CHAPTER IV

METHODOLOGY
OF THE STUDY
## CONTENTS

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CHAPTER IV
METHODOLOGY OF THE STUDY

INTRODUCTION

Research in common parlance refers to a search for knowledge. Research, simply put, is an endeavour to discover answers to problems (intellectual and practical) through the application of scientific method to the knowledge universe.

John Dewey (1938) suggested a pattern that is found to be helpful in identifying the elements of deductive inductive process:

A method of science
1. Identification and definition of the problem
2. Formulation of a hypothesis – an idea as to a probable solution to the problem, an intelligent guess or hunch.
3. Collection, organization, and analysis of data
4. Formulation of conclusions
5. Verification, rejection, or modification of the hypothesis by the test of its consequences in specific situation.

According to John W. Best (1996) – “Research may be defined as the systematic and objective analysis and recording of controlled observations that may lead to the development of generalizations, principles, or theories, resulting in prediction and possibly ultimate control of events”.

So research is a continuous process, every time searching in a different ways to understand better and more and more about the truth.

Our search for definition of methodology would require us to know the nature of course pursued by research scholars in social science. “The procedures by which researchers go about their work of describing, explaining and predicting phenomena are called methodology” (Dickinson McGaw, George Watson, John Wiley & Sons. Inc 1976).

Methodology is defined as “the study of methods by which we gain knowledge…. it deals with the cognitive processes imposed on research by the problems arising from the nature of its subject-matter”. (Rickman, H.P., 1967)
The motive of a social investigator is to uncover truth or fact. Methods comprise the procedures used for generating, collecting and evaluating data. Methods are ways of obtaining information useful for assessing explanations (Kenneth W. Eckhardt and M. David Ermann, 1967).

Thus, Methodology prepares the investigator to adopt techniques to neutralise the effects of such hurdles. There are numerous “tools” utilised by social scientists to uncover truth, find the explanation for the occurrence of a phenomenon and to facilitate the understanding of problems and situations which would help scientists to foretell the reoccurrence of a similar phenomenon in the future under similar conditions. Research methodology is the description, explanation and justification of various methods of conducting research (Abraham Kaplan, Chandler 1964).

In this chapter, an attempt is made to describe the following aspects :-

- Development and validation of computer assisted instructional packages in teaching Physics at Std. XII.
- Development of Criterion Referenced Tests (CRT) in the content areas selected for instruction in the experimentation.
- Establishing the reliability and validity indices of the measuring instruments used in the study.
- Experimental Designs and
- The conduct of the experimentation.

DEVELOPMENT OF SYLLABUS BASED COMPUTER SOFTWARE PACKAGES IN PHYSICS

Software consists of all types of programs which include the functioning of various parts of computer and to operate together; the languages that enable one to write new programs; and the programs that perform specific tasks. Historically, software has not experienced as many dramatic advances as that of hardware. However it is likely that those roles will be reversed in the future. Quality is a matter of perception – an evaluative judgement, and hardly absolute – but there are least some widely accepted indicators of quality. Software packages are widely used and most of them are designed and developed for very specific
groups of adult learners.

Criswell (1989) asserts that more the users know about design and development, the more competent they become to select quality software for purchase.

Nelson (1987) stated, “if you have never written a program, it’s like never having driven a car. You may get the general idea, but you may have little clear sense of the options, dangers, constraints, possibilities, difficulties, limitations, and complications”.

Many people including teachers and researchers begin to work on software out of sheer interest, joy of a challenge, and the desire for a new skill. For the beginners it is a challenging one. They may have some fear and hesitation regarding what they are going to do. However, they may take some comfort on knowing that hundreds of others have succeeded and survived! They may also become one of those who really does find that software development is fun.

Software creation is a time-consuming process. It is unrealistic to think that a teacher will be able to develop a significant amount of software for the classroom. However, they can develop sufficient skill to utilise limited areas of their teaching. Many teachers focus software development efforts on content areas that are especially very difficult for students to follow. Their teaching experience or their study of methods of teaching should help them to identify the problem areas.

