CHAPTER V
SUMMARY AND CONCLUSION

5.1 Statement of the Problem
The study was undertaken with a view to investigate the “Effect of Varied ICT Instructional Approaches on Academic Achievement and Retention in Science among Secondary School Students”.

5.2 Definition of Technical Terms

i. Information and Communication Technology (ICT):

ICT is the digital processing and utilisation of information by the use of electronic computers. It comprises the storage, retrieval, conversion and transmission of information (Ifueko Omoigui Okauru, 2011).

ICT (information and communications technology – or technologies) is an umbrella term that includes any communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning. ICTs are often spoken of in a particular context, such as ICTs in education, health care, or libraries. The term is somewhat more common outside of the United States (Margaret Rouse, 2005).

ICT covers all forms of computer and communications equipment and software used to create, design, store, transmit, interpret and manipulate information in its various formats. Personal computers, laptops, tablets, mobile phones, transport systems, televisions, and network technologies are just some examples of the diverse array of ICT tools (http://www.uq.edu.au/ICT/what-is-ICT 2012).

All the definitions share a similar notion that, information has to be generated and shared. They also assert that, such information must be digital or electronic. The definitions generally do not restrict ICT
and IT to only computers, they mention telecommunications equipment (mobile phones, printers, scanners etc) as well.

There isn't much difference in the definitions above. However, Margaret Rouse goes further to explain ICT as applying to software, and not only hardware as seems to be the case in the other definitions. This difference isn't so obvious, as one can argue that, in order for the equipment mentioned in the other definitions to serve their purpose, software (or an engine) is needed to run them.

"ICT implies the technology which consists of electronic devices and associated human interactive materials that enable the user to employ them for a wide range of teaching - learning processes in addition to personal use." These technologies include computers, the Internet, broadcasting technologies (radio and television), and telephony.

"ICT is that technology which uses the information to meet human need or purposes including processing and exchanging."

All these definitions combine Communication technology and Information technology that have thin line between them but cannot do away without each other. When these technologies are applied in the field of education, it is termed as ICT in education. The term too can be used as the connotation to the term Educational; technology because it also uses any hardware and software approaches that can enhance yield better learning outcomes. In the era of Computer technology the term ICT mainly focuses on the infrastructure, devices and sources of computer technology and thus it is imperative to discuss about the use of ICT in education by focusing mainly on Computer based technology.

Conclusively, ICT /IT is a general term, that describes the process of creating, modifying, storage, transmission of information, in varied formats, between humans and machines alike globally, using several different electronic technologies, to achieve an outcome (be it recreational, or otherwise).
ii. Computer Based Learning (CBL):

The term CBL is gaining popularity to describe all students learning related to the computer. Some consider this term more generally because the term learning more naturally encompasses situations where the computer is used as in educational tool but is not delivering information or instructing the students. The term CBL is therefore used as the umbrella term for all educational uses of the computer. Using CBL approach in the classroom, teachers should be familiar with different roles. Hannafin and Savenye (1993) and Cheung (1995) pointed out that when information technology is used in classrooms, teachers act as managers, organizers, coaches, guides, initiators, and facilitators. Thus, CBL is not limited to students, computers, and software but can also include and encompass various combinations of the computer with other advanced technologies to create learning experiences for the students.

Computer Based Learning refers to instruction on a given topic, where the learning interface is a computer. Computer Based Learning is used to transfer knowledge of situations, processes, skills, and techniques to the learner.

Computer Based Learning can be used as a cost effective tool to bring efficiencies to the transfer of knowledge. It can be used for a wide range of learning and development processes, and if delivered via the internet, it can be readily modified and deployed in an updated form instantly.

Computer Based Learning should not be used in isolation. To gain the optimum effectiveness out of a learning process, the process of blended learning should be applied. Blended learning combines Computer Based Learning with: Assessment tools, Workplace exercises, Personal activities, Group discussions, Face-to-face workshops for skill development, Coaching, Project work. These
combine to ensure a transfer of learning to workplace outcomes to deliver sustainable gains in productivity.

**iii. Computer Based Instruction (CBI):**

Computer-based instruction is defined as the delivery of instructional content by means of the computer to achieve learning goals through desired outcomes (*Lowe, 2004*). When computer delivers some instructional material (*Taylor, 1980*) then this situation is termed as Computer Based Instruction. Computer Based Instruction has traditionally has been composed of four components i.e. drill and practice, tutorials, games and simulations and modeling. The term computer based instruction is used to describe computer applications in education. CBI is also used frequently but again the term instruction might imply only educational uses of the computer where the computer is delivering information to the student and does not include the tool usages of machine. When this term is used, it refers to use of the computer to deliver information to the student. The following are the characteristics of CBI may be considered:

(i) **Individualisation:** It is an individualized method of teaching. Student should be allowed to work at their own rate.

(ii) **Learner Control:** when teachers direct instructional activities, they control pace and direction. When computers are used to deliver instruction, the focus of control changes. Originally, most CBI allowed the students considerable flexibility in controlling the pace and route of the lesson.

(iii) **Attitude Changes:** It is possible to design CBI so that student’s attitude can be changed both toward the topic being taught and toward the importance of CBI.

(iv) **Computer Anxiety:** A significant proportion of any group of computer users will be considerably more anxious than others in the same group and this anxiety has been shown to be related to problems these people have when they use computers.
iv. Teacher-Centered Approach: (TC)

The traditional instruction environment is based on a textbook approach, using chapters of a textbook related to topics. It is teacher-centered and involves lecturing and sometimes questioning. Generalizations, rules and definitions are given firstly as a top down approach, and then examples are provided. The students listen and take notes in their own places (Duatepe, 2004).

In the teacher-centered approach, the teacher provides instruction through lectures, focusing attention to the textbook material and to some extent the problem solving. During treatment to this group “chalk and talk” remained the most frequently used approaches of the teacher. In addition, the teacher requires students to solve some questions and problems on their notebook and discuss with their class fellows.

v. Academic Achievement

Academic achievement or (academic) performance is the outcome of education — the extent to which a student, teacher or institution has achieved their educational goals. Academic achievement is commonly measured by examinations or continuous assessment but there is no general agreement on how it is best tested or which aspects are most important — procedural knowledge such as skills or declarative knowledge such as facts.

