</td>
<td>Learners engaged in learner-initiated learning (they learned to “cheat” at the simulation in order to solve difficult problems).</td>
<td></td>
</tr>
<tr>
<td>Fuertzeig (1992): Function Machines</td>
<td>Investigated the use and benefits of visualization in model-based inquiry activities</td>
<td>The researcher suggested that appropriate computer modelling activities can make the experience of doing science concrete and highly motivating for high school learners.</td>
<td></td>
</tr>
<tr>
<td>Guzdial (1995): EMILE</td>
<td>Created a scaffolded environment in which helped learners to create physics simulations in HyperCard without learning to program first</td>
<td>Learners learned about programming, and learned physics concepts (velocity, acceleration, projectile motion) through creating simulations in HyperCard.</td>
<td></td>
</tr>
</tbody>
</table>

Different studies across the globe suggest that computer simulations and models can be effectively utilised in supporting/challenging models that learners make to develop their science concepts. Some works like Biota, suggest contrary results on development of scientific reasoning skills.

(Mohanty & Routray, 2012) present a novel and efficient ways of E-learning, E-experimenting and E-assessment for a basic level course on embedded systems for
undergraduate learners. In a country like India where the total number of learners in electrical sciences in a given semester is close to 500,000 an automated and animated laboratory in embedded systems is very useful. In this virtual web based laboratory, a learner can perform experiments, simulations and experimental validation of results. 3D animation sequences are provided in each experiment, to facilitate a real world experience of microcontroller programming, interfacing and real time processing. The entire process is of three stages comprising the learning, experimenting and self-assessment to achieve the objectives set forth.

The review of the summary in the table shows that studies have been conducted in specific conceptual areas in science but studies pertaining to developing a broader understanding of addressing alternative frameworks are very few.

According to (Thamarai Selvi & Panneerselvam, 2012), Indian learners lack the skill of Self-regulated Learning (SRL) that is indispensable for lifelong learning. A Learning Management System (LMS) is presented that provides learners with electronic materials and supporting tools to inculcate Self-regulated Learning by way of providing an environment to learn a programming language. The results show that the learners who underwent the course show increase in the self-regulation components and the interest to learn in-depth.

(Bhattacharya, Chakraborty, Basu, & Roy, 2012) addressed the issue of providing personalized user interface to e-learner under web based e-learning environment. A frame work, based on concept map trees has been proposed that intelligently tracks the learning pattern of an e-learner and helps the learner to attain his learning objective through the recommender agent.

(Pati, Misra, & Mohanty, 2012) have developed a virtual laboratory for software engineering course. According to the study, the virtual labs software engineering help in improving software engineering education and, in turn, in preparing software engineering learners for professional careers. It is envisaged that the virtual lab will also help the software engineering educators in underprivileged educational institutions having lack of teaching resources, and who are willing to improve education at their institutions. The study emphasises that the evaluation of the effectiveness of learning software engineering by using virtual labs should be
addressed and proposed a conceptual model for evaluating effectiveness of software
engineering virtual labs course.

3.5 Computer Assisted Learning and Effective Teaching Learning Processes

Whenever the issue of Computer Assisted Learning in school system is raised, the
question of comparing Computer Assisted Language with traditional teaching is a
rational one. In the sub-section 3.4, we have reviewed studies related with integration
of curricular areas. Let us now see what do studies comparing Computer Assisted
Learning with traditional teaching say.

Comparison with Traditional Teaching

(C.Y. Chang, 2001) explored the effects of a Problem -Based Computer-
Assisted Instruction (PBCAI) in contrast with Direct-Interactive Teaching Method
(DITM) accompanying with regular computer-internet usage, on learners' earth
science achievement in Taiwan. An analysis of covariance on the Earth Science
Achievement Test post test scores with learners’ IQ and pre test scores as the
covariates suggested that the PBCAI was more effective in promoting learners' achievement than was the DITM. The study also suggests that learners in the
experimental group had significantly higher achievement scores than did learners in
the comparison group, especially on the knowledge and comprehension test items, but
not on the application test items.