Software making is a tedious processes. The activities, involved in the software development processes are :-

- Generation – analysis – establishment of ideas for computer software packages in teaching Physics.
- Designing and development of educational packages in Tutorial, Drill & practice and Simulation modes
- Developing programs in Tutorial, Drill & practice and Simulation modes
- Production of support material and
- Field Trails
These are discussed in detail as follows:-

**Generation, Analysis and Establishment of Idea(s)**

Creative ideas for educational software in different modes may strike teachers or educators who are familiar with computers and their applications in education. Necessity of the idea(s) mainly related to learners' as well as teachers' important needs are, to learn individually, to teach effectively, to learn more materials at any time, to have desired time for learning as well as teaching, to motivate the learners, to create realism, to simulate the learner, to self-regulate the learning as well as teaching, etc. Thus the generation of idea(s) mainly pivot around the learners as well as teachers and their necessity. Innovative ideas related to interest and necessity of the learners and their further development make a good educational software package.

Hebenstreit (1985) differentiated “teachware” commercial software designed to be self-instructional, from “courseware”, which is teacher-developed as just described. He also saw courseware as a way to give student access to parts of a discipline for which there is otherwise not enough time or for which student skill levels are inadequate. He stated, “the biggest impact of computers will come from courseware because it allows activities in the classroom that are not possible today. It will also progressively lead teachers towards more efficient teaching, a different pedagogy and a different curriculum”.

Finally, we may use the ideas to modify and enhance existing software, such as public domain programs and their suitability be tested.

Although a teacher makes use of time and skill, major software development projects are almost always team efforts. Romiszowski (1986) noted that the symbiosis on a team depends upon a level of mutual understanding. Criswell (1989) stated that a designer of CAI needs an understanding of programming languages as well as design principles. The skills of the individuals’ who are undertaking to develop the software will enable to fill the role of content expert and designer for more complex interactive materials than their programming skills permitting them actually to create.

Before the implementation of idea(s) about the educational software we should discuss their originality, applicability, feasibility, flexibility, etc., on the
computer and educational setting by a group discussion method where the
participants are experts in physics, education, computer programming, etc. From
this group discussion, the investigator can decide whether the idea(s) need to be
modified or refined and then reconsidered. If the team is heterogeneous,
consisting of experts in physics, education and computer science, a co-ordinator
who is well-versed in computer software and has a certain degree of mastery over
the content may be designated so that the development of the software will turn
out to be a smooth project.

**Designing and Developing of Educational Software Packages**

**Software Lesson Design** is based on a five phase model called **ADDIE**:

Analyze, Design, Develop, Implement, Evaluate. In analyzing the software
packages, first the instructional problem is to be defined as software product that
could address effectively. The next aspect is the identification of intended
students, their age and attention span, ability level, motivation, prior knowledge
assumed and so on. The performance objectives that could be gained from the
experience are to be specified. The instructional strategy to be used in drill and
practice, tutorial and simulation should be clearly determined. For this, the
content outline, has to be developed in order to establish scope and sequence of
the software packages. In line with this, usefulness of the curriculum should be
ascertained. The role of the teachers in preparing students to use the materials is
also clarified and specified.

A general concept for designing the software package was conceived and
developed by Gagnes. They are being applied in the form of nine events of
instructions as follows:-

1. Gain attention / motivate
2. Present Objective(s)
3. Recall pre-requisites
4. Present Stimuli
5. Guide Learning
6. Require performance
7. Provide feedback
8. Assess achievement and
9. Promote retention
For the general organization of the software, the structure charts are to be prepared and developed into flowcharts for program logic. The designs of the screen types are to be planned accordingly. The support materials used in the packages are important ones.

To develop the software packages, the software are to be coded and then tested and debugged. Now suitable materials are to be produced in accordance with the organization and logic presented in the structure charts and the flowcharts. Instructions for the use of materials are also to be written. Support materials are to be produced as per the plan. Then, for a formative evaluation, a pilot test using a few members of the target sample is to be conducted. The quantum of learning is measured and at the same time point of confusion, operating difficulties and approaches that do not work in the use of the software packages are noted down. Revision of materials is to be made accordingly.

In implementation, the actual try-out has to take place with the indented group of students.

In evaluation, the attainment of objectives is to be assessed with the help of proper tools. Based on the findings, the software packages can be again revised as required.