An academic achievement is something you do or achieve at school, college or university - in class, in a laboratory, library or fieldwork. It does not include sport or music. An academic achievement, such as graduating 1st in one's class, is sometimes a purely quantitative matter, while having the findings of lengthy, comprehensive research published by a recognized journal is also a notable academic achievement. Being named head/chairman of a particular department at a university is both a professional and an academic achievement.
According to Bingham (1937) “It is a close relationship between achievement tests and aptitude tests because achievement in a particular branch of knowledge or skill is considered as a good indicator of aptitude.”

vi. Retention

The condition of retaining (keeping) something. "You may be able to memorize facts in the short-term, but how well is your retention of those facts over the long-term?” "Successful students need to foster a good environment so that their retention remains at a high level.”

5.3 Rationale for the Study

The present challenge of education is to integrate information technology with curriculum transaction and empowerment of children to enable them to function effectively in a world that is going to be increasingly information and technology driven. In order to “learn to learn” and “how to learn” the student must be able to use computers as an important aid. The environment, provision, support and initiative of the educational institutions should ensure their functionality through the computer to facilitate every student to comfortably make use of the computer as one of the main sources of learning at school and home.

The main emphasis in the Xth plan period is on upgradation and qualitative improvement of education, orientation of teachers to keep them abreast with modern techniques in the teaching-learning situation, computer education etc. The important schemes of Directorate of Education, Goa with reference to information and communication technology are Edunet scheme, incentives to provide laptop for teachers, ICT@school scheme and computer literacy project. The ‘cyberage scheme’ - under which computers or laptops were provided to the students about a decade back. Reportedly the
computer will be provided with security system to make sure that the computers are used for the academic purpose under the parent supervision.

The effects of Computer-based instructions and Computer-based learning is important not only because of the effort and money being invested in Indian schools and colleges on ICT but most importantly, the great potential for increased student learning if it is proved effective. Foreseeing the importance of computer in the process of educational transaction of students the present study is an attempt to determine the effect of varied ICT instructional approaches on academic achievement and retention in science among secondary school students.

**5.4 Research Questions:**

This research study permitted to investigate the following questions.

1) Is there a difference in pre-test and post-test achievement scores of the students through Computer Based Learning (CBL), Computer Based Instruction (CBI) and Teacher Centered (TC) approaches?

2) Is there a difference in pre-test and post-test achievement scores of boys and girls with respect to different approaches?

3) Is there a difference in pre-test and post-test achievement scores of the students with respect to different ability levels (below average, average and above average ability levels)?

4) Is there any significant interaction effect among the different treatment groups (CBL, CBI and TC) and gender (boys and girls)?

5) Is there any significant interaction effect among the different treatment groups (CBL, CBI and TC) and different ability levels (below average, average and above average ability levels)?
6) Is there any significant interaction effect among the gender (boys and girls) and different ability levels (below average, average and above average ability levels)?

7) Is there any significant interaction effect among the different treatment groups (CBL, CBI and TC) X different ability levels (below average, average and above average ability levels) X gender (boys and girls)?

5.5 Objectives of the Study

1) To study the effect of pre-test achievement scores of three treatment groups Computer Based Learning (CBL), Computer Based Instruction (CBI) and Teacher Centered (TC).

2) To study the effect of post-test achievement scores of three treatment groups (CBL, CBI and TC).

3) To study the effect of delayed post-test retention scores of three treatment groups (CBL, CBI and TC).

4) To study the effect of pre-test achievement scores of gender (boys and girls).

5) To study the effect of post-test achievement scores of gender (boys and girls).

6) To study the effect of delayed post-test retention scores of gender (boys and girls).

7) To study the effect of pre-test achievement scores of students of different ability levels (below average, average and above average).

8) To study the effect of post-test achievement scores of students of different ability levels (below average, average and above average).

9) To study the effect of delayed post-test retention scores of students of different ability level (below average, average and above average).
10) To study the interaction effect of post-test achievement scores of gender (boys and girls) and different treatment groups (CBL, CBI and TC).

11) To study the interaction effect of delayed post-test retention scores of gender (boys and girls) and different treatment groups (CBL, CBI and TC).

12) To study the interaction effect of post-test achievement scores of different treatment groups (CBL, CBI and TC) and different ability levels (below average, average and above average ability levels).

13) To study the interaction effect of delayed post-test retention scores of different treatment groups (CBL, CBI and TC) and different ability levels (below average, average and above average ability levels).

14) To study interaction effect of post-test achievement scores of gender (boys and girls) and different ability levels (below average, average and above average ability levels).

15) To study interaction effect of delayed post-test retention scores of gender (boys and girls) and different ability levels (below average, average and above average ability levels).

16) To study the interaction effect of post-test achievement scores of gender (boys and girls) X different treatment groups (CBL, CBI and TC) X different ability levels (below average, average and above average ability levels).

17) Study the interaction effect of delayed post-test retention scores of gender (boys and girls) X different treatment groups (CBL, CBI and TC) X different ability levels (below average, average and above average ability levels).

18) To study the effect of post-test achievement and delayed post-test retention scores of boys.
19) To study the effect of post-test achievement and delayed post-test retention scores of girls.

20) To study the effect of post-test achievement and delayed post-test retention scores of CBL treatment group students.

21) To study the effect of post-test achievement and delayed post-test retention scores of CBI treatment group students.

22) To study the effect of post-test achievement and delayed post-test retention scores of TC treatment group students.

23) To study the effect of post-test achievement and delayed post-test retention scores of below average ability level students.

24) To study the effect of post-test achievement and delayed post-test retention scores of average ability level students.

25) To study the effect of post-test achievement and delayed post-test retention scores of above average ability level students.

26) To study the effect of post-test and delayed post-test achievement scores of school-1 students.

27) To study the effect of post-test achievement and delayed post-test retention scores of school-2 students.