A special multimedia software, developed by (Panagiotakopoulas, George,
Shields, & Behrman, 2002), using a high level language, which simulated standard
time perception tests. Results of the study on effectiveness of this software indicated
superiority in children's judgments’ when multimedia software was used. The study
claimed that this superiority was most pronounced in experiments that involved
motion or action.

The study by (Kramarski & Hirsch, 2003) investigates the differential effects
of Computer Algebra Systems (CAS) and self-regulated learning (SRL) on algebraic
thinking and self regulated skills. The study found that CAS+SRL learners used more
easily and correctly generalized letters (variables) and algebraic manipulations. The
study reveals that the poor performance of the CAS learners may have stemmed from
the limited metacognitive techniques employed in solving word problems.
(Mioduser, 2002) analyzed the data collected in 10 schools in Israel, which have incorporated ICT and have succeeded in devising innovative classroom pedagogies and changes in teachers and learners roles and outcomes. The findings indicate that the domains 'digital space' and 'didactic solutions' underwent the most significant changes by the implementation of ICT. Next were the learner role, the teacher/learner interactions, and the assessment methods. The physical space and time configuration, the content areas and the interactions among teachers were less affected by the innovations. An important conclusion, according to the study, that can be drawn from these observations is that the main beneficiaries of the innovations were the learners. The innovations implied for them new roles, learning situations, patterns of interaction with the teachers, learning spaces, and forms of assessment.

(Choudhary, 2005) studied the efficacy of Computer Aided Learning using method of inquiry (CALMI) in teaching physics at the secondary level on achievement and concept attainment and differential effect of CALMI if any, across the sex divide. Major Findings of the Study were that intervention produces significant achievement in cognitive domain and at its various levels; and the model approach is more effective in comparison with the conventional method in this regard. It is also found that CALMI affects differentially across sexual division favouring girls as far as achievement scores in higher cognitive domains are concerned but does not affect differentially the global achievement scores.

(Palaniappan, 1990) studied the effectiveness of Computer Assisted Instruction (CAI) in learning triangles as compared to the traditional method. The study asserted that learning through CAI enhanced better learning than the traditional method. There was also significant difference between the low achievers of both the groups that indicated that learning through CAI enhanced better performance among the low achievers than the traditional method of teaching-learning. The study thus claimed that there was an overall improvement in performance while teaching-learning through CAI.

This experimental study by (Mahmood, 2012) examined effectiveness of the computer assisted instruction (CAI) on learners’ achievement in general science as compared with the traditional method of instruction (TMI). This experimental study was conducted in a public secondary school in Lahore, Pakistan. The CAI program
comprising interactive tutorials in Urdu language was used for learning by the experimental group. The control group was taught the same content in the classroom by the teacher through textbook based lecture method, which is the traditional method of teaching in public schools in Pakistan. An achievement test assessing knowledge, comprehension and application components of learning was administered to both the groups after a two month long treatment period. The experimental group performed better on all the three components of the achievement test as compared to the control group. The CAI group also scored higher than the TMI group in various content areas of general science.

According to the study by (Dewan, 2010), e-learning is the buzz word in the field of education. Realising the advantages of using technology in education, the University of Delhi is launching its e-learning portal. Based on a survey of 240 college learners from both private management institutes and colleges of University of Delhi, the study focuses at gauging the existing state of technology in these institutes. The survey shows that the present state of technology in higher educational institutes is not good enough to effectively use technology in education. Thus, the merits of traditional classroom teaching and ICT tools should be integrated into a single system (Dewan, 2010).

By drawing on practices and metaphors familiar to children in the Indian school environment, the study done by (Viswanathan & Blom, 2010) developed mobile learning solutions that are grounded on the existing educational practices but have the potential of revitalizing the approach to learning technologies in a developing world context such as India. Field observations and interviews revealed challenges associated with the current educational context in India. The school visits also led to identification of a design metaphor, namely the "Slate, which is believed to provide the study team with an inspirational approach for the design of the eventual concept. A creative workshop was arranged with children, the purpose of which was to come up with design drivers for mobile learning solutions (Viswanathan & Blom, 2010).
Computer for Delivering Coursework

The studies cited in subsection 3.6 focussed upon using the interactive nature of computer. Moving towards school settings, we need to take notice of what does the studies related to curricular ideas area show.

