Chapter III

REVIEW OF RELATED LITERATURE

3.1 STUDIES RELATED TO COMPUTER BASED INSTRUCTION

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REVIEW OF RELATED LITERATURE

The review of related literature is considered as an important aspect of any investigation. It involves systematic identification, location and critical analysis of the studies related to the research problem.

An effective research is based upon past knowledge. It is a fact that reviews of past knowledge and studies will help us equip ourselves for the present. The major purpose of reviewing the literature is to determine what has already been done that relates to our topic. According to Mouly (1963), “The review of literature promotes a greater understanding of the problem and its crucial aspects and ensures the avoidance of unnecessary duplication”.

The survey of related studies implies locating, studying and evaluating reports of relevant researches, published articles, going through related portion of encyclopaedias and research abstracts, pertinent pages out of comprehensive books on the subject and going through related manuscripts if any. In the words of Good, Barr and Scates (1941), “The competent physician must keep abreast of the latest discoveries in the field of medicine. Obviously, the careful student of education, the research worker, and investigator should become familiar with location and use of sources of educational information”.

Review of related literature helps the researcher to build on existing work; he or she should understand what is already known on a topic (Polit and Hungler, 2003). It enables the researcher to delimit and define his problem and serves as the basis for the formulation of objectives and hypotheses. Also it provides helpful suggestion for scientific investigation. Hence the Investigator has made an attempt to survey the literature related to the topic under study.

The present study was intended to develop a Computer Based Instructional Package in Physics at the higher secondary level and to ascertain the relative effectiveness of this package with existing Activity Oriented Method of Instruction. To test the effectiveness of the Computer Based Instructional Package, evaluation is done based on the changes in the five domains namely Knowledge, Application, Process, Attitude and Creativity as suggested by Yager and Mc Cormark (1989) in their taxonomy of science teaching. Therefore the Investigator classified the reviewed research studies as well as scholarly works as follows.
3.1 Studies related to Computer Based Instruction

3.2 Studies related to Process Skills in Science

3.3 Studies related to Scientific Attitude

3.4 Studies related to Scientific Creativity

3.1 STUDIES RELATED TO COMPUTER BASED INSTRUCTION

In the study made by Nosik, Williams, Garrido and Lee (2013), behaviour skills training (BST) is compared to a computer based training package for teaching staff implementation of discrete- trial instruction with an adult with autism. Following training, participants were evaluated in terms of their accuracy on completing critical skills for running a discrete trial program. Six participants completed training; three received behaviour skills training and three received the computer based training. Participants in the BST group performed better overall after training and during six week probes than those in the computer based training group. There were differences across both groups between research assistant and natural environment competency levels.

Dori and Kaberman (2012) conducted a study which describes the implementation and assessment of a learning unit designed for 12th grade chemistry honours students. The organic chemistry part of the unit was taught in a Computerized Molecular Modelling (CMM) learning environment where students explored daily life organic molecules through assignments and two CMM software packages. The research objective was to investigate the effect of the CMM learning unit on students’ modelling skill and sub-skills. Students indicated that the CMM environment contributed to their understanding of the four chemistry understanding levels and the links among them. Students significantly improved their scores in the five modelling sub-skills.

The study ‘Using Post feedback Delays to Improve Retention of Computer-Based Instruction’ conducted by Johnson and Dickinson (2012) shows that Self-pacing, although often seen as one of the primary benefits of Computer-Based Instruction (CBI), can also result in an important problem, namely, computer-based racing. Computer-based racing is when learners respond so quickly within CBI that
mistakes are made, even on well-known material. Post test scores favoured the use of post feedback delays to improve learning over incentives/disincentives and control conditions. Post feedback delays negatively affected satisfaction in comparison to the control condition, although no satisfaction differences were found between incentives/disincentives and post feedback delays.

Maheswari (2012) conducted a study in which a team of staff at the University of Western Sydney (UWS) were involved in developing a multimedia package, called Sustainable Water Use in Agriculture (SWAG), to assist the first and second year students to learn about the use, management and conservation of water in agriculture. A range of media techniques including text, sound, diagrams, pictures, video clips and animation were used to present the subject matter in an interesting, interactive and effective format. It also contained activities that students can undertake interactively to reinforce and test their learning. An important lesson from this project is that developing a multi-media package is a complex task and requires considerable time, effort and budget to develop an effective student learning package. It also requires a multitude of skills that are not always available in university lecturers who are more likely to be content experts than programmers of such packages.

In the study “Developing Tools for Assessing and UsingCommercially Available Reading Software Programs to Promote the Development of Early Reading Skills in Children”, Wood et al. (2012) developed 2 tools that can support early childhood educators in the selection and use of early literacy software. First, based on models of reading and input from experts in reading research, they developed taxonomy of reading skills. Then they used this taxonomy to assess the literacy skills being trained in 30 commercially available software programs designed for children in preschool, kindergarten, and Grade 1. The results indicated that although some skills were trained in a developmentally and pedagogically appropriate manner, others were absent or had incomplete presentations.

The study ‘Effectiveness of Interactive Computer-Based Instruction: A Review of Studies Published between 1995 and 2007’ made by Johnson and Rubin (2011) revealed that Computer Based Instruction is an effective and viable training technique.
The study made by Serin (2011) aims to investigate the effects of the computer-based instruction on the achievements and problem solving skills of the science and technology students. The result of the study reveals that there is a statistically significant increase in the achievements and problem solving skills of the students in the experimental group that received the computer-based science and technology instruction.

The study ‘The Role of Technology and Computer-Based Instruction in a Disadvantaged Alternative School’s Culture of Learning’ made by Watson and Watson (2011) revealed that new approaches to instruction are increasingly being advocated to meet the needs of diverse learners. Educational researchers have identified the further development and application of computer-based instruction technologies for managing differentiated learning for all students as essential for shifting to a learner-centred paradigm of instruction in future schools. This study examines how a disadvantaged alternative high school implemented technology use and computer-based instruction to support a learner-centred culture of learning.

Wang, Kinzie, McGuire and Pan (2010) conducted a study on Applying Technology to Inquiry Based Learning in Early Childhood Education. The study describes that children naturally explore and learn about their environments through inquiry, and computer technologies offer an accessible vehicle for extending the domain and range of this inquiry. Over the past decade, a growing number of interactive games and educational software packages have been implemented in early childhood education. However, most software packages have yet to integrate technology into inquiry-based learning for early childhood contexts. Based on existing theoretical frameworks, they suggested that instructional technologies should be used in early childhood inquiry education to (a) enrich and provide structure for problem contexts, (b) facilitate resource utilization, and (c) support cognitive and Meta cognitive processes

Yusuf and Afolabi (2010) investigated the effects of Computer Assisted Instruction (CAI) on secondary school students' performance in biology. Also, the influence of gender on the performance of students exposed to CAI in individualised or cooperative learning settings package was examined. The findings of the study showed that the performance of students exposed to CAI either individually or
cooperatively were better than their counterparts exposed to the conventional classroom instruction. However, no significant difference existed in the performance of male and female students exposed to CAI in either individual or cooperative settings.

This study conducted by Quinn, King, Roberts, Carey and Mousley (2009) investigated student performance and attitudes when they have to complete a traditional dissection and a computer based learning (CBL) package (virtual dissection). Test results showed that students performed better directly following the traditional practical approach in both groups despite pre-exposure to the CBL simulation in the second group. Student comments indicated that they preferred the traditional dissection and that it should not be replaced by the virtual practical. However, they also indicated that they enjoyed the different type of interactivity offered by the CBL package and would like to see both approaches used together to complement one another and reinforce their biological knowledge.