5.6 Research Hypotheses

1) There is no significant difference between the effect of pre-test achievement scores of three treatment groups Computer Based Learning (CBL), Computer Based Instruction (CBI) and Teacher Centered (TC).

2) There is no significant difference between the effect of post-test achievement scores of three treatment groups (CBL, CBI and TC).

3) There is no significant difference between the effect of delayed post-test retention scores of three treatment groups (CBL, CBI and TC).
4) There is no significant difference between the effect of pre-test achievement scores of gender (boys and girls).

5) There is no significant difference between the effect of post-test achievement scores of gender (boys and girls).

6) There is no significant difference between the effect of delayed post-test retention scores of gender (boys and girls).

7) There is no significant difference between the effect of pre-test achievement scores of students of different ability levels (below average, average and above average).

8) There is no significant difference between the effects of post-test achievement scores of students of different ability levels (below average, average and above average).

9) There is no significant difference between the effect of delayed post-test retention scores of students of different ability level (below average, average and above average).

10) There is no significant difference between the interaction effect of post-test achievement scores of gender (boys and girls) and different treatment groups (CBL, CBI and TC).

11) There is no significant difference between the interaction effect of delayed post-test retention scores of gender (boys and girls) and different treatment groups (CBL, CBI and TC).

12) There is no significant difference between the interaction effect of post-test achievement scores of different treatment groups (CBL, CBI and TC) and different ability levels (below average, average and above average ability levels).

13) There is no significant difference between the interaction effect of delayed post-test retention scores of different treatment groups (CBL, CBI and TC) and different ability levels (below average, average and above average ability levels).
14) There is no significant difference between interaction effect of post-test achievement scores of gender (boys and girls) and different ability levels (below average, average and above average ability levels).

15) There is no significant difference between interaction effect of delayed post-test achievement scores of gender (boys and girls) and different ability levels (below average, average and above average ability levels).

16) There is no significant difference between the interaction effect of post-test achievement scores of gender (boys and girls) X different treatment groups (CBL, CBI and TC) X different ability levels (below average, average and above average ability levels).

17) There is no significant difference between the interaction effect of delayed post-test retention scores of gender (boys and girls) X different treatment groups (CBL, CBI and TC) X different ability levels (below average, average and above average ability levels).

18) There is no significant difference between the effect of post-test achievement and delayed post-test retention scores of boys.

19) There is no significant difference between the effect of post-test achievement and delayed post-test retention scores of girls.

20) There is no significant difference between the effect of post-test achievement and delayed post-test retention scores of CBL treatment group students.

21) There is no significant difference between the effect of post-test and delayed post-test achievement scores of CBI treatment group students.

22) There is no significant difference between the effect of post-test and delayed post-test achievement scores of TC treatment group students.
23) There is no significant difference between the effect of post-test achievement and delayed post-test retention scores of below average ability level students.

24) There is no significant difference between the effect of post-test achievement and delayed post-test retention scores of average ability level students.

25) There is no significant difference between the effect of post-test achievement and delayed post-test retention scores of above average ability level students.

26) There is no significant difference between the effect of post-test achievement and delayed post-test retention scores of school-1 students.

27) There is no significant difference between the effect of post-test achievement and delayed post-test retention scores of school-2 students.

5.7 Variables of the Study

I. Independent Variables:
   1) Computer Based Learning (CBL- Experimental group-1)
   2) Computer Based Instruction (CBI- Experimental group-2)
   3) Teacher Centered (TC- Control group)

II. Dependent Variables
   1) Achievement
   2) Retention

III. Moderator Variables
   a) Gender (Boys and Girls)
   b) Different Ability Levels (Below Average, Average, Above Average)
5.8 Research Design

Experimental method is found to be more suitable for this type of research work, since the study required the manipulation of the experimental variables.

The methodology was designed to collect data required to achieve objectives. The research design envisaged collection of data using various resources, techniques and role of teachers for the treatment of different groups. A Summary of research methodology used for this purpose is as below:

<table>
<thead>
<tr>
<th>Treatment Groups</th>
<th>Resources</th>
<th>Techniques</th>
<th>Role of teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CBL</strong></td>
<td>Text books, computer, EDUNEXT software, multimedia, telephone, developed instructional materials</td>
<td>Self-pacing searching Use of Internet Use of e-mail On-line help</td>
<td>Facilitator / navigator</td>
</tr>
<tr>
<td><strong>CBI</strong></td>
<td>Text books, computer, EDUNEXT software, multimedia</td>
<td>Interactive, cooperative, self-pacing</td>
<td>Guide</td>
</tr>
<tr>
<td><strong>Teacher Centered</strong></td>
<td>Text Book</td>
<td>Chalk and talk</td>
<td>Provide instructions through teaching</td>
</tr>
</tbody>
</table>
5.9 Population and Sample

The population of the study was comprised of students of class nine studying science.

A multistage sampling technique was employed to choose respondents for the study. At the first stage, the study was divided into South and North Goa districts. At the second stage, North Goa district was divided into six talukas and Pernem taluka was selected. At the third stage the student respondents were chosen from two schools of Korgao village of Pernem taluka. The total sample size was 75 students out of which 39 students from school-1 and 36 students from school-2.

The sample students of 75 was divided under three categories i.e. above average, average and below average by adopting stratified sampling technique through pre-test scores of the students. Thereafter each category of students were randomly distributed among three different treatment groups i.e. Computer Based Learning (CBL), Computer Based Instruction (CBI) and Teachers Centered (TC).
Fig. 5.1 Multistage Sampling Procedure

Goa State

North Goa

Ponda
Sattari
Bicholim
Pernem

South Goa

Tiswadi
Bardez

Korgao

School-1
Kamleshwar

School-2
Kamleshwar

Total Sample
(N=75)

School-1
Boys = 19
Girls = 20

School-2
Boys = 19
Girls = 17

Legend:
- North Goa
- South Goa
- Ponda
- Sattari
- Bicholim
- Pernem
- Tiswadi
- Bardez
- Korgao
- School-1
- School-2
- Kamleshwar
- Boys
- Girls
5.10 Construction / Selection of Tools

**Instruments**

Instruments were used for the collection of data required to find out the correlation between the achievement score and retention scores of students.