According to (C Y Chang, 2000), many teachers or researchers in the area of geosciences education have attempted to develop computer programs or to employ computer-assisted instruction (CAI) at the college level. They found that the CAI is effective in developing problem-solving skills, particularly for learners with greater prior exposure to science and engineering.

The study of (Wegerif, 1998) outlines, illustrates and evaluates a distinctive approach to the use of computers within the primary curriculum. The results of the evaluation show (a) that the quality of interaction around computers can be improved by off-computer coaching in exploratory talk and (b) that the approach to design is effective in stimulating talk which supports curriculum learning. The researchers argue that this framework is not limited to citizenship and science but could, in principle, be applied across the curriculum.

Game-themed programming assignment (GTA) modules were designed by (Hillyard et al., 2010) specifically for the faculty members. The related study demonstrated that it is straightforward to blend the GTA modules into existing classes with minimum alterations. In these ways, the GTA modules are excellent catalysts enabling faculty to begin exploring and developing their own expertise and materials to teach with games.

(Vasanithi, 2003) studied the effectiveness of teaching chemistry through Computer Assisted Instruction over the Traditional Teaching Method. Findings of the study suggest that: (1) there is a significant difference between the mean gain score of the control group taught through TTM and the experimental group administered by the CAI in all units put together. (2) There is no significant difference between the mean scores of pre test of control group taught through TTM and experimental group administered by CAI in all units put together (Electro Chemistry and Bonding). (3) There is a significant difference between the mean scores of post-test of control group taught through TTM and experimental group administered by CAI in all units put together.
(Kadhiravan, 1999) studied Effectiveness of Computer Assisted Instruction in Relation to Learners Use of Self-regulated Learning Strategies. Lecture Method (LM), Computer Assisted Instruction (CAI) as individualized strategy and Computer-assisted Instruction with Peer Interaction (CAIPI) in terms of their effectiveness in improving the performance in physics among the higher secondary learners with different levels of cognition, viz. knowledge, understanding and application was studied. The study findings suggest: (1) among the instructional strategies, viz. LM, CAI and CAIPI. CAIPI was the most effective instructional strategy in terms of realizing the instructional objectives in physics at higher secondary stage. (2) Among the three instructional strategies, CAIPI is the most effective one in terms of its effectiveness in realizing the instructional objectives in the context of contents with low difficulty level. (3) There was a significant difference among different instructional strategies, viz. LM, CAI and CAIPI in enhancing the learners' use of SRL strategies. (4) CAI and CAIPI had some influence on learners' use of SRL strategies while lecture method had not. (5) There was significant difference among the instructional strategies, viz. LM, CAI, and CAIPI in terms of their effectiveness in enhancing the retention of what was already learnt in Physics. (6) There was a differential effect on the cognitive development of the learners in Physics due to their use of self- regulated learning strategies.

Learners’ and Teachers’ Outlook towards Computers

Even if Computer-Assisted Learning is emerging as being more effective than traditional classroom teaching, learners’ and teachers’ approach is an important consideration for introducing Computer Assisted Learning in school settings. Let us see what related studies show in this area.

(Chanlin, 2006) investigates the factors that influence teachers’ use of technology in creative and effective teaching-learning process. The study identified four factors namely environmental, personal, social and curricular factors. The findings depict that not only creative teaching-learning environment and personal factors influenced the integration of computer technology but also social and curricular factors surrounding teaching-learning issue.

(Waite, 2004) compares practicing teachers' responses in 1998 and 2001 to a questionnaire about the aims and uses of ICT in primary schools for literacy activities.
in the West of England. The study suggests that the success of ICT in transforming the nature of teaching-learning and learning and giving children skills for working will depend on its congruence with teachers' existing constructs of what their own 'job' entails.