The study made by Kablan and Erden (2008) deals with the instructional efficiency of integrating text and animation into computer-based science instruction. The results of the study showed that processing integrated text and animation format in computer-based science instruction requires less mental effort than the separated format, and that the performance of the students in the group with integrated presentation format group is higher than that of students in the group with separated presentation format. Instructional efficiency of the integrated presentation group was found to be higher than that of the separated presentation group. Finally, there was no difference between the two groups for instructional time.

The research by Akpinar and Bal (2006) aimed to devise a set of computer based tools to meet the diverse needs of learners to comprehend a science learning unit. A model of computer based tools on the learning unit for developing procedural knowledge to solve work problems was developed together with a set of teacher customization and collaboration tools. The evaluation studies presented encouraging and promising results.

Gandole (2006) conducted a study on effectiveness of computer software for laboratory practical learning. The computer software was found effective in
communicating laboratory activities in a better way compared to the traditional method.

Manivannan (2006) discusses computer technology in teaching and learning. In his study, the author reveals that growing emphasis is on technology as a fundamental tool uplifting the quality of education is not just “adding” technology, but expecting teachers to provide interesting, inspiring and enhanced technology.

Okorodudu (2006) examined the Nature of technology education in Nigeria: problems and prospects in the new millennium. The study shows that application of technology in Nigerian class rooms in terms of modern computer hardware and software assisted learning exists only at the dream stage. The study also suggested the ways for closing the present digital divide arising from existing ignorance and inequity in the utilization of information and communication technological devices in the 6-3-3-4 education system in Nigeria.

Ortega and Gomez (2006) explored the extent to which computer assisted teaching facilitates the learning of basic mathematical concepts and skills on children with Down Syndrome (DS). Thus the effectiveness of a multimedia teaching method is compared with a traditional one in the teaching of counting and cardinality abilities and concepts. The multimedia group showed a higher performance than the paper and pencil assisted teaching group on a variety of tasks and measures, suggesting a clear relation between teaching method and mathematical learning on DS children.

The study conducted by Thomson (2006) was to determine the effectiveness of teaching of English as a second language with computer and without computer at private intensive English institutes for international studies. The standard measure used was the test of English as a foreign language (TOEFL). The results of the study state that the skill of reading was reinforced by the use of CAI and students in the experimental group had higher reading rates than those in the control groups.

Wighting (2006) conducted a study on the effects of computer use on high school students’ sense of community. The results indicate that using computers in the class room positively affects student’s sense of learning in a community.

Basil and Akporhonor (2005) investigated the use of computer in higher education in Nigeria, with particular reference to the University of Benin. The study revealed that Computers available at present are used mainly for administrative
purposes. The results of the study showed that these computers can be used to enhance the teaching - learning process.

Canon’s (2005) study examined achievement, retention, persistence and success of students who began elementary algebra, progressed into intermediate algebra and subsequently obtained their goal of completing an initial college level mathematics course. Two groups were selected for the study, where one was taught using lecture based approach and the other through computerized instructional approach. The study revealed that lecture student’s achievement rates were significantly higher than the students who received computerized instruction. Retention, persistence and success did not show any significant difference between the two groups.

Chen (2005) evaluated the effects of a personalized computer assisted Mathematics problem solving programme on the performance and attitude of fourth grade Taiwanese students. The results of the study showed that the personalized computer assisted programme on Mathematics word problems improves student performance and attitude.

Kadhiravan and Balasubramanian (2005) provide summaries of the development and validation of computer tutorials. The study reports that computer tutorials have wide spread applications in the field of education, and therefore their development and validation are of paramount importance in the changing situation.

Arulsamy and Sivakumar (2004) studied the effects of interactive computer simulation in education. While stating that computer simulation offers an opportunity to bring elements of practice into the class room, the authors aver that simulated environments can provide enough complexity and flexibility to make them worthwhile vehicles for the practice of many activities, which are not possible by the other teaching methods.

Garland and Noves (2004) conducted a study on The Effects of Mandatory and Optional Use on Students Ratings of a Computer- Based Learning Package. Findings indicated that students whose use was mandatory rated the learning package as more useful than those whose use was optional.

George (2004) took up a study to see the effectiveness of computer assisted instruction strategy on achievement in Biology of vocational higher secondary
students. The investigator found that CAI is more effective than conventional method of lecturing on the achievement in Biology.

**Karthikeyan (2004)** conducted a study on the effectiveness of computer assisted instruction on achievement in applied genetics of students at higher secondary level. The major conclusions of this study are (i) CAI is more effective than text book oriented method on achievement in applied genetics of higher secondary school students. (ii) The CAI is more effective than the text book oriented method on achievement in biology at higher secondary level under the following categories a) knowledge b) understanding c) application and d) skill.

**Kumar (2004)** presents the results of integration of information communication technology with pedagogy. The author avers that integration of ICT with pedagogy involves a challenging process where in the curriculum makers have to consider the social, economic and such other factors of ICT along with the basic structure and approaches to pedagogy.

**Kadhiravan and Suresh (2003)** studied the impact of computers with peer interaction on teaching of Physics. The study attempted to find out the impact of different instructional strategies viz., lecture method, computer assisted instruction as individual instructional strategy and computer assisted instruction with peer interaction (CAIPI) on the achievement of students on Physics. It is found that CAIPI is the most effective instructional strategy in enhancing the achievement of students in Physics.

**Lonigan et al. (2003)** evaluated the use of computer assisted instruction in providing training in phonological sensitivity skills to 45 pre-school children at - risk for reading problems. Children exposed to CAI made significantly greater gains on rhyming and elision skills as compared to the control group. It was also found that expressive vocabulary scores were predictive.

**Rani (2003)** studied the effectiveness of computer assisted instruction on achievement in Mathematics at secondary level. It was found that students using CAI did significantly better than the control group.

**Shubbar (2003)** examined the effectiveness of using computer assisted instruction in teaching the shapes of atomic orbital. This study investigated the effect of CAI used as a supplement to classroom instruction for improving secondary school
students’ understanding of orbital shapes. The results indicate that the CAI approach enhances students learning. It also helps them figure out cues portrayed in diagrams of atomic orbital.

**Ardac and Sezen (2002)** examines the relative effectiveness of guided versus unguided computer-based instruction with regard to regular instruction in improving content knowledge and process skills among students with low and high chemistry achievement levels. The effectiveness of computer-based instruction increases when learning is supported by teacher-directed guidance.

**Balasubramanian (2002)** developed syllabus oriented computer software package in teaching physics at higher secondary level and validated the developed computer software package from technical and pedagogical points of view by experts, educationists and practicing teachers.

**Balasubramanian and Meera (2002)** studied the relative effectiveness of different modes of computer based instruction on teaching biology. The study looks at special instructional strategies to overcome the differences in the students learning rates. The authors suggested that the development of software packages would help the students to learn at their own pace.

**Blok et al. (2002)** made qualitative studies in English and Dutch that dealt with the effectiveness of using computers to teach beginning reading to children aged 5 to 12. The study revealed that there was positive effect of computer assisted beginning reading instruction compared to instruction without CAI.

**Christine (2002)** compared the effectiveness of CAI to traditional book method with children having reading difficulty. The study revealed that the children who were given computer assisted instruction could learn to react more effectively than children who learned in traditional text book method.

**Davenport and Dafleur (2002)** studied computer assisted reporting in classrooms and its diffusion to news rooms. This study replicates and updates another quantitative research by that examiner reporting instruction in journalism schools. The study concludes that many programmes are catching up with the new industry’s use of computers.
Limburger (2002) studied the effectiveness of using computers for teaching English in Japanese schools. In this study he stressed the use of effective and interactive multimedia software.