Hence evaluation is not the end of instruction. It is the beginning of the next and continuing cycle of the systematic ADDIE model for effective use of instructional media.

Development: The development of the educational software packages in three different modes viz. Tutorial, Drills & Practice and Simulation is not a simple task. It is a series of laborious work. It is skeleton of the entire software work, because here the learners' necessity and attainment are to be fulfilled. This section has been classified into three categories viz. educational utility, screen design, and draft and documentation of program. These three are not isolated with themselves but all of them are interrelated with one another.

Educational utility: The instructional objectives of the content states the goals of the instructions. But from the viewpoint of the student learner, instruction is merely an effective instrument of the learning.
Mayer (1975) stated a useful objective achieves as follows:

- Identifies the learners for whom it is applicable
- States the task the learners will be able to perform
- Specifies the conditions under which the learner must perform.
- Defines the criteria for acceptable performance.

To develop the content outline suggest points for interaction, alternative paths through the lesson and so on, content analysis need to be taken up. Content analysis can be done along the following:

First, by brainstorming, a list of content points and steps of procedures the student will need to follow are to be established. Then, we have to limit the scope of the content. Finally, we have to complete the sequencing of those components that require it and compile a list of those that can be learned in any order.

Flowchart: It consists of universally known and used symbols that indicate specific steps.

Screen Design: We must recognize that the monitor screen was not an electronic version of a printed page but converted point to screens produces a program with no value added beyond the original text format, and often less, the basic interactive instruction used standard micro-computers and keyboard input and the screen and frame interchangeable terms.

The concept of screen design is a measure of consistency in displays, tempered variety for differentiation and interest. The following are the functional categories of screens:

- **Introductory Screens** include opening logos, title screens, and credits. They convey little lesson content, if any. They are called as identifier frames. Here graphics are mostly used for attention and motivation.
- **Menu or Instruction Screen** displays list of options from which the student may choose. It is also called as identifier frame.
- **Directions or Instructions Screen** inform the user of operating details. These details are placed at the bottom of the screen, since they are intended for actions that follow the reading of that screen.
- **Instructional or Text Screens** present the lesson content. They may be the combination text, picture, sound, animation, etc.
• *Exercise or Practice to Question – Response Screens* check or test the students' comprehension and ability to apply new learning. They include question(s), user responses, feedback and reinforcement. Here, we have to strictly avoid graphics and use lower cases for question & upper case for responses i.e. answers. Mostly Multiple Choice Objective Tests (MCOT) with 4 responses and True or False type questions are used. Each of the items will cover any one of the Bloom’s Taxonomical classifications viz. knowledge, understanding, applications, etc.

For *Tutorial*, the exercise or practical screen is followed by the text screen.

For *Drill & Practice*, the two different exercise or practice screens, viz. the first exercise screen having low difficulty level question and the second exercise screen having high difficulty level question, are given one by one after the text screen.

For *Simulation*, the exercise or practice screen, with a static picture of realism related to the question for simulation, is given followed by the text screen.

*Conclusion Screens* report the learner's performance called as progress report at the conclusion of the lesson or topic, suggesting the next learning step besides bidding farewell.

Students should be aware of these different types of screens. The instructional screens and the exercise or practice screens should have a consistent layout that is distinct from other screens. Thus the different screens are formed as frames or forms. Example: Text Form, Question Form, etc.

**Text and Color Consideration**: Text screen deals with the following considerations:

To read the text easily it should be typed in upper and lower case but for emphasis use upper case only. Duin (1988) found that a double column showed reading speed substantially. Therefore use a single column text. Hathaway (1984) and Duin (1988) found that the double-space text yielded faster reading times with greater accuracy. The followings are to be avoided for good text screen layout. They are extra space between paragraphs, right justification, hyphenate words and break a sentence across screens.
Color can add a new dimension to screen in the following ways: Considering one color pattern for instructional or text screens, a different one for exercise or practice screens and so on. Effectiveness may be reduced if more than three or four colors are used on one screen.