These were *(i) Pre-test  (ii) Post-test  (iii) Delayed Post-test*

**i. Pre-test**

Pre-test was prepared by researcher with the help of senior subject teachers acted as judges in establishing content validity of the achievement test. They examined the test items instructions and the scoring procedure *(see Appendix-I)*. They were satisfied with the relevance of the test items and adequate coverage of the content. The researcher administered the pre-test to the students of the particular class. Later to classify them into three groups i.e. above average, average and below average based on their pre-test achievement scores.

**ii. Post-test:**

This post-test was developed to measure the achievement of students of all three groups (above average, average and below average) on the topic taught to them during the study. The test was based on the content of science, chapters *“Matter in Our Surroundings”* and *“Is Matter Around Us Pure”* taught to the students during the experiment. This test comprised of three parts. Part- I comprised of 20 items Multiple Choice Questions (MCQs) and Part-II contained 10 items of short answer type questions and Part-III comprised of two essay type questions with the option to solve any one *(Appendix II).*
1. Reliability of the post-test

Stability Coefficient:

The coefficient of the stability of the achievement test was determined by the test retest method. For this purpose the achievement test was re-administered to 50 students out of 100 involved in the first tryout two weeks after the first administration. Then correlation between the test and retest scores was completed. The coefficient of correlation between the two sets of scores on the achievement test was found to be 0.945, which is quite significant at 0.05 level.

Consistency Coefficient:

The coefficient of consistency of the achievement test was determined by the split half method. For this purpose, scores obtained on re-administration of the achievement test to 100 students involves for determining stability value were used. The total scores were divided into two halves – one relating to add numbered items and the other to even numbered items. The obtained coefficient of correlation between the scores on the halves was corrected for full length of achievement test be means of Spearman-Brown Porphecy formula (3.353). The coefficiency of consistency of the achievement test was found to be 0.957, which is significant at 0.05 levels.

2. Validity of the Achievement Test

Intrinsic Validity

Intrinsic Validity of the achievement test was computed from its reliability coefficient (Guilford 1954, p 399). The range of validity coefficients was between 0.9149 and 0.9645, which speaks of the intrinsic validity of the test.
Content validity:

Five teachers of secondary schools teaching science subject acted as judges in establishing content validity. They examined the test items, instructions, scoring procedure and adequate coverage of the content which speaks of the content validity.

iii. Delayed Post-test

The delayed Post-test (Appendix –III) was developed for the purpose of measuring the retention of the topics taught to the students of all three groups. This test was in the form of Post-test. Changing the sequence of questions and the time interval between administrations of the two tests reduced the sensitization to the instruments.

iv. Development of ICT Instructional Package

The researcher developed an interactive learning material for the Computer based learning (CBL) treatment group with the help of Adam M. Boyd, Sr Education Associate, office of K-8 science, American Chemical Society and software engineer Kamalesh Gawas. This software package covered the content of Class IX science chapters namely “Matter in our surroundings” and “Is matter around us pure” in an interesting animated format. It is based on the revolutionary i-Learning concept and it has features like tests, notes, experiments, sounds, slides with music for better understanding of the concepts.

For Computer Based Instruction treatment group, the researcher used EDUNEXT : LearnNext. It is a computer based interactive, independent learning solution for students. LearnNext is promoted by Next Education India Pvt. Ltd., based at Hyderabad, India.
5.11 Procedure of Conducting Experiment

i. Group Formation

Complete section of class IX students from each school was taken for the Pre-test. The students were categorized into three groups i.e. below average, average and above average based on their marks obtained in the Pre-test scores.

ii. Orientation and Training for Students of Computer Based Learning (CBL) and Computer Based Instruction (CBI) Groups

It was felt necessary to give orientation and hands on opportunity to the students of these groups on use of computers. A one-week programme (plan of work) was therefore organized for students of CBL and CBI groups. A teacher of computer science of their school familiarized students with fundamentals of computer such as introduction to Peripheral devices, getting starting on PC and introduction to MS-office. During one-week orientation in the break time, the students got good opportunity to familiarize about the computer.

The students of CBL groups were familiarized with use of e-mail, Chatting and Internet. The e-mail addresses of all the students of this group were made. The students of this group were trained in composing scientific questions, assignments, sending, replying and receiving the e-mail messages of the teachers.

iii. Computer Based Learning (CBL)

The computer based learning group was the most privileged, equipped with all possible information and communication technologies and resources. The groups were furnished with computers, CD-Rom, multimedia, Instructional Package developed by researcher and internet connection. A single printer was connected to all computers for the use of students.
The researcher started the class with brief introduction of the concepts to be studied on that day. The researcher used self prepared instructional package along with EDUNEXT Software. Each class was of 40 minutes duration.

The students of this treatment group were involved in group discussion, work place exercises, face to face interactions with the researcher. The topics in “Matter in Our Surroundings” and “Is Matter Around Us Pure” were taught during the experimental period of 30 days. The students also had an opportunity to access the study material through computer independently at their own pace.

At the end of each class, the students were given homework from the text book and researcher checked the same in the next class.

**iv. The Role of Researcher in Computer Based Learning (CBL):** The role of researcher in this group was of facilitator and navigator. The researcher helped the students in searching material on the topic.

**v. The Computer Based Instruction (CBI)**

The computer based instructional approach was used to the reference group- II on the same chapter of science of secondary classes. This group was furnished with computers with built – in CD Rom, Multimedia and EDUNEXT Software. EDUNEXT : **LearnNext** is a computer based interactive, independent learning solution for students. LearnNext is promoted by **Next Education India Pvt. Ltd.**, based at Hyderabad, India.

Each student was provided with one computer and CD’s of EDUNEXT software. However, a single printer was connected to all computers for the use of students.

The students of this group were familiarize with use of computer and software. For every lesson of 40 minutes duration each for experimental period of 30 days. At the beginning of each class the
researcher introduced the topic for first 15 minutes and then invited the students to open the lesson on **LearnNext** on “Matter in Our Surroundings” and “Is Matter Around Us Pure”. The students started listening and watching using option to browse the ongoing screens for going backward and forward in a screen.