(Vale, Gilah, & Leder, 2004) investigates gendered views of computer-based mathematics among junior secondary learners. The qualitative data that were gathered showed that girls and boys held similar views about the use of computers in mathematics. However, girls were more likely than boys to give responses about whether computers would help and enhance their performance in mathematics or not. Boys more often viewed using computers in mathematics as a source of pleasure and a way of making mathematics relevant. For boys, computers as a source of success in mathematics or enhancement to their performance were more indirect relationships and concerned changing the ways of learning. Year level was a factor in attitudes to computer-based mathematics, suggesting that the length of time using computers in mathematics, the nature of the learning environment or the mathematics curriculum also impact on learners' views. Girls who rate themselves highly in achievement in computing are more likely to have a positive attitude to computer-based mathematics. Whilst this was also the case for boys, boys who aspired to achieve at high levels in computing were also more likely to be positive about the use of computers in mathematics. The study suggests that teachers of mathematics in the middle years of schooling need to be aware of the balance that they need to achieve in meeting the needs of both boys and girls.

(Medhi & Toyama, 2007) presents the use of full-context video to motivate and aid non-literate, first-time users of PCs to successfully navigate a computer application with minimal assistance. Following previous work focused on non-literate users, the study observed that in spite of our subjects' understanding of the UI mechanics, they experienced barriers beyond illiteracy in interacting with the computer: Lack of awareness of what the PC could deliver, fear and mistrust of the technology, and lack of comprehension about how information relevant to them was embedded in the PC.

(Das, 2003) assessed the attitude of learners and teachers towards computer education, infrastructure facilities in the schools and gender disparities in computer
science in both Government and private secondary schools of Assam. The Findings suggest: (1) Learners have a positive attitude and outlook, towards computer education received in their respective schools. Some learners have suggested a revamping of the traditional modes of teaching by introducing computers in teaching which they think will make their education more exciting and interesting. (2) Teachers are confident about their knowledge of the subject; they are not devoid of anxiety. Majority of the learners teachers have recognized the important role that computers play in today's society. (3) The English medium learners were found to display higher level of confidence, a sense of competence in their approach to and use of computers than the Assamese medium learners. (4) In spite of funding and all other infrastructural facilities provided by the North Eastern Council in a collaborative venture with the Board of Secondary Education Assam, nothing fruitful or lasting evolved from the course of computer education imparted to the learners of government schools. (5) Girls have a positive attitude towards computers as being more user-friendly and express less anxiety about the use of computers.

(B.H.H. & Manickam, 2002) studied attitudes of teachers and correlates for Computer Assisted Instruction. The Findings show: (1) there was no significant difference on the teacher competency in the pre and post scores or between the experimental and control group. But teacher competency was positively related to post knowledge in CAI of the experimental group. (2) There was significant difference between the groups in their attitude towards computer education. As a result of training in Computer Assisted Instruction (CAI), the attitude of the experimental group became more favourable towards computer education. (3) There was correlation between age and attitude towards use of computer. (4) There was significant difference in the pre and post scores of the experimental group on knowledge in CAI and attitude towards use of computer.

(Tanner, 1992) assesses the extent to which IT skills are used or developed within mathematics in Britain and examines factors, which are limiting development. The results of an action study project shows that beginners with computer software often need support in the classroom in the early stages; lack of access to computers is a problem for many mathematics teachers; and the integration of computer based
lessons into schemes of work facilitates forward planning and thus access to hardware.

**Effects on learners' performance**

The studies reviewed in the above discussions subsection 3.9 reveal a number of differences among the teachers and learners in different contexts with reference to age, socio-economic backgrounds, curricular areas, etc. One important consideration remains related to the performance and achievement of learner influenced by Computer-Assisted Learning. Let us try to understand what the studies related to this question bring forth.

(Asan, 2003) describes an interactive and self-paced multimedia tutorial programme that provides pre-service teachers with a complete range of school system and teaching-learning strategies. This study concludes that using multimedia in teacher education enriches pre-service teachers' learning and provides them with an opportunity to view and critique various teaching-learning methods and classroom activities collectively.