Netto (2002) compared the effectiveness of different electronic media on the achievement in Physics at secondary level. The findings are (i) Radio lessons are more effective than conventional lecture method (ii) Computer lessons are more effective than conventional lecture method (iii) Radio lessons are more effective than computer lessons.

George (2001) conducted a study on the effectiveness of computer assisted instruction on achievement in chemistry at higher secondary level. The study reveals that CAI is more effective than the conventional methods in student’s achievements.

Malik (2001) in his work features education as a physical and intellectual tool and computers as a “truly generic tool”, limited in application only by the imagination of the user. The author then blames the computer as a subject to be studied rather than a tool to be used in practical life. The study also effects a framework direction and recommendation for including information technology with education.

Pant (2001) in his study, ‘Computer in School Education’ stresses the significance of the computer in the education system. He discloses the fact that the availability of computer based education programmes and their effectiveness in improving the educational objectives have not yet gained significance.

Snyder (2001) had done an assessment of the role of computer technology in the classroom. Results of the study suggested that students scored significantly higher on material presented through the active learning teaching style without computer technology than students who were presented with material using the computer based technology.

Varghese (2001) conducted a study on the effectiveness of computer assisted lesson on simple tense on 8th standard. The study revealed that computer assisted learning is significantly superior to lecture method and self learning method (SLM) with regard to achievement. It also revealed that CAI was superior to SLM in realizing select instructional objectives.
Vijayalakshmi (2001) studied the effectiveness of CAL in Physics at Secondary School stage using the pre-test, post-test, parallel group design on a sample of 510 XI standard students. The study revealed that CAL is more effective than lecture method in learning of Physics for realization of instructional objectives – knowledge, understanding, application and skill.

Al-Saleh and Al-Debassi (2000) conducted a study on Computer based instruction in Saudi education: A survey of commercially produced software. The investigators found that enrichment, computer literacy and individualized instruction are major use of instructional software.

Ashmore (2000) tried to find out the relationship between computer engagement and an estimate of gains for students at two year college. The purpose was to examine computer engagement of students at a two year college and determine its impact if any, upon academic and social involvement. The data collected with the help of questionnaire showed that computer usage was significant in the significant variables under study.

Fan (2000) conducted a study on computer assisted language evaluation. This study reveals how English test item analysis is carried out with the help of a computer programmed approach, what significance this has, and how beneficial it could be to the teachers of English all over the world.

Lakshmi (2000) designed and implemented a computer assisted lesson on genetics and also compared it with self learning materials and lecture method. A judgement schedule was also administered to both teachers and students. The results throw light on the fact that the achievement of students taught using computer lessons were higher than that of the group taught using self learning materials.

Moore, M & Calvert, S. (2000) examined the impact of computers on the vocabulary acquisition of young children with autism. Children’s attention, motivation, and learning of words were compared in a behavioural programme and an educational software programme having salient qualities such as interesting sounds and object movements. Children with autism were more attentive; more motivated, and learned more vocabulary, in the computer than in the behavioural program.

The major findings of the study made by Maya (1999) revealed that computer assisted instruction is significantly superior to lecture method in terms of
achievement and in realizing education outcomes. The study also revealed that the existing curricular factors are suitable to implement the CAI at secondary schools.

**Mohan (1999)** concluded that CAI was more effective than the modular learning and it was more effective for the high and average intelligence group of students.

**Ryan (1999)** compared the classroom instruction and computer based instruction with that of the conventional method of Navy training course and found that computer based instruction was more effective.

**Cooper (1998)** developed and implemented an instructor created computer tutorial for students in elementary mathematics education course. The results proved that computer tutorials help to explain the topic in depth. Here the students are provided with a choice of assignments to complete in relation to information in tutorial.

**Ford and Klicka (1998)** conducted a study on the effectiveness of individualized computer assisted instruction in basic algebra and fundamentals of mathematics courses. The study showed that CAI sections had significantly higher exam pass rates than traditional sections.

**Zamani (1998)** made a study of implementation issues in the introduction of computers into the Indian education system. The results of the study confirmed that there is lack of hardware, software and maintenance; lack of trained people; and lack of clarity about the objectives.

**Radwan and Rasheed (1997)** studied the effectiveness of computer assisted intelligent tutoring system model developed to improve specific learning skills of special need students. The study revealed that utilization of intelligent tutoring mode would significantly improve the learning skills of students in maths and developed a positive attitude towards computer and schools as a whole.

**Schnackenberg (1997)** work ‘learner control over full and lean computer based instruction under differing ability’ levels revealed that subjects in the full program scored significantly higher on the post test than those in the lean program. Higher ability students scored significantly higher than the lower ability students.
Schnackenberg and Sulliven (1997) took up a study to know learner ability and learner control in computer assisted instructional programs. The idea of learner control over instruction has enjoyed increasing popularity as a result of the growth of computer assisted instruction in the schools.

Bolanle (1996) did a study on the efficiency of computer courseware designs to support concept learning in college level physiology. The study revealed that nearly all the students liked the programmes and expressed deep interest in using similar courseware in other courses.

Xin (1996) analysed the effects of computer assisted co-operative learning in Mathematics in integrated classroom students with or without disabilities. The findings revealed that the co-operative learning group had high scores, on performance of the learning subject effort accomplishment and self confidence than those in the whole class learning group.

Aldamesh (1995) compared the influence of animated visuals with static visuals upon college students understanding of organic reactions mechanism in chemistry. The results indicated that students using animated visuals did significantly better than control group.

Biemans and Simon’s (1995) study computer assisted instruction and conceptual change investigated the instructional conditions required to teach students how to initiate and employ learning activities aimed at conceptual change. Results indicated that scaffolding is fruitful instructional approach to foster self regulated learning aimed at conceptual change.

Burchfield and Gifford (1995) studied the effect of CAI on the attainment of science process skills of community college students based on the scores obtained in the test of integrated process skills. The study revealed that the experimental group showed marked improvement on the individual sub test involving graphing and data interpretation.

Fante (1995) conducted a study to find out the effects of computer assisted instruction on developmental English instruction at a community college. The results of the study supported the effectiveness of the computer assisted instructional method.
Inoue (1995) conducted a study on determinants of the use of computer assisted instruction at a university in Singapore. The study was to identify and prioritize the factors influencing the university faculties’ use of CAI. The results indicated that inhibitors were due to lack of time and technical support.

Reddy and Ramar (1995) conducted a study on the effectiveness of computer assisted instruction in teaching science to slow learners. The study arrived at the following results. There were significant difference between the post-tests mean scores of control group slow learners taught through traditional lecture method and that of the experimental group slow learners taught through CAI. Further the achievement of experimental group slow learners was higher than the achievement of control group slow learners.

Culliver and Obi (1994) conducted a study on using CAI to enhance the peer acceptance of main streamed students with mild disabilities. This study applied CAI technique to improve peer acceptance. In the results no significant difference between peer acceptances among experimental and control groups were found.

Davidson (1994) conducted a study to find out the effectiveness of CAI in developing reading skill. The study confirmed that those students trained in using CAI performed better than those taught through text book approach.

Neiderhauser and Stoddart (1994) conducted a study on Teacher’s Perspective on CAI: Transmission versus construction of knowledge. The elementary school teachers favoured a more transmission oriented view of how computer can be effectively used while secondary teachers tended to favour a more constructivist view.

David (1993) explored the effect of computer based writing programme on the attitudes and performance of students requiring English as a second language. The major findings of the study identified that the most effective programmes were those conducted by teachers experienced in the writing process and that the teacher effectively serves more than twice as many students than other English teachers were serving without the help of the computer.

Edwards (1993) conducted a study to investigate whether more complex concept maps could be generated on Mathematics by the use of paper and pencil or by the use of computer software. The findings indicated that students who used organizational computer software produced concept maps.
Shaoya (1993) studied the details about computer knowledge, interests and attitudes and uses among faculty in two universities in China. The survey revealed that majority of teachers showed a very positive attitude and there is potential to increase computer use among them.