Each screen of instruction was followed by self-assessment questions. The students of each sub group got an ample opportunity to first discuss and then give responses of the questions. At some occasions students got printed the self-assessment questions for a practice at home. At the end of each class, the students were given homework from the text book and researcher checked the same in the next class.

**vi. The Role of Researcher in Computer Based Instruction (CBI):**

The researcher guided the students if they come across some specific difficulty of content and accent as and when they require.

**vii. Teacher Centered (TC)**

The teacher centered group represented the customary approach used in teaching of science. The teacher provided instruction through lectures focusing attention to text book material. During the treatment to this group science teacher taught the lessons “Matter in Our Surroundings” and “Is Matter Around Us Pure” of 40 minutes duration each for period of 30 days. “Chalk and talk” method remained the most frequently used approaches of the teacher.

In addition, the teacher required the students to discuss concepts and questions on their notebook and discuss with their class fellows. This deliberating effort to get students involves in drill and practice and interaction was considered as essential part of the treatment because the coverage of such techniques of teaching science is not promoted in the text book. The home work was given to the students and checked regularly by the teacher.
viii. **Selection of Teachers for Teacher Centered Approach:** One science teacher from each school was selected to carry out Teacher Centered Approach.

5.12 **Collection of Data**

For the collection of data the following secondary schools of Pernem Taluka of North Goa District were selected for conducting the experiment:

1) **Kamaleshwarr School – Petichawada, Korgao – Pernem Goa**
2) **Kamaleshwarr School – Dewulwada, Korgao – Pernem Goa**

The schools were selected for the experiment for the following reasons:

i) These schools were situated near to each other;

ii) Computer laboratory was available in both the schools, it was easy to manage all computer related equipments.

iii) The management and headmasters of these schools showed great enthusiasm in the study and offered their willingness to give computer laboratories and facilitate the teachers and students.

5.13 **Statistical Techniques Used**

**i. Tabular presentation:**

The data collected were presented in tabular form to facilitate easy comparison. Tabular presentation was adopted to compile general characteristics of the sample. In its most general form, tabular analysis includes any analysis that uses tables, in other words, almost any form of quantitative analysis.

**ii. Independent-Sample t-test:**

The independent t-test is an inferential test designed to tell us whether we should accept or reject our null hypothesis. An independent t-test can be used to compare the mean of one sample with the mean of another sample to see if there is a statistically
significant difference between the two. The independent-samples t-test (or independent t-test, for short) compares the means between two unrelated groups on the same continuous, dependent variable.

**iii. Descriptive statistics**

Descriptive statistics provides simple summaries about the sample and about the observations that have been made. Such summaries may be either quantitative, i.e. summary statistics, or visual, i.e. simple-to-understand graphs. These summaries may either form the basis of the initial description of the data as part of a more extensive statistical analysis, or they may be sufficient in and of themselves for a particular investigation. Descriptive statistics is the discipline of quantitatively describing the main features of a collection of data. Descriptive statistics is also a set of brief descriptive coefficients that summarizes a given data set that represents either the entire population or a sample. The measures that describe the data set are measures of central tendency and measures of variability or dispersion. Descriptive statistics are used throughout data analysis in a number of different ways. Simply stated, they refer to means, ranges, and numbers of valid cases of one variable.

**iv. Paired t-test**

The paired t-test (see Student’s t-test) is useful for looking at differences in two variables. Paired samples t-tests typically consist of a sample of matched pairs of similar units, or one group of units that has been tested twice (a "repeated measures" t-test). Paired samples t-tests are often referred to as "dependent samples t-tests" (as are t-tests on overlapping samples). A paired samples t-test based on a "matched-pairs sample" results from an unpaired sample that is subsequently used to form a paired sample, by using additional
variables that were measured along with the variable of interest.\textsuperscript{[9]} The matching is carried out by identifying pairs of values consisting of one observation from each of the two samples, where the pair is similar in terms of other measured variables. This approach is sometimes used in observational studies to reduce or eliminate the effects of confounding factors.

\textbf{v. ANOVA}

Analysis of variance (ANOVA) is a collection of statistical models used to analyze the differences between group means and their associated procedures (such as "variation" among and between groups), in which the observed variance in a particular variable is partitioned into components attributable to different sources of variation. In its simplest form, ANOVA provides a statistical test of whether or not the means of several groups are all equal, and therefore generalizes $t$-test to more than two groups. Doing multiple two-sample $t$-tests would result in an increased chance of committing a type I error. For this reason, ANOVAs are useful in comparing (testing) three or more means (groups or variables) for statistical significance.

ANOVA is a particular form of statistical hypothesis testing heavily used in the analysis of experimental data. A statistical hypothesis test is a method of making decisions using data. A test result (calculated from the null hypothesis and the sample) is called statistically significant if it is deemed unlikely to have occurred by chance, \textit{assuming the truth of the null hypothesis}. A statistically significant result (when a probability (p-value) is less than a threshold (significance level)) justifies the rejection of the null hypothesis.
5.14 Major Findings

1) There is no significant difference between the pre-test achievement scores of students of school-1 and school-2 with respect to CBL, CBI and TC groups.

2) CBL treatment group of school-1 students have higher mean scores as compared to school-2 in the post-test achievement scores. There is no significant difference between CBI group of school-1 and school-2. However TC group of school-2 students have higher mean scores than TC group of school-1.

3) CBL treatment group of school-1 students have higher mean scores as compared to school-2 in the delayed post-test retention scores. There is no significant difference between CBI group of school-1 and school-2 and TC group of school-1 and school-2 students.

4) There is no significant difference between pre-test, post-test achievement scores and delayed post-test retention scores of boys and girls of school-1 and school-2.

5) Below average ability level of school-1 students have higher mean scores as compared to school-2 in the pre-test achievement scores. There is no significant difference between average ability level of school-1 and school-2 students. However above average ability level of school-2 students have higher mean scores than above average ability level of school-1 students.