(Song, 2002) describes the use of the Virtual Reality Modelling Language (VRML) to visualize 3-D objects for middle school geometry classes in a networked environment. It also shows its usefulness for both teacher and learners. Results of the study show that the application of VRML-based 3-D objects have a positive effect on learners' learning for geometric topics. VRML-based geometry classes provide a virtual reality of figures and objects that cannot easily be described verbally. Any geometry figure can be easily modelled into VRML drawings making it a good visual aid toll of the geometry class.

(Jayaraman, 2003) worked on Facilitate Children's Achievement in Mathematics at Primary Level through Learning Activity Centred Style.

Findings show that Usage of the technology accessed low cost learning kits for mathematics is found to be useful for upper primary children to learn mathematics individually in class as well as at home. Teachers have welcomed this new style of approach viz., learning activity centred style.

(S. Srivastava, 2012) studied Educomp smart class as one of the applications of ICT and is of the opinion that the concept of smart classrooms does not completely do away with the traditional method of teaching. Rather it seeks to club the use of
technology with conventional methods of teaching. The resultant product is a harmonious blend of the modern and the traditional. For instance, the teacher while teaching a lesson on volcanoes will supplement the information given in books by showing a video of how a volcano erupts. Educomp smart class is one of the applications of the ICT. The curriculum reach unfolds from kindergarten to grade twelve covering subjects like Mathematics, Science, English, EVS, Social Studies, Physics, Chemistry, Biology, History, Geography, Economics and Business Studies. The study contends that Educomp Smart Class programme has an overall positive impact on learners more in terms of generating curiosity and grasping complex concepts rather than capturing attention, while it helps teachers in managing time.

**Use of Computer and the Socio-Cultural context**

The above discussion focused upon achievement and performance of the learner. Let us now see what these studies tell us about the socio-cultural context with reference to Computer Assisted Learning and problems faced in implications of Computer Assisted Learning.

(Demetriadis, 2003) the Greek secondary school teachers' attitude towards the introduction of ICT in the curriculum was presented by the researchers and it shows teachers are interested in using ICT to attain a better professional profile only to take advantage of any possible learning benefits offered by ICT but always within the context of the school culture.

(Crosier, 2002) discusses a study project in which a virtual environment (VE) to teach radioactivity was developed and tested in a number of schools. An important finding of this study was the importance of acknowledging any "contextual considerations" early in the design phase. The researchers argue that a learner-centred design and development phase is useful and beneficial for judging the needs for software on the classroom. They also suggest that school-based evaluation studies are important for gaining an overview of how the software will be used and integrated in a school setting. They further claim that observing learners using the software and gathering their opinions of it will ensure that in addition to the educational goals being satisfied, the software is useful, enjoyable and easily understandable by learners.

(Olkun, 2005) investigates the possible impacts of computers on Turkish fourth and fifth grade learners' geometry scores and further geometric learning.
Results of the study showed that learners who had computers at home initially had significantly higher geometry scores. However, these differences were minimized with an appropriate intervention containing computer-based Tangram puzzles. During the intervention, learners actively searched for the solution by turning and arranging the shapes in different orientations, thus, making them internalized or formed solid mental images of basic geometric forms. The study suggests that at schools, it seems more effective to integrate mathematical content and technology in a manner that enables learners to do playful mathematical discoveries.

As per a survey conducted by the Apeejay Stya Educational Research Foundation (ASERF), it was found that unlike most other subject/domains of learning, infrastructure for a successful ICT programme requires intensive maintenance and management at all times, not just in terms of hardware components, but also Operating System software, application software tools, networking, internet bandwidth & content-filtering, antivirus management, power equipment, security (for both equipment and data) etc. This requires a perfect synthesis between teachers, administrators, hardware/software/power vendors. Many a times, a small snag in the system brings the entire ICT programme to a halt.

**Using Computers for Cooperative/ Collaborative Learning**

Pedagogical shift in current practices incorporates cooperative and collaborative learning environments in our classrooms. Let us see if Computer Assisted Learning studies help us in understanding this aspect.

(Grant, 2005) evaluates the findings of one school experience with using mobile laptop carts, or computers on wheels (COWs) to effect change in teacher practice and learner learning. The learners identified electronic presentations: writing 'stories'; graphing things like an ordered pair’s lesson in mathematics; using draw/paint to create an original flower in science. The study emphasized three factors as indicators for change in impacting technology integration: teacher technological knowledge and efficacy; pedagogical knowledge and a supportive community.