Sharonkay (1993) found out the impact on learning of CAI when aligned with class room curriculum in second grade Mathematics and fourth grade reading. The study found that there was no evidence showing statistically significant difference for second grade students in reading who received CAI.

Orabuchi (1992) designed a study to determine the effectiveness of using computers with programs in the areas of making inference, making generalizations, and maths problem solving. A statistically significant difference was found between CAI and non - CAI groups in generalizations and mathematic problem solving and in affective domains such as attitudes toward school, attitude towards computers, and skills students could do with computers.

Rose (1992) prepared software for CAI. The investigator compared the effectiveness of computer assisted instruction with the teacher support and without teacher support system for teaching underachievers. The results were positive. However CAI used in conjunction with the trainee support systems proved to be more beneficial to the under achievers.

Brain (1991) investigated the effect of animation of visual information when used in combination with text and static visuals in micro computer based instruction. Primary focus was on those levels of learning that demonstrates knowledge of a dynamic process. The results of this study were supportive to the contribution made by the animation of visuals in micro computer based instruction to the recall of information about dynamic process.

Jayamani (1991) developed a computer assisted instruction package in Physics for Class XI students. The experimental group received CAI and after experiment it was found that they performed higher in the post-test than the control group. The differences were insignificant in terms of sex and medium of instruction.

Singh, Ahluwalia, and Varma (1991) conducted a study to see the effectiveness of computer assisted instruction in teaching Mathematics. The study
revealed that students who used the computer scored significantly higher than those taught through the conventional method.

Handelsman (1989) designed a computer assisted instructional programme written in the computer language BASIC to help 11th and 12th grade Algebra students better understand the concepts of linear equations. After four weeks of use, students in the target group showed significant gains in their abilities to write linear equations.

Joseph (1988) did a survey on the introduction of micro computer in education. Findings of the study revealed that introduction of micro computers into education is a highly significant innovation. The study revealed that micro computers offer the schools the opportunity radically to enhance the quality of education.

Ayoubi (1988) studied the effectiveness of micro computer assisted instruction on achievement in chemistry. The findings revealed that students spending half their class instructional time studying chemistry from micro computer programs reached the same level of achievement as students receiving instruction only from teachers.

Hawley, Fetcher and Piele (1986) in their study of “costs, effects and utility of CAI” noted that the cost differences between CAI and traditional instruction were significant and concluded that “the micro computer assisted instruction was the cost-effective alternative of choice” for the learners.

3.2 STUDIES RELATED TO SCIENCE PROCESS SKILLS

The purpose of the study done by Cotabish, Dailey, Robinson and Hughes (2013) was to assess elementary students' science process skills, content knowledge, and concept knowledge after one year of participation in an elementary Science, Technology, Engineering, and Mathematics (STEM) program. The results of the study revealed a statistically significant gain in science process skills, science concepts, and science-content knowledge by general education students in the experimental group when compared with students in the comparison group.

The study conducted by Chabalengula, Mumba and Mbewe (2012) showed that pre-service teachers had limited conceptual understanding of science process skills. On the other hand, they had higher performance on the science process skills.
Whilst majority of the pre-service teachers were unable to provide correct definitions of the science process skills, they performed well on the test that involved novel situations of the process skills.

The major findings of the study conducted by Aruna and Sumi (2011) were (i) there is significant difference in the mean achievement score of experimental group and control group for the two variables, attitude towards science and process skills in science. (ii) At the initial stage, there was no significant difference in the mean scores of pre-test of non verbal intelligence, class room environment, socio economic status and achievement in science. From the findings it is evident that the process approach in science is superior to the constructivist model of teaching for increasing attitude towards science and process skills in science.

In order to increase the quality and quantity of science instruction, elementary teachers must receive professional development in science learning processes. The study made by Cotabish, Dailey, Hughes and Robinson (2011) was part of a larger randomized field study of teacher and student learning in science. The researchers randomly assigned teacher participants to the experimental and control conditions. The results revealed a statistically significant difference between the adjusted post-test scores for the two groups, with the experimental group scoring higher than did the control group, indicating a significant gain in teachers' science process skills.

The study made by Manoj and Devanathan (2011) concludes that (i) Problem based learning strategies significantly enhance process skills in biological science. (ii) Process skill in biological science and scientific attitude are positively correlated. (iii) Problem based learning has bearing on improving scientific attitude of students at secondary level.

The study conducted by Tek, Tuang, Yassin, Baharom and Yahaya (2011) reports on a study that aims to develop a valid and reliable Malaysian-based science process skills test for secondary schools. The final set of items for the all-encompassing Malaysian-based science process skills test earmarked for the main study consists of 60 questions. It has a KR-20 reliability of 0.88, difficulty indices that range between 0.25-0.75 and discrimination indices above 0.40. These three test characteristics are within the acceptable limits for a reliable test.
The study made by **Coil, Wenderoth, Cunningham and Dirks (2010)** revealed that most scientific endeavours require science process skills such as data interpretation, problem solving, experimental design, scientific writing, oral communication, collaborative work, and critical analysis of primary literature. These are the fundamental skills upon which the conceptual framework of scientific expertise is built.

The study undertaken by **Veal, Taylor and Rogers (2009)** proved that self reflection significantly helped students develop basic and advanced process skills, yet did not seen to influence the general understanding of the science content.

**Vikas (2009)** developed a performance test in chemistry for assessing the process skills of students of standard VIII. The performance test prepared and standardised by the investigator is a valid and reliable means of measuring the process skills of students of standard VIII of Kerala State syllabus. The study revealed that better students will perform better in all the different performance sub-tests and different process skills included in the developed performance test irrespective of gender, type of school and locale.

**Aktamis and Ergin (2008)** have conducted a study on “The effect of scientific process skills on students’ scientific creativity, scientific attitude and academic achievement”. It was determined that the scientific process skills education increased the students achievements and scientific creativities, however no meaningful progress was made on their attitude towards science when compared to the teacher centred methods.

**Geevarghese (2007)** conducted a study on school related variables and process outcomes in Mathematics at the secondary school stage. Major findings of this study were the attainment of process skills in mathematics of secondary school pupils was not satisfactory. Process skill outcomes are very much related to learning environment and teacher effectiveness. The attainment of process skills of pupils doing both textual exercises and extra textual exercises are better than that of those who are doing solely textual exercises.

**Hancer and Yilmaz (2007)** conducted a study on “The effect of the characteristics of adolescence on the science process skills of the child” and
discovered that the science process skills of the adolescents do not differ according to their scores and ages but according to their socio cultural conditions.

John (2007) aimed to find out the acquisition of the selected science process skills among the students of standard nine of Ernakulam District with special reference to gender, locale and type of management and found that boys of standard nine possess higher acquisition of selected science process skills than girls. Also the students of aided schools possess higher acquisition of selected science process skills than girls. The students of aided schools possess higher acquisition of selected science process skills than those of government schools. Students of rural school possess higher acquisition of selected science process skills than those of town schools. There is significant relationship between scores on the selected science process skills and creativity of students of standard nine of Ernakulam District. It can be interpreted as the student’s science process skills are more creative.

Monhardt and Monhardt (2007) published a study about “creating content of the learning and science process skills through picture books”. The study provides suggestions on ways in which science process skills can be taught in a meaningful content through children’s literature.

Aruna and Usha (2006) investigated on “Influence of cognitive style, intelligence and classroom climate on process outcomes on science”. The study revealed that (i) Sex and management have significant effect on process outcomes in science of secondary school pupils. (ii) Locale has no contribution in the development of process outcomes in science. (iii) In process outcomes in science, girls are found to be superior to boys and (iv) Private school pupils score higher in process outcomes in science than government school pupils.