6) There is no significant difference between the post-test achievement scores of students of school-1 and school-2 with respect to below average, average and above average ability levels.

7) Above average ability level of school-1 students have higher mean scores as compared to school-2 in the delayed post-test retention scores.
There is no significant difference between below average and average ability level of school-1 and school-2 students.

8) Boys of CBL group have higher mean scores than the CBI and TC groups in the post-test achievement scores. However girls of CBL group have higher mean scores as compared to CBI and TC group girls.

9) Boys of CBL group have higher mean scores than the CBI and TC group boys in the delayed post-test retention scores. However girls of CBL group have higher mean scores as compared to CBI and TC group girls.

10) There is no significant difference between the students of CBL, CBI and TC group with respect to below average ability level in the post-test and delayed post-test retention scores. Where as students of CBL group have higher mean scores than the students of CBI and TC groups with respect to average and above average ability levels.

11) The boys of above average ability levels have considerably higher scores than the girls. Where as girls of average ability level have higher mean scores as compared to boys. However the boys in post-test and girls in delayed post-test have higher mean scores. In the post-test and delayed post-test retention scores.

12) In the three-way interaction (ANOVA) when we compare the post-test achievement scores of students of three treatment groups X Gender X Different ability levels, the major findings are as follows:

i. In the main interaction- there is no significant difference between boys and girls. However post-test scores of CBL group students have higher mean scores as compared to CBI and TC groups. Where as above average students have higher mean scores than the below average and average students.
ii. In the two-way interaction- there is no significant difference between gender X different treatment groups, gender X different ability levels and different treatment groups X different ability levels.

iii. In the three-way interaction- there is no significant difference between gender X different treatment groups X different ability levels.

13) In the three-way interaction when we compare the delayed post-test retention scores of students of three treatment groups X Gender X Different ability levels, the major findings are as follows:

i) In the main interaction- there is no significant difference between boys and girls. However delayed post-test scores of CBL group students have higher mean scores as compared to CBI and TC groups. Where as above average students have higher mean scores than the below average and average students.

ii) In the two-way interaction- there is no significant difference between gender X different treatment groups, gender X different ability levels and different treatment groups X different ability levels.

iii) In the three-way interaction- there is no significant difference between gender X different treatment groups X different ability levels.

14) The effect of post-test achievement and delayed post-test retention scores of boys indicate the significant difference among both the tests. The post test achievement scores of boys have higher mean scores than the delayed post-test retention scores.

15) The effect of post-test achievement and delayed post-test retention scores of girls indicate that there is no significant difference among both the tests.
16) The effect of post-test achievement and delayed post-test retention scores of CBL group students indicate the significant difference among both the tests. The post test achievement scores of CBL group have higher mean scores than the delayed post-test retention scores.

17) The effect of post-test achievement and delayed post-test retention scores of CBI group students indicate the significant difference among both the tests. The post test achievement scores of CBI group have higher mean scores than the delayed post-test retention scores.

18) The effect of post-test achievement and delayed post-test retention scores of TC group indicates that there is no significant difference among both the tests.

19) The effect of post-test achievement and delayed post-test retention scores of below average ability students indicate the significant difference among both the tests. The post test achievement scores of below average ability students have higher mean scores than the delayed post-test retention scores.

20) The effect of post-test achievement and delayed post-test retention scores of average ability students indicate the significant difference among both the tests. The post test achievement scores of average ability students have higher mean scores than the delayed post-test retention scores.

21) The effect of post-test achievement and delayed post-test retention scores of above average ability students indicate that there is no significant difference among both the tests.

22) The effect of post-test achievement and delayed post-test retention scores of school-1 students indicate that there is no significant difference among both the tests.

23) The effect of post-test achievement and delayed post-test retention scores of school-2 students indicate the significant difference among both the tests. The post test achievement scores of school-2 students have higher mean scores than the delayed post-test retention scores.
5.15 Conclusion:

There is no significant difference between the effect of pre-test achievement scores of three treatment groups i.e. Computer Based Learning (CBL), Computer Based Instruction (CBI) and Teacher Centered (TC).

In the post-test, the mean scores of CBL and TC groups of School-1 have performed well as compared to School-2.

In the delayed post-test retention CBL group showed higher achievement as compared to other two groups of CBI and TC.

There is no significant difference between the effect of schoolwise pre-test, post-test achievement and delayed post-test retention scores of boys and girls.

There is no significant difference between the post-test mean scores of different ability groups.

Whereas above average group students have higher mean scores when compared to average and below average ability levels in delayed post-test retention.

There is a significant difference between the gender and different treatment groups in post-test achievement and delayed post-test retention scores.

Above average and average students have shown higher performance as compared to below average students in post-test achievement and delayed post-test retention scores with respect to CBL, CBI and TC groups.

There is a significant difference between the gender and different ability groups in the post-test achievement and delayed post-test retention scores.
In the three-way interaction, when the researcher compared to post-test achievement scores of three treatment Groups x Gender x Different ability levels the following results are as shown below:

i. In the main interaction – CBL group students have higher mean scores as compared to CBI and TC groups.

ii. In the two-way interaction – There is no significant difference between groups.

iii. In the three-way interaction – There is no significant difference between Gender x Different ability groups x Different ability levels.

In the three-way interaction of delayed post-test retention scores, CBL group students have higher mean scores as compare to CBI and TC groups.

5.17 Discussion

The present study was undertaken to compare the effects of use of information and communication technology in CBL CBI, and TC approaches on achievement and retention of students of science in North Goa District of Goa state. The effectiveness of a more appropriate approach of teaching of science to the students of Pernem Taluka in North-Goa District at secondary level was also investigated. The findings from the achievement instrument (Posttest) indicated no significant differences between the reference and control groups. However, while comparing the achievement of CBI and TC groups, the CBI group performed better than the TC group. Similarly, by comparing the CBL and TC groups, the CBL group performed better than the TC group on achievement test. The findings from the retention instrument (delayed-Posttest) showed a significant difference between the treatment and control groups. The CBL group performed better than the CBI and TC groups in delayed-Posttest meaning that the students retained the learned matter of science for a long time if
they are taught the subject of science through CBL approach, These results are robust when viewed in light of CBL, CBI and TC approaches reported in almost similar kind of studies.