Draft and Documentation of Program

Nelson (1987) advises that, “Design long, program short. Don't be in a rush to write code. Think about the problem from every angle, figure out in detail how different strategies affect each other. When you're sure the design is right, code it. Impatience is the enemy. Design is productive work”. Thus planning is the critical stage in developing effective software, unit very clearly defined concepts and carefully consider the strategy to employ, and visualize the final product quite clearly, until the logic is defined for producing it, not ready for further development.

A flowchart is a visual representation of an algorithm. It consists of universally known and used symbols that indicate specific types of steps. Storyboarding means completing a paper version of each screen in the program, with additional details such as acceptable responses and the branching that links the screens.

Structured programming

The planning process is simplified by top-down design structured programme. It reduces the complexity of developing program code to manageable proportion.

Schnake (1985) termed it as, “a set of techniques designed to improve the organisation of the program, to facilitate solving problem, and to make the code easier to write and read”. It rests upon three major concepts: modularity, limited logical constructs and documentation.
Modularity is the coding analog of top-down design; To follow the critical module characteristics (James Lockard, 1992).

They are:-
2. Independence from other modules.
3. One way in, one way out.
4. At least one path through the modules.

Constructs are simply the ways in which program execution may flow, the fundamental units of program logic. There are only three logical constructions required to be solved for any programming task (Boehn & Jacopini, 1966). They are sequence, selection and repetition.

Documentation identifies what a program does, how it does this, and perhaps even why External documentation includes all of the documents from top-down design work, flowcharts, screen forms and storyboards, as well as printed user guides or manuals. Internal documentation means comments placed within the program code to enhance its readability and explain its structure and functioning.

Production of Software Support Materials

Some support materials are included to the software. They are educational aims and objectives of the program, educational content of the program, usability of the program in the classroom. They are also indication of suitable age ranges, abilities and groupings, the background material relevant to the program, the educational limitations, procedure to load and run the program and details of hardware on which the software can run.

All the above said principles were observed very strictly in the development of the CAI packages. The packages were syllabus-based and in the modes of Tutorial, Drill & Practice and Simulation. The contents of the packages were from the Physics syllabus prescribed for Std. XII. The selected content areas included 1. Discharge Tube, 2. Properties of Cathode Rays, 3. Properties of Canal Rays, 4. Radio Broadcasting, and 5. Radio Reception. In toto, there were fifteen instructional packages comprising five in each mode. The instructional objectives
Field trials

The field trials were arranged at various schools with teachers having experience in using computers in the classroom; teachers without computer knowledge; and teachers with variety of teaching styles.

During the field trials, care was taken to observe whether the aims and objectives were achieved; the progress made by unsupervised learners; the clarity of screen layout; motivation and reaction of the learners; flexibility and performance of the program, usage of help facilities by the learners; etc. The user guide to handle the instructional software packages is given in the Appendix:-IV.

All the steps used for the development of the software packages are mentioned in the Figure:- 1.
FIGURE 1
STEPS FOLLOWED IN THE DEVELOPMENT OF THE CAI PACKAGES.
DEVELOPMENT OF CRITERION REFERENCED TEST IN PHYSICS

In order to test the relative effectiveness among different modes of CAI, there was a need for developing Criterion Referenced Tests in the content areas taught to the control and experimental groups. Hence an attempt was made to do so.

"Criterion – Referenced tests must be very specific if they are to yield information about individual skills. This has both an advantage and disadvantage. Using a very specific test enables you to be relatively certain that your students have mastered or failed to master the skill in question. The major disadvantage of Criterion – Referenced Tests is that many such tests would be necessary to make decisions about the multitude of skills typically taught in the average classroom.” (Tomkubiszyn & Gray Borich, 1984). The outcome of the classroom instruction can be judged by conducting class tests. The tests are being conducted by following traditional methods. These are found to be inadequate to ascertain the learning capacity of the students. In order to overcome this defect, a new type of test known as Criterion Referenced Test (CRT) has been introduced. It is used as an achievement test to understand the students’ status and behaviour.

Developing the Criterion Referenced Tests is a difficult task since the concept of Criterion Referenced Test itself add many variations. In view of the above, it is very difficult to find a suitable procedure for construction of such tests.