Lumbantobing (2006) conducted a “Comparative study on process skills on the elementary science curriculum and text bodies between Indonesia and Japan”. Research findings indicated that the objective of Indonesian curriculum 1994 does not set the substance of process skills and Indonesian text books primarily emphasize basic skills in all grades levels. Japanese text book emphasize basic skills in the third grade and integrated skills in the fourth fifth and sixth grades.

Roth and Roychoudhary (2006) conducted the study, ‘The development of science process skills in authentic contexts’. Findings from the study indicate that
students develop higher – order process skills through non traditional laboratory experiences that provided the students with freedom to perform experiments of personal relevance in authentic contexts. Students learned to (a) identify and design define pertinent variables, (b) interpret, transform, and analyze data, (c) plan and design an experiment, and (d) formulate hypotheses finalize of this study suggest that process skills need not be taught separately. It is clear from the above study that integrated process skills develop gradually and reach a high level of sophistication when experiments are perform in meaningful context.

The purpose of the study by Temiz, Taser and Tau (2006) was to develop multiple format instruments, in order to measure the development of 12 science process skills. For this purpose, a questionnaire with fifteen constructed response type items and one hand on tasks was developed. In its final from, it was administered to a total of eighty 9th grade students on four different high schools in Turkey. The test administration time was set as 90 minutes. The reliability of the instrument was also established and found to be high (r = 0.88). Initial results suggested that the procedures followed in this study could provide guidance for researchers working on the development of test and activities. The results appeared to imply that a multiple format instrument that included both hands on task and paper pencil items could be successfully developed and used.

Aruna (2004) conducted a study “Process outcomes in science and classroom climate”. The correlation analysis revealed that the relationship between process outcomes in science and classroom climate is positive and significant for the total sample and subsamples based on sex, locale and management except rural sample.

The aim of the study conducted by Hartikainen and Sorumunen (2003) was to investigate seventh grade pupil’s scientific process skills, their ideas about learning and studying science and views about science and scientific investigation. One of the major findings of this study was the quality of the pupils’ procedural thinking concerning the scientific investigation is quite modest.

The study conducted by Nancy (2002) was intended to investigate the relationship between process outcomes on biology and each of the selected dimensions of study habit and to predict process outcome in terms of the independent
variables which are correlated with process outcome. The study obtained significant correlation between process outcomes and most of the dimension of study habit.

The purpose of the study “science process skills and achievement in research methodology course” by Onwuegbiai (2000) was to investigate the relationship between student competency on science process skills and their conceptual knowledge of research concepts, methodologies and applications. Findings revealed that the students who demonstrated the highest competency in process skills also tended to exhibit level of performance in the research methods course. The relationships were moderate to large.

Joseph (1998) identified cognitive, affective and environmental variables related to process outcomes in Physics. It was concluded that process outcomes in Physics could be predicted by employing four independent variables, viz. intelligence, attitude towards science learning, science learning interest and socio-economic status. These predictions were found to be highly correlated to process outcomes in Physics.

German (1994) found that academic ability, biology knowledge and language preference had significant direct effects on science process skills and achievement. There were significant mediated effects by cognitive development, parent’s education and attitude towards science on schools. The variables of cognitive development and academic ability had the greatest total effects on science process skills.

Lazarowits and Huppert (1993) conducted an experimental study on “Science process skills of tenth grade biology students on a Computer Assisted Learning (CAL) setting”. The results indicate that the experimental group performed significantly better on three science process skills a) group communication b) interpreting data and c) controlling variables. The integration of CAL into the existing Biology curriculum is discussed in the light of its potential to help students master science process skills and improve their academic achievement.

Sebastian (1993) conducted a survey of selected enquiry skills among standard nine students of Mangalore City Corporation which revealed that boys and girls are equally good in process skills, but the skill of observation seems to be higher among boys. Science club membership and other science facilities seem to be significantly related to the acquisition of science enquiry skills.
**Norman (1992)** reported effectiveness of modelling as teaching strategy on learning science process skills. The teachers of urban sixth to ninth grade students were taught modelling techniques: two sets of teachers served as controls. Results indicated that students taught by teachers employing modelling instruction exhibited significantly higher competence in process skills. Concrete operational students did not make gains equivalent to those beyond concrete stage.

**Rubin and Norman (1992)** assessed the effectiveness of the systematic modelling teaching strategy on integrated science process skill and formal reasoning ability. The analysis of data revealed that a) students receiving modelled instruction demonstrated a significant difference in their achievement of process skills when compared to either of the control groups (b) students taught by teachers who had received special process skill and strategy training demonstrated a significant difference in their process skill achievement when compared with the control group (c) students at different cognitive reasoning levels demonstrated significantly different process skill ability.

**Singh and Black (1991)** conducted a study to find out the effects of task contexts on pupil’s performance in science process skills. The study revealed that there exists an apparent interaction between process skills and contexts. Pupil’s achievement on the interpretation skills was significantly high in everyday contexts than in scientific contexts, where as in application skills it was significantly higher in scientific context.

**Suresh (1991)** tried to identify the sociological cognitive and environmental variables related to process outcome in biology. It was concluded from the study that process outcomes in biology could be predicted by employing four independent variables viz., Intelligence, science learning approach, parental education and parental income. These predictors were found to be positively and significantly related to science process outcome.

**Lobo (1990)** found that the teacher students who possess science process skills were able to improve pupil’s achievement through their modified behaviour. It was also found that as a result of process skills teaching, teachers tend to be more heuristic, problem solving oriented and speculative in contrast with those who are not given the training.
Tanuputra (1989) conducted an investigation of the extent to which science process skills were present in the lower secondary science curriculum. The findings from the interview of teachers showed that some teachers seemed to know which methods are appropriate to promote student active learning. Some teachers expressed their wish to include question or statements in the worksheets, which encourages students to think and a small number of teachers suggest opportunities for students to devise investigations.

Hsuing (1988) conducted a study on the relationship among integrated process skills achievement, logical thinking abilities and academic science achievement. The results showed that (i) there was a significant but moderate correlation between integrated science process skills and logical thinking abilities. (ii) There were significant gender differences in science process skill achievement, logical thinking abilities, and academic science achievement, males out performed females. (iii) Neither test of integrated process skill nor group assessment of logical thinking was effective prediction of individual academic science achievements.

Poulouse (1987) examined the influence of certain personality variables, gender, and residence on process outcomes in Physics of University entrants. The study found that the f-value corresponding to the main effects of personality variables were significant in the case of four out of the nine variables. Gender and residence of the subjects were also found to have a significant influence on process outcomes. Males were seen to be superior to females in their process achievements.

Helseth (1984) conducted a study to find out the relationship among process skills, instructions, achievement, formal operational thinking ability, academic aptitude, perceived locus of control and achievement motivation for man science major enrolled in a college biology course. The finding revealed that the instructional strategy emphasizing integrated science process skills was not effective in promoting significantly higher biology achievement and formal operational thinking ability. Students’ integrated science process skill achievement, mathematical aptitude and formal optional thinking ability were consistently related to biology achievement at the end of the course.

Walkosz and Yeany (1984) through the study, ‘Effects of Lab Instruction Emphasizing Process Skill on Achievement of College students having different
cognitive Developments level’s compared the process skill achievement of students completing traditional laboratory exercises with students not only completing the same exercises but also receiving instruction in such integrated skills as identifying variables and stating hypotheses. The study indicates that, along with gain in content achievement, process skill achievement can be improved in students at all levels of cognitive development through reasonable modifications of existing laboratory exercises.