The results on achievement test of this study reinforce evidence of Clark (1983, 1984) that media do not influence learning, but merely provide access. According to Clark (1985), gains in achievement are attributable to the instructional method and content rather than the method or mode of delivery, The use of CBL and CBI approaches as reference group while comparing with the Teacher Centered (TC) approach in this study supported the research carried out by Carrier et al., (1985) where he concluded that "placing a child in a situation which has a high level of instructionally - relevant content does not mean that he or she will afford to or use this information productively".

The significant achievement of CBI group over the TC group in this study is also identical to a study conducted by Nutta (2000). The results showed that for all levels of English proficiency, the computer-based students scored significantly higher on open ended tests covering the structures in question than the teacher-directed students. The results also indicated that computer-based instruction can be an effective method of teaching L2 grammar.

The significant achievement of CBL group over TC group came up in identical to many studies in which CBL approach appears to have a rather consists positive effect on achievement. Many reviewers found increase in achievement from 0.27 to 0.56 standard deviation for computer-based technologies when compared with traditional approaches (Pisapia & Perlman, 1992).

Cavaaogls and Karaoglan et al. (2004) conducted study on “The Use of Information Communication Technologies in Primary science : Education: A New Teaching and Learning Approach”. The project
aimed at designing an educational model for science education that deploys active learning concepts in school and home environments and assesses the effects of the model on the learning of the children. It was found that ICT based science education has a positive impact on the learning of children. It was also observed that children in the experimental group are more willing to participate in the class discussion.

Although Kulik and Kulik reported positive effects of computer related instruction in the meta-analysis of a large body of research, the statistical power of using multiple studies is compromised in the confounding of variables.

A study entitled "Classroom Instruction Differences by Level of Technology used in Mathematics" was conducted by Waxman and Hung (1996). The results of this study indicated that there were significant differences in classroom instruction by the amount of technology used. Instruction in classroom settings where technology was not often used tended to be whole-class approaches where students generally listened or watched the teacher, instruction in classroom settings where technology was moderately used had much less whole-class instruction and much more independent work. These findings are quite similar to the researches that support the notion that technology use may change teaching from the traditional teacher centered model to a more student-centered instructional approach.

The Effects of Computer-Based Learning Activities and School Contextual Factors on Student Math Achievement By Ahlam Lee. The results of the study indicated that the computer-based learning activities are helpful for students to enhance their academic achievement in mathematics at the student level and at the school level. Successful principal leadership, which can be characterized as distributed leadership, is positively and significantly associated with
student mathematics performance. A synthesis of the results of research questions suggests that school principals play an important role in improving computer technology infrastructure in classrooms and supporting teachers to pursue a progressive mathematics curriculum by integrating technology into the traditional mathematics curriculum. Another study on the effect of CBI on students was published by *Abbas Johari (1998)*. Johari subjects were students of pre-calculus class. He had one CBI and the other traditional lecture group. The group that received the computer based instructions scored significantly higher on the post-test. The researchers concluded that relationship exists between the use of a computer based instruction and achievement of students of mathematics.

In a study by *Augustine (2000)* on effectiveness of teaching mathematics on-line, the researcher has used the computer based learning approach and compared with the achievement of student exposed through traditional methods. The researchers found that there was a significant difference on achievement of both groups. The CBL group scored higher significantly. The findings of Augustines’ study support the results of present study where the CBL group scored significantly higher than the TC group on achievement test.

The present study showed significant difference on retention between the reference (CBL and CBI) and control (TC) groups meaning that instruction imparted through CBL and CBI approaches are retained by the learners for a long time as compared to TC group. This result indicates that the learning though use of information technology (CBL and CBI) has long lasting effects, Although there was no significant difference among these groups on achievement but the same groups have came up with significant difference among which the CBL is the highest one when measured after four weeks period. The result of the study shows that the use of information and communication
technology has longer effects on retention which is the ultimately objective of teaching of mathematics as indicated by Tahir (2001).

A study entitled “Learning with Computer-Based Learning Environments : A Literature Review of Self-Efficacy” by Moos and Azevedo (2009). The results of the study indicated that the computer based learning environments are becoming more prevalent in the classroom and have been used to keep students learn about challenging topics (Azevedo, 2005; Graesser, McNamara and VanLehn, 2005; Mandinach and Cline, 1996). Computer based learning environments can serve a variety of functions in the classroom, ranging from increasing the productivity of students class work to acting as intellectual partners to foster learning (Jacobson & Kozma, 2000). Furthermore, most Computer based learning environments provide a learning environment with multiple forms of representations (e.g.- text, audio, video) and allow students to pursue personal goals by presenting information in a non-linear format (Dillon & Jobston, 2005).

The results of the present study indicate that there is no significant difference between boys and girls with respect to post-test achievement and delayed-posttest retention scores. According to Iravani and Delfechresh (2011), The results have shown that there is no significant difference between girls and boys in term of achievement in science after treatment and it indicates that both have got higher scores in achievement in science which it means that the CAI software package in science subject has equally affected on boys and girls and the gender factor does not have its effectiveness on achievement in science scores of students.