Analysis of Instructional Domain

“A domain is described differently by various authors. However, we may think of a domain in terms of a chunk of course content called out of a particular topic or unit of learning. This chunk of syllabus may vary from small scale piece of information to the largest segment of knowledge in that area. This segment of content which may vary from smallest piece of information to that of the biggest segment of knowledge may be considered as a domain from the point of viewing.” (Pritam Singh, 1983)

We can identify cognitive learning outcomes also with regard to the segment of content and a similar hierarchy can be established ranging from the
simple knowledge of specifics to the higher mental process as shown below:

\[
\begin{align*}
\text{Knowledge of facts} & \Leftrightarrow \text{Understanding of concepts} & \Leftrightarrow \text{Application of knowledge}
\end{align*}
\]

We may choose the cognitive level at which a particular domain is to be tested. All domains cannot and need not be tested at all the three cognitive levels.

After the completion of the ground work for the above grid maintenance, two strategies can the adopted for test construction. The first strategy involves the selection of domains and testing of knowledge, understanding and application. The second strategy involves the testing of the key idea which is the core of the intending learning outcome. In the second strategy if the students can attain the core key the intended learning outcome, it has to make sure that the student is capable of applying his knowledge of the concepts. Because of the non-inclusion of lower level concepts in the approach, this strategy will help to reduce the length of the test.

If we can formulate specific objectives for each domain, we can develop tests that can be interpreted as pre-determined criteria. The basis of important production and scorability will not be helpful in this case.

According to domain description, the process of identification is content hierarchy and also hierarchy of learning outcomes. As such the investigator will look out for the type of judgement in terms of expected or intended performance as required by the behaviorally stated specific objective.

**Design CRT Instructional Content**

**Step I:** The first step in development of Criterion-Referenced Test is decision taken about the subject matter, areas- units- and topics are to be worked out. For example one may take up Mathematics, English, Environmental studies, etc., depending upon the need of the area and the resources one can utilize for one or more subject area(s) and their units or topics.

After the decision is taken about area(s), the next step is to select the
unit(s) or topic(s) on which Criterion Referenced Tests are developed. This unit(s) or topic(s) may have more than one modules/selections/domains which comprise the total unit(s) or topic(s). Depending upon the need, one or more than one sections or chunks of instructional contents may be taken up for construction of Criterion Referenced Test.

**Step II:** As the domain refers to a specific segment of the instructional content, the areas and topics are to be examined and segregated into various segments. Later on they are developed into well-defined separate domains. Each of such separate domain is verified and analysed for the study of following facts i.e. concepts, principles, process, etc. Later on they are arranged as per their increasing complexity. Another important factor is the description of domain because it provides the base for item writing. It clearly indicates the nature and scope of the content specifications in hierarchical sequential or developmental order.

**Step III:** Having described about the content elements of a domain selected, the next is to formulate the instructional objectives or expected learning outcomes which may be categorized in terms of knowledge, understanding, application, skills, attitudes, etc. These objectives should be stated so precisely that the performance of students could be clearly interpretable in terms of adequacies or inadequacies in terms of intended learning outcomes. For more clarification sample prototype items framed may accompany each specific objectives.

The tasks identified should be reviewed by those who are not involved in identifying the domain and its descriptions in terms of content elements and the specific objectives. However, a teacher who teaches Physics also should be involved in this task, so that he may be able to clarify doubts, if any raised by the external reviewers. Major purposes of this review is to sharpen domain description and the specific objectives in order to make more realistic and functional.

The designer of the CRT should himself examine all specific objectives along with one or more sample items which accompany each specific objectives. The focus of this review is on sharpening further the specific objectives, if necessary.
At first, the CRT is to be reexamined by the experiencing teachers. After examining, it is to be checked for any content flaws and for conformance of items with the domain description.

By field trial, the CRT should be tried out on a limited number of students, say minimum 10 to get a fix on the elements in the instruction which might be proved drastically wrong. It is best that the teachers who administer the test(s) to accompany with developers in order to attend queries if any, relating to the instructional content or procedure that might arise during try out of the tests.

The internal review on CRT(s) would depend upon the changes, if any that are to be made as a result of the review or the field try out. The purpose of the internal review is to certify the final format of the test(s) and pass it for print and use.