Mohammed (1983) conducted a study to determine the effects of science process skills instruction among in-service secondary school teachers. It was found that teaching of science process skill objectives and process activities of trained teachers were significantly better than the untrained teachers.

3.3 STUDIES RELATED TO SCIENTIFIC ATTITUDE

The study conducted by Bektasli (2013) shows that it is hard to change students' attitudes toward science. This study specifically explored if media affect pre service science teachers' attitudes toward astronomy and their astronomy achievement. The results showed no significant differences between groups for attitudes and achievement. There were no effects of media on pre service science teachers' attitudes toward astronomy and achievement in astronomy class. However, pre service science teachers' attitudes toward astronomy and achievement in astronomy both improved significantly within each group (with or without media). Even though media was not apparently the reason for the significant changes, it is notable that the pre service science teachers did develop positive attitudes toward astronomy and also increased their achievement in astronomy.

Tortop (2013) conducted a study to develop a new scale for measuring teachers' attitude towards science fair. Teacher Attitude Scale towards Science Fair (TASSF) is an inventory made up of 19 items and five dimensions. The study included such stages as literature review, the preparation of the item pool and the reliability and validity analysis. The results of the study demonstrated that this new Teacher Attitude Scale towards Science Fair was a valid and reliable scale to measure teachers' science fair attitudes.
The purpose of the investigation conducted by Henige (2011) was to compare student attitudes toward two different science laboratory learning experiences, specifically, traditional, cookbook-style, low-inquiry level (LL) activities and a high-inquiry level (HL) investigative project. In addition, they sought to measure and compare students' science-related attitudes and attitudes toward science. Likert scale surveys administered before and after each 5-wk period showed no significant changes in student attitudes to scientific inquiry, adoption of scientific attitudes, enjoyment of science lessons, or motivation toward science when the three time points were compared. The findings in this study have helped to provide suggestions for better implementation of HL projects in the future.

The study conducted by Lou, Shih, Diez and Tseng (2011) was designed to explore the effects of problem-based learning (PBL) strategies on the attitudes of female senior high school students toward integrated knowledge learning in science, technology, engineering, and mathematics (STEM). The results of the study indicate that PBL strategies can be helpful in enhancing students' attitudes toward STEM learning and the exploration of future career choices.

The case study conducted by Molotsky (2011) examined the impact of the application of an inquiry-based concept related physics curriculum on student attitudes and learning in a secondary physics classroom in southern New Jersey. Students who had previously used a traditional physics curriculum were presented with a 10 week inquiry-based concept related physics curriculum on electricity and magnetism. The study utilized observations, a pre/post attitudinal survey, interviews of students and teachers about their perceptions of the inquiry-based curriculum, and artifact analysis of student work. The results showed a positive change in students' attitude in four of the eight categories designated in the CLASS survey. The observations, interviews and artifact analysis revealed that students were more engaged in learning physics through their discoveries in relating physics concepts to real world applications, a growing personal interest in the value and relevance of science learning and a disconnect between the students' and teacher's perceptions about what is important in learning physics.

The study conducted by Chen and Howard (2010) examined the effect of live simulation on students' science learning and attitude. The findings revealed positive
changes in students' attitudes and perceptions toward scientists, while male students had more positive adoption toward scientific attitudes than females. The study also found that the change in student's science learning was significantly influenced by the teacher. Hence, teacher classroom preparation for the simulation experience proved vital to students' attitudes toward science as well as their scientific understanding.

The purpose of the study made by **Telli, Denbrok and Cakiroglu (2010)** was to examine associations between Turkish high school students' perceptions of their science teachers' interpersonal behaviour and their attitudes towards science. Students' perceptions of the teacher-student interpersonal relationship were mapped with the Questionnaire on Teacher Interaction (QTI), which uses two relational dimensions: influence and proximity. Multilevel analyses of variance indicated that influence was related with student enjoyment, while proximity was associated with attitudes towards inquiry and with enjoyment.

The objective of the study conducted by **Zain, Samsudin, Rohandi and Jusoh (2010)** was to improve students' attitudes toward science using instructional congruence. The results show that instructional congruence in science education promotes positive students' attitudes toward science, especially in the constructs of the practical work of science, science outside of school, future participation in science, and a combined interest in science. The results suggest that more effort should be made to integrate science learning in school with science-related experiences outside of school. Additionally, science teachers should concentrate more on making students feel more confident about their abilities in science.

The aim of the study by **Aktamis and Ergin (2008)** was to investigate the effects of teaching scientific process skills education to students to promote their scientific creativity, attitudes towards science, and achievements in science. The research includes a pre-test post-test research model with a control group. As a result of the research, it was determined that the scientific process skills education increased the students' achievements and scientific creativities, however, no meaningful progress was made on their attitudes towards science when compared to the teacher-centered method.

The study conducted by **Nwagbo (2006)** was designed to investigate the relative efficacy of the guided inquiry and the expository teaching methods on the
achievement in and attitude to biology of students of different levels of scientific literacy. The results showed that the guided inquiry method was significantly better than the expository method in enhancing cognitive achievement in biology for students of all levels of scientific literacy, especially the high ones. Students of different levels of scientific literacy showed positive attitude to biology. The interactive effects of teaching methods and scientific literacy levels, on both achievement in and attitude to biology, were not significant.

Unnikrishnan (2001) in his study “construction and Standardisation of a Scientific Attitude Scale and its Application at Secondary Level” came into the conclusion that there is no significant difference in the level of scientific attitude possessed by the boys and girls.

Morrel (1992) examined the relationship between student’s attitude towards school and attitude towards classroom science and found that significant relationship between these two variables.

Satheesh (1992) studied scientific attitude in relation to science interest and creativity. The major findings were (i) there was no considerable relationship between scientific attitude and science interest for boys, rural-urban subjects and government institutions. (ii) There was no relationship between scientific attitude and creativity among the total sample and sub samples. (iii) There was no close and considerable relationship between scientific attitude and scientific reasoning in the case of the total sample, boys and rural-urban subjects.

Ampili (1991) in her study assessed separately the possible relationship of process outcomes in science to science interest, scientific attitudes, and attitude towards academic work of total sample and relevant subsamples. She found a positive and significant relationship between process outcomes and science interest, scientific attitude and attitude towards academic work.

Geetha (1986) investigated the effect of school climate on scientific attitude of secondary school pupils. She found out that the positive school climate plays a significant role in raising the scientific attitude of secondary school pupils.

A study was conducted to determine the influence of scientific attitude on some select variable by Ghosh (1986). The major findings of the study were: (i) there was a positive relationship between scientific aptitude and scientific attitude and
academic motivation. (ii) Rural students belong to high socio economic status (SES) did not show better scientific attitude than rural students belonging to the low SES group.

**Baker (1985)** during his study using the scientific attitude inventory found that, middle school students with A and B grades in science had negative attitude towards science while those with C and D grades have positive attitude towards science.

**Hasen (1985)** conducted a study to determine the influence of some selected instructional methods and home variable on attitude towards science of secondary school students in Jordan. The study has revealed that one variable out of the seven investigated variables has an important effect on student’s perception of his science ability.

A study of the factors related to learning outcomes of VIII graders using regression analysis was carried out by **Taglieber (1983)**. He found that attitude towards science was significantly associated with science achievement scores.

**Hough (1982)** made an investigation in to the relationship between pupil’s attitude towards science and their science achievement. The analysis revealed that the relationship was significant and high.

**Shinde (1982)** in his study found that the correlation between the scientific attitude scores and non-formal science activity scores was negligible and not significant. Thus the scientific attitude of secondary school pupils was related to their scientific attitudes. Scientific attitude of the students differed from region to region. The students with high academic achievement had high scientific attitude. Boys and girls from the same cultural groups did not differ significantly in their scientific attitude.