As a result of the rapid development of the information and communication technology, the use of computers in education has
become inevitable. The use of technology in education provides the students with a more suitable environment to learn, serves to create interest and a learning centred-atmosphere, and helps increase the students’ motivation. The use of technology in this way plays an important role in the teaching and learning process (İşman, Baytekin, Balkan, Horzum, & Kıyıcı, 2002). In parallel with the technological advances; technological devices, particularly computers began to be used in educational environments to develop audiovisual materials such as animation and simulation, which resulted in the development of the computer-based instruction techniques. The best example of the integration of science and technology is the Computer-Based Instruction technique. The use of computers in the teaching and learning activities is defined as Computer-Based Instruction (CBI). CBI is the use of computers in the teaching and learning activities (Brophy, 1999). CBI enables the students to learn by self-evaluating and reflecting on their learning process. CBI motivates children to learn better by providing them with the immediate feedback and reinforcement and by creating an exciting and interesting game-like atmosphere. The studies in the field reveal that the students’ achievements increase when the CBI technique is provided as a supplement to the classroom education. CBI is more effective on less successful children. The reason for this is that the computer-based instruction enables the children to progress at their own pace and provides them with appropriate alternative ways of learning by individualizing the learning process (Senemoğlu, 2003). The most familiar function of the science education is to teach the children the science concepts in a meaningful way and enable them to learn how they can make use of these concepts in their daily lives (Çepni, Taş, & Köse, 2006).
The general increase in computer use in schools that has accompanied education stakeholders’ strongly held subscriptions to the technicist view of educational technology is mirrored in a commensurate increase in the use of computers in high school science classrooms. The existence of a predominantly optimistic view of the potential of computer use in science education, mirroring the view often found in the general education literature as noted by Bryson & de Castell (1998), has also been identified by researchers in the field of science education. For example, Roth et al. (1996) noted that science educators have often been ‘unabatedly enthusiastic about the possibilities for learning with computers’ while Linn (1998) suggested that the use of computer technology is ‘often viewed as a catalyst, panacea or solution to limitations in students’ science understanding’. Not surprisingly therefore, the advances in computer software and hardware and the introduction of such technologies into schools have been warmly welcomed with a sense of anticipation by many science teachers and science education theorists.

5.18 Educational Implications:

Based on the discussion of the findings of the study, the following implications could be drawn:

i) Learning and teaching activities in the education process have an important role in presenting permanent information to students. In order to enable students to learn better, their advanced mental process skills have to be developed. In other words, the skills needed in order to create solution for problems and learn by comprehension instead of memorizing have to be given to students. Therefore an effective science education has to be provided in school. Accordingly, in science education
teaching the skills for reaching information is much more important to providing the available information to students (Black, 2005; Karaçöp, 2010; Kim, Yoon, Whang, Tversky & Morrison, 2007; Wu & Shah, 2004). In this context, there are various methods like Computer Based Learning (CBL) and Computer Based Instruction (CBI) are used in science education in order to enable the topics to be better comprehended.

ii) The study shows that Computer Based Learning (CBL) by way of simulation programs makes the concepts and processes more concrete and causes the students to understand more easily the relationship between them and as a result of this, a more permanent learning is achieved. It has been shown through researches done so far that computer based learning influences the successes of the students much more positively than in any other traditional methods (Reed, 1986; McCoy, 1991; İbis, 1999; Yiğit and Akdeniz, 2003). It has also been identified that the successes of the students increase in physics lessons taught by computers (Bennett, 1986; Yiğit and Akdeniz, 2003; Meyveci, 1997).

iii) The findings of this study indicating that computer based learning enables higher academic achievement in comparison to traditional teaching methods is in line with the results of the previously conducted studies (Aydoğdu, 2006; Frailich, Kesner & Hofstein, 2009; Karaçöp, 2010; Özmen, 2008; Özmen, Demircioğlu & Demircioğlu, 2009).

iv) The studies in the field reveal that the students’ achievements increase when the CBI technique is provided as a supplement to the classroom education. CBI is more effective on less successful children. The reason for this is that the computer-
based instruction enables the children to progress at their own pace and provides them with appropriate alternative ways of learning by individualizing the learning process (Senemoğlu, 2003). The most familiar function of the science education is to teach the children the science concepts in a meaningful way and enable them to learn how they can make use of these concepts in their daily lives (Çepni, Taş, & Köse, 2006).

v) The computer-based Instruction makes teaching techniques far more effective than those of the traditional teaching methods as it is used for presenting information, testing and evaluation and providing feedback. It makes a contribution to the individualization of education. It motivates students and gets them to take an active part in the learning process. It helps to develop creativity and problem solving skills, identity and self-reliance in learners. CBI provides drawings, graphics, animation, music and plenty materials for the students to proceed at their own pace and in line with their individual differences. It serves to control lots of variables having an impact on learning, which cannot be controlled by means of traditional educational techniques (Kaşlı, 2000; Chang, 2002).

5.19 Suggestions for Further Research

Having gone through research work on Effect Of Varied ICT Instructional Approaches On Academic Achievement And Retention In Science Among Secondary School Students in North-Goa District of Goa State, the researcher is able to make the following suggestions.

i) A national survey on availability, utilization and skills of teachers of Science in computer related technologies may be carried out for proper planning, training and using information technology in classroom teaching.
ii) The computer software may be developed locally, covering all the topics of Science according to the new science curriculum.

iii) A model of teacher training on use of information and communication technology may be developed for effective instruction of science and other subjects.

iv) The use of information and communication technology may be integrated in all the subjects and specifically in the subjects like science and mathematics at secondary level. For this purpose, an appropriate adjustment and room may be made in the scheme of studies and in the school time table.

v) The below average students of science may be given supplementary coaching through use of information and communication technology for the purpose of reinforcement.

Experimental and empirical studies may be carried out in Indian situation as below;

i. The study from poorer families and lower socio-economic background demonstrate higher or lower levels of motivations toward learning information and communication technology may be carried out.

ii. Effect of information and communication technology rich classrooms and teaching on at-risk students (the below average students) may be carried out.

iii. Study of information and communication technology rich classrooms and teaching on gifted students may be carried out.

iv. Computers and related technologies skills are required for the students of mathematics at secondary level may be carried out.

v. Best use of information and communication technology to provide immediate feedback on student learning may be carried out.
5.20 Limitations of the Study

i. This study was limited to secondary level only.

ii. The study was restricted to science subject of class IXth.

iii. The researcher restricted North Goa District for collecting the data.

iv. It was restricted to only Pernem Taluka of North Goa District for collecting data.

v. It was limited to two schools of Korgao village of Pernem Taluka only.

vi. Only 75 students were chosen for the experiment.

vii. This study was limited to conducting to experiment only three treatment i.e. Computer Based Learning (CBL), Computer Based Instruction (CBI) and Teacher Centered (TC).