(Dhume, Pattanshetti, Kamble, & Prasad, 2012) indicates that teachers' reflection on their practices might result in increased awareness of their own practices, shared planning and evaluation of the teaching-learning-learning process created an appropriate context for teachers' professional learning. The study argues
that teachers need personal experience with the use of information and communication technologies if the use of information and communication technologies if they are to make them an essential component of the learning environment).

### 3.6 Computer Assisted Learning and Construction/Reconstruction of Concepts

In order to implement computer-assisted learning in addressing Alternative Frameworks among learners in science, the role computer-assisted learning can have on construction and reconstruction needs to be explored.

(Liao & She, 2009) reports the impacts of the Scientific Concept Construction and Reconstruction (SCCR) using digital learning system on eighth grade learners’ concept construction, conceptual change, and scientific reasoning involving the topic of “atoms”. This study successfully demonstrates that the experimental group learners outperformed the conventional group learners in the domains of concept construction, conceptual change and scientific reasoning. Moreover, learners with a higher level of scientific reasoning were more able to successfully change their alternative conceptions.

(Kuhn, 2006) evaluate the advantage of computational modelling and simulation in learning probability. The study showed that the learners were able to model independently and knew how to build models to explore larger or smaller complex problems. Moreover, the learners were able to construct meaningful representations and had little or no difficulties using the tool and the devices. It also indicated that the process of modelling, simulating, analyzing and presenting led to a deeper understanding of methods to calculate probabilities.

(Rose & Bloomington, 2000) assessed the growth of university learners' conceptual understanding of the seasons of the Earth, and eclipses and phases of the Moon upon completing a three-dimensional (3-D) modelling-based Introduction to Astronomy course. Interviews prior to the course identified a range of learner Alternative Frameworks regarding the composition and mechanics of the Solar System. During the course, learner groups constructed three 3-D models of increasing complexity representing different aspects of the Solar System. Learners explored these models in a 3-D virtual environment and posted their final projects on
the course World Wide Web page. Post interviews were targeted toward quantitative and qualitative assessment of learner conceptual growth. Learners showed significant improvement in their conceptual understanding concerning the phases and eclipses of the Moon and reasons for the seasons. Results also suggest that 3-D modelling can be used to support learners' understanding of many fundamental astronomy topics.

(Jimoyiannis & Komis, 2001) studied two groups (control and experimental) of 15-16 years old learners to determine the role of computer simulations in the development of functional understanding of the concepts of velocity and acceleration in projectile motions. Both groups received traditional classroom instruction on these topics; the experimental group used computer simulations also. The results of the study show that learners working with simulations exhibited significantly higher scores in the study tasks. The researchers claim that computer simulations could be used complementary or alternative to other instructional tools in order to facilitate learners' understanding of velocity and acceleration.

3.7 Conclusions and Reflections

Different studies related to Computer Assisted Learning in the present information society are so broad-based that it is not possible for the researcher to incorporate all areas and dimensions. Some of them have been reviewed in this chapter. The overall literature reviewed indicates that computers can be useful in confronting learners with their Alternative Frameworks and promoting conceptual change. Initial investigations related to use of computers for acquisition of conceptual knowledge seems promising. Computer use can be related with effective problem-solving strategies, appropriate theory building, enquiry activities etc.

The key points that emerged in the context of the study are as under

- Computers can be used in a number of ways and in a number of contexts. In order to support the learning environments, computers can be used in a variety of ways. The multimedia approach of using a computer in which audio-visual aids are being provided by the computer is one approach. Going beyond the multimedia approach, computers have so many different roles to play.
- Science learning involving formation of mental models to understand different dimensions of experiences with reality can be supported by the use of computers
in the classroom and also outside it. Similarly, the same computers can be used for stimulating cognitive dissonance, articulating their own is testing hypothesis facilitated analysis and reflections, and creating and scaffolded environment. The interactive nature of computer can be harnessed by creating tutorials, designing concept specific tools and cultivating an online two-way communication.