A study on scientific attitude and its purpose was conducted by **Wareing (1981)**. The purpose of the study was to determine whether global or analytical cognitive style of students in Science Curriculum Improvement Study (SCIS) affect their attitude towards science. When the Pearson’s Product Moment Correlation was calculated for scientific attitude and cognitive style a value of $r = 0.01$ was achieved indicating that such a relationship is negligible.
A study of the scientific attitude and its measurement was conducted by Srivasthava (1980). The major findings of the study were; (i) the amount of scientific knowledge or general exposure to science courses made impact on scientific attitude positively. (ii) Scientific knowledge helped in the formation of scientific attitudes (iii) boys and girls differ in respect of scientific attitude (iv) male and female teachers do not differ in respect of scientific attitude.

A study was conducted by Gopalakrishnan and Benny (1977) to find the relation between scientific attitude and intelligence of graduate students. Their study revealed that the correlation between intelligence and scientific attitude though positive is very low.

### 3.4 STUDIES RELATED TO SCIENTIFIC CREATIVITY

The "Learn to Think" (LTT) Intervention Program was developed by Hu et al. (2013) for raising thinking abilities of primary and secondary school students. Several longitudinal intervention studies showed that LTT could promote the development of students' thinking ability, learning motivation, and learning strategy as well as raise academic performance in primary schools. The study also revealed that the LTT did promote the development of scientific creativity of secondary school students, and the effects on the scientific creativity were not necessarily immediate, but tended to be long-lasting.

This research done by Cho, Chung, Choi, Seo and Baek (2012) explores the emergence of student creativity in classroom settings, specifically within two content areas: science and social studies. The three types of student creativity emerging in the teaching and learning process found in this research were: (a) heuristic creativity, (b) interpretive creativity, and (c) integrative creativity. The study results will challenge teachers to find instances of student creativity in their teaching and learning situations and to facilitate student creativity when the students interpret data or materials related to the contents of the curriculum.

The study conducted by Chander (2012) attempted to find a realistic connection between the "little c creativity" of individuals and science education through a heuristic study. Evidence revealed that science teaching, if done properly, could develop reasoning skills, curiosity, open-mindedness, critical thinking and
problem-solving attitudes, all of which are necessary ingredients for the fostering of "little c creativity" in learners.

Resmi (2011) conducted a study on the self concept, achievement motivation and scientific creativity of secondary school students. The study revealed that there is no significant relationship between self concept and scientific creativity of secondary school students with regard to gender, locality of institution and SES.

The study performed by Welch and Huffman (2011) was designed to examine the impact of participating in an after-school robotics competition on high school students' attitudes toward science. Results indicated that students who participated in a robotic competition had a more positive attitude toward science and science-related areas in four of the seven categories examined: social implications of science, normality of scientists, attitude toward scientific inquiry, and adoption of scientific attitudes.

The study conducted by Newton and Newton (2010) reports on a series of studies designed to explore teachers' conceptions of creative thinking in primary school science. Study #1 examines pre-service primary teachers' ideas of what constitutes creativity in science lessons, using a phenomenographic analysis. The study found that their conceptions tend to be narrow, focusing on practical investigations of fact and are prone to misconceptions. Although teachers are often encouraged to support creativity, their notions of how to accomplish this within specific school subjects may be inadequate. Study #2 involves asking primary school teachers to rate lessons according to the opportunity offered to children to think creatively in science. This study found that teachers generally distinguish between creative and reproductive (as in mimetic) activities, but tend to promote narrow conceptions of creativity in school science, where fact-finding and practical activities are prominent. Some teachers identify creativity in reproductive activities as well as on the basis of what simply stimulates student interest and generates on-task discussion. Study #3 is designed to check pre-service teachers' conceptions of scientific creativity through an assessment of creative elements in children's explanations of simple scientific events. This study found little agreement in teachers' personal assessments of creativity.
Creativity is generally considered to be something to encourage in young children. It is, however, popularly associated more with the arts than with the sciences. The study done by Newton and Newton (2009) used phenomenographic analysis to identify some primary school student teachers’ conceptions of creativity in school science lessons. Teacher trainers are advised that student teachers’ conceptions of creativity can be grossly inadequate in several ways and they may omit significant opportunities for creativity. As conceptions may be shaped by creativity in the arts, it is suggested that science educators might loosen the connection by introducing students to the broader term of "productive thought", i.e. a combination of creativity and critical thought which is particularly relevant in science.

Shanahan and Nieswandt (2009) argued that ignoring creativity and other qualities that are important to the practice of science not only leaves students with a misunderstanding of science, it also limits the qualities and characteristics with which they can identify in the science classroom, which will potentially alienate them from further study. This is of particular concern in students making their first decisions about what science is and whether they see themselves pursuing science in the future.

The study conducted by Rosamma (2007) found that the variables intelligence, scientific creativity and home environment clearly discriminated the high, average and law achievement groups. So these variables have significant association with achievement in science.

Haneshia (2001) conducted a comparative study of scientific creativity of pupils in DPEP and non DPEP schools in the state of Kerala. The study found that the two groups differ significantly with respect to fluency, flexibility originality and total creativity.

Sansanwal and Deepika (1997) found that, (i) Male and female students did not differ significantly in scientific creativity. (ii) Interaction between standard and gender did not have any significant influence on scientific creativity. (iii) Scientific creativity scores of students belonging to high and low levels of intelligence did not differ significantly.

Asmali (1994) conducted a study on the relationship between science achievement, science interest, scientific attitude, process outcomes in science and...
scientific creativity of secondary school pupils and found that there was a significant relationship among the variables viz. Science achievement, science interest, scientific attitude, process outcomes in science and each component of scientific creativity and each of the experimental variables can discriminate significantly between the high, average and low creative pairs in the dimension of scientific creativity.

**Craine (1994)** conducted a study on the relationship between students learning styles and creativity and performance in introducing college chemistry. The study was designed to examine the relationship between the four independent variables such as sensing, feeling, sensitive thinking, initiative thinking, incentive feeling and the dependent variables of performance. Based on the study the major finding was there exists a relationship between student learning styles, creativity and performance.

**Maha (1994)** investigated the relationship between teachers expressed attitudes towards creativity and their actual instructional behaviours in the classroom. The findings indicated that there was a negative relationship between attitude and instructional behaviour. The analysis of variance indicated that the demographic variables such as teacher’s age, educational background and teaching experience have no relationship with attitude and instructional behaviours and there have no influence in creativity.

**Parkhurst and Bruce (1994)** conducted a study on developing creative thinking on the three stage of creativity, i.e.; Analysis, comparison and synthesis on the 7th and 8th grade students. The subjects were pretested with Torrance Test of creative thinking - verbal and figured forms A and with Torrance Test of creative thinking - verbal and figural form B and analysis of results did not indicate significant difference between control and experimental groups.

**Tafari and Marie (1994)** in their study ‘effects of creativity on teacher – student interactions’ sought to determine the effects of teacher’s creative abilities on their interaction with children. Results indicated that no significant relationship existed between teacher’s creativity with respect to teacher’s expectations of students’ creative aptitude. Significant relationship exists between teacher’s creativity and amount of response opportunities, questions, answers and terminal feedback they
provided to students. Also significant differences existed between group means based on gender and creative abilities of students.

Anilkumar (1993) conducted a study on the relationship between creativity in science and certain demographic variables of secondary school pupils. The study showed that there exists a significant relationship between each of the components of creativity in science and total creativity in science with each of the demographic variables, namely gender locale and socio economic status.

Devi (1992) studied the relationship of pupils between attitude towards science and creativity of secondary school pupils and arrived at the following conclusions. The positive correlation obtained for the total sample and subsamples with attitude towards science and creativity in science and each of its components correlated was significant at 0.01 level. This study concluded that attitude towards science has certain role in the development of creativity in science among pupils.

Sukla and Sharma (1987) administered a scientific creativity scale in 330 urban, rural and refugee students in the middle school to text for fluency, flexibility and originality. The results indicated that the lowest scores came from tribal pupils and rural pupils scored higher in fluency than the refugees.

Misra (1986) conducted a study on effect of home and school environment on scientific creativity. The major findings showed that boys do not differ significantly from girls with respect to inquisitiveness which is an aspect of scientific creativity. However girls excel boys in three aspects viz., fluency, flexibility and originality. All the significant relation among the variables seemed to be tied with verbal intelligence, non – verbal intelligence and socio economic status.

Yawalker (1985) investigated into the development of some personality correlates of scientific creativity. The study was aimed of investigating the efficiency of two creative teaching techniques, viz. bionics and morphological correlates analysis conducive to develop some personality correlates of scientific creativity. The personality variables under study were self reliance, dominance emotional ability and super ego strength.
Conclusion

From the review of related literature, it becomes clear that Computer Based Instruction has emerged as an effective and efficient media of instruction in advanced countries of the world as well as in India. A great deal of researches has been conducted on the effects of computer use on student achievement, attitudes, process skill development and other variables like learning rate.

The empirical studies lead the Investigator to conclude that development of an interactive Computer Based Instructional Material is a more challenging task than just providing a few activities or explanations through computers. In order to bring desired output among learners, it is necessary to arrange innovative activities, explanations, illustrations, simulations provision for drill and practice, colourful pictures and animations in an interesting manner.

Researches show that when Computer Based Instruction (CBI) is implemented correctly, the results are as good as or better than traditional teaching-learning process. The single best-supported finding in the research literature is that the use of Computer Based Instruction produces achievement effects superior to those obtained with traditional instruction alone. This finding holds true for students of different ages and abilities and learning in different curricular areas. This finding is supported by the researches done by Serin, 2011; Yusuf and Afolabi, 2010; Thomas, 2006; Chen, 2005; George, 2004; Karthikeyan, 2004; Kadhiravan and Suresh, 2003; Rani, 2003; Shubbar, 2003; Limburger, 2002; George, 2001; Varghese, 2001; Vijayalakshmi, 2001; Fan, 2000; Lakshmi, 2000; Maya, 1999; Mohan, 1999; Ford and Klicks, 1998; Fante, 1995; Davidson, 1994; Jayamani, 1991 and Ayoubi, 1998.

The studies conducted by Ortega and Gomez, 2006; Lonigan, 2003; Christine, 2002; and Moore et al., 2000 revealed that Computer Based Instruction is suitable for exceptional children and for students having certain learning difficulties. Watson and Watson, 2011; Akpinar and Bal, 2006; and Radwan and Rasheed, 1997 pointed out that CBI is useful to meet the needs of diverse learners. It is useful for the achievement of slow learners (Reddy and Ramar, 1995) as well as for higher ability students (Schnackenberg, 1997). The development of such software packages would help the students to learn at their own pace (Balasubramanian and
Meera, 2002). The achievement rate of students also increased by the use of Computer Based Instructional Approach (Canon, 2005).

The review of the studies done by Maheswari, 2012; Kablan and Erden, 2008; and Aldamesh, 1995 revealed that the learning of the students can be improved if a range of media techniques including text, sound, diagrams, pictures video clips, and animations were used to present the subject matter in an interesting, interactive and effective format. The studies done by Johnson and Rubin, 2011; Arulsamy and Sivakumar, 2004; and Brain, 1991 shown that interactive Computer Based Instruction is an effective and viable technique. Wang et al., (2010) suggests that technology should be used in early childhood education for ensuring inquiry based learning. The researchers like Quinn et al., 2009; Kumar, 2004; and Malik, 2001 opined that ICT should be integrated with traditional approaches for the improvement of student learning.

The studies revealed that Computer Based Learning is suitable for skill development in general (Dori and Kaberman, 2010; and Gandole, 2006) and development of science process skills in particular (Burchfield and Gifford, 1995 and Lazarowitz and Huppert, 1993). The studies done by Cotabish, Dailey, Robinson and Hughes (2013) suggested that, in order to increase the quality of science instruction, elementary teachers must receive professional development in science learning process. Also participation of students in Science, Technology, Engineering, and Mathematics (STEM) programmes improve science process skills. The studies also revealed that laboratory experience develops process skills among students (Rath and Ray Chaudhari, 2006; Walkesx and Yeammy, 1984). Also science club membership and science facilities enhance the inquiry skills among learners (Sebastian, 1993).

Students’ science process skills are more creative. Science process skill education increases students’ achievement and scientific creativities (John, 2007; Aktamis and Ergin, 2008). Several suitable strategies can be used for developing process skills among learners (Manoj and Devanathan, 2011; Veal, Taylor and Rogers 2009; Aruna and Suni 2011).

The study conducted by Chander, 2012 revealed that science teaching, if done properly could develop reasoning skills, curiosity, open-mindedness, critical
thinking, and problem-solving attitude, all of which are necessary ingredients for fostering creativity in learners. ‘Learn to think’ did promote the development of scientific creativity of students, but the effects of creativity were not necessarily immediate (Hu et al. 2013). Although teachers are often encouraged to support creativity, their notion of how to accomplish this within specific school subjects may be inadequate (Newton and Newton, 2010). But ignoring creativity and other qualities that are important to the practice of science not only leaves students with a misunderstanding of science, it also limits the qualities and characteristics which they can identify in the science class rooms, which will potentially alienate them from further study.

The scientific creativity scores of high and low levels of intelligence did not differ significantly (Sansanwal and Deepika, 1997). But there exist relationship between science achievement, science interest, science attitude, process outcomes and scientific creativity of students (Aktamis and Ergin, 2008; Asmali, 1994; Devi, 1992; Ampili, 1991; Taglieber, 1983; Hough, 1982; Shinde, 1982; Srivastava, 1980). But Satheessh, 1992 found that there was no relationship between scientific attitude and creativity and no considerable relationship between scientific attitude and scientific creativity.

Chin and Howard, 2010 observed that live simulations enhance students’ science learning and attitude. The researches done by Bektasil, 2013; Tortop, 2013 and Henig, 2011 revealed that positive attitude increases the achievement. Inquiry based concept related curriculum (Molotslay, 2011), Problem Based Learning Strategies (Lou, Shih, Diez and Tsang, 2011) and Guided inquiry method, (Nwagbo, 2006) are helpful in enhancing student’s attitude towards science.

Chen, 2005 and Orabuchi, 1992 pointed out that Computer based Instruction is useful for developing a positive attitude among learners and using computers in the classrooms positively affects student’s learning in a community (Wighting, 2006). Growing emphasis on technology as a fundamental tool uplifting the quality of education is not just adding technology, but expecting teachers to provide interesting, inspiring and enhanced technology (Manivannan, 2006). Majority of teachers showed a very positive attitude and there is potential to increase computer use among them (Shaoya, 1993). But availability of Computer
Based Education Programmes and their effectiveness in improving the educational objectives have not yet gained significance (Pant, 2001). Inhibitions in using CAI are due to the lack of time and technical support (Inoue, 1995). Also there is lack of hardware, software and maintenance (Zamani, 1995). However Computer Based Instruction is considered as the “cost effective alternative choice” for the learners (Hawley, Fetcher and Piele, 1986).

The review of literature revealed the importance of Computer Based Learning Materials in the teaching-learning process in a technologically advanced society and provided clear justification for undertaking this study. It has also established important background understanding which helped the Investigator to frame the overall research design.