- Manipulation of variables is an important process for understanding cause and effect relationships in science. Simulated microcomputer-based laboratory experiments can be used to support this manipulation of variables. Different strategies have been used for delivering coursework at different levels of science learning and the effectiveness of the strategy to use computers has been supported by many studies. This approach of delivering coursework gains special importance when there is a question mark on the authenticity of sources available to the learner. Many times some wrong information is available to the child as a source which becomes a reason for Alternative Frameworks.

- Many researchers have compared traditional teaching methods with the use of computers in classrooms. In different subject areas and across boundaries of content, use of computers has largely been seen as being more effective than traditional classroom approaches and strategies. Although the whole system seems to be benefited by this approach, the science learners have been argued to be main beneficiaries. The use of computers in the classroom or outside it by both learners and teachers demands a positive outlook by them towards computers.

- The context of the learners and the teachers including their ages and socio-economic backgrounds has been seen to be correlated with their outlook towards computers. This correlation can be logically attributed to the skill set that the teachers and learners have for engaging with a computer. Thus the question of fundamental working knowledge of computers (both for teachers and learners) becomes an important issue in using computer-assisted learning for addressing Alternative Frameworks among learners in science.

- Non-interactive computer use like accompanying lectures with PowerPoint presentations does not significantly affect learners’ achievement. Also this sort of intervention does not motivate the learner. It is the interactive, model-based simulation or variable control type of experimentation in which some activity on
the part of the learner is inbuilt, may be effective as far as use of computers in the classroom is concerned. And on the other hand, just information dissemination type of approach of using computers might not be useful.

- Studies related to the computer use and socio-cultural context suggests that there is a problem of engagement of the learner in the computer-based interventions and may result in distractions. Difficulty with in language used in the computer-assisted learning material has also been observed. Studies suggest that it seems more effective to integrate content and technology in a manner that enables learners to do playful discoveries than just providing information.

- Anonymity of the participant in the interactive computer use which involves different learners and teachers has been found to be a strong motivating factor to participate willingly in the discussions. Studies related to the cognitive and collaborative learning using computers indicate that the learners most benefited by this type of intervention are those who were found to be fast learners or the learners who learn more.

- The technology integration has to be impacted by teacher’s technological knowledge, pedagogical knowledge and a supportive community.

- Beginners in computer use may need support in the classroom. Studies related to using Computer Assisted Learning for Conceptual understanding concerning the phases of Moon, reasons for seasons etc have been found to support the learners’ understanding and addressing Alternative Frameworks. The learners self-sufficiency related to model building and exploring the larger or smaller complex problems, constructing meaningful representations etc. have been observed.

- Focusing on computer’s role in addressing Alternative Frameworks among learners in science, (Social Development Theory) Vygotsky's idea of MKO (More Knowledgeable Other) gives an opportunity for a computer to interact with the learner and contribute to her learning with respect to a particular task or process. Specifically, if it is an alternative framework, computer may be seen as a non attacking More Knowledgeable Other. Thus ZPD (Zone of Proximal Development) in this model will be the distance between learner’s ability to ‘perform a task under computer’s guidance and support’ and ability to ‘perform the task independently’.
• However in this model the reciprocal relationship between the learner and computer is not possible in an effective manner unless the computer program is designed to gain feedback from learners and improve itself. This possibility is till date a distant reality as self-developing computer programs are not in feasibility and demonstrability stage. But it is possible to incorporate the cultural tools that a child uses, in the Computer Assisted Learning program developed by the experts. These experts should essentially (due to nature of the task) be a collaborative group of science teachers, pedagogues, andragogues, science content experts and computer programmers.

This chapter has built the contrast between the non-interactive and interactive computer use. While researches on the use of models and simulations highlighted the paucity of understanding their use in addressing Alternative Frameworks. They also point towards the applicability of Computer Assisted Learning in addressing Alternative Frameworks amongst learners in science. The researches on the computer use and concept construction/reconstruction brought about diversity in teaching-learning contexts in science. A need for a more intense exploration for developing an understanding of teaching learning contexts has also been brought out by the research review.