Implementation of the CRT

First, the final form of the CRT may be cyclostyled and then administered on the groups. A sign off sheet may be used to conduct and the various tests as they move from above steps. Each test is kept in a folder in which the signed sheet is to be attached. This enables the developer to keep track of the given test. To monitor the progress of the test as it goes through and the various stages of development, a master progress sheet is used.

The copies of the C.R. Tests are then to be used in the classroom. Two tests are to be conducted to test the domains which are covered by the tests. The domains being tested are arranged according to the needs of the teachers and administrated one after the other in the sequential order. Student’s responses recorded can be tabulated in accordance with the scheme of analysis which are mostly in terms of specified domain instructional objectives.

Evaluation of the CRT

Since the data are available on the tests, the reliability and validity of them can be found out using various techniques.

All the steps discussed in Analysis, Designing, Development, Implementation and Evaluation of the CRTs are given in the Figure :- 2.
FIGURE – 2
PROCESS INVOLVED IN THE DEVELOPMENT OF CRTs
All the above said principles were strictly absorbed in the development of Criterion Referenced Tests in the study. The blue prints of the pretest and posttest are given in the Tables :- 1, 2, respectively.

**TABLE 1 : BLUE PRINT OF THE CRT IN PHYSICS (PRETEST)**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Contents</th>
<th>K</th>
<th>U</th>
<th>A</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Atomic Physics</td>
<td>5 (1)</td>
<td>3 (1)</td>
<td>2 (1)</td>
<td>10</td>
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<tr>
<td>2.</td>
<td>Electronics</td>
<td>5 (1)</td>
<td>3 (1)</td>
<td>2 (1)</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Grand Total</td>
<td>10</td>
<td>6</td>
<td>4</td>
<td>20</td>
</tr>
</tbody>
</table>

K – Knowledge; U – Understanding & A – Application

Note : The number of items for each components is given in the table. The numbers given in the brackets indicate the weightage given to each item.

**TABLE 2 : BLUE PRINT OF THE CRT IN PHYSICS (POSTTEST)**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Contents</th>
<th>K</th>
<th>U</th>
<th>A</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>Discharge Tube and its Phenomena</td>
<td>9 (1)</td>
<td>7 (1)</td>
<td>3 (1)</td>
<td>19</td>
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<td>2.</td>
<td>Properties of Cathode Rays</td>
<td>6 (1)</td>
<td>4 (1)</td>
<td>2 (1)</td>
<td>12</td>
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<tr>
<td>3.</td>
<td>Properties of Canal Rays</td>
<td>4 (1)</td>
<td>2 (1)</td>
<td>2 (1)</td>
<td>8</td>
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<td>4.</td>
<td>Radio Broadcasting</td>
<td>6 (1)</td>
<td>3 (1)</td>
<td>3 (1)</td>
<td>12</td>
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<tr>
<td>5.</td>
<td>Radio Reception</td>
<td>7 (1)</td>
<td>4 (1)</td>
<td>2 (1)</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Grand Total</td>
<td>32</td>
<td>20</td>
<td>12</td>
<td>64</td>
</tr>
</tbody>
</table>

K – Knowledge; U – Understanding & A – Application

Note : The number of items for each components is given in the table. The numbers given in the brackets indicate the weightage given to each item.

The copies of the Pre and Post tests along with the answer keys are given in the Appendices :- V, VI respectively.

**ASSESSMENT OF PERSONALITY**

One of the objectives of the study was to find out the relative effectiveness among the different modes of CAI in relation to learners’ personality. Hence, it was decided to assess the learners’ personality using Myers-Briggs Type Indicator (MBTI).
Myers-Briggs Type Indicator (MBTI)

More than three million people are administered MBTI each year in the U.S., and it has also been translated into more than two dozen languages. It is used for similar purposes in countries such as Canada, the United Kingdom, Australia, New Zealand, Japan, Germany, Italy, India, Singapore, Korea and several other countries. The MBTI was designed explicitly to test Jung’s (1921/1971) theory of psychological types, and a means of reducing interpersonal tensions and promote personal growth. The MBTI was developed by the mother-daughter team of Isabel-Myers and Katharine Briggs beginning in the 1940’s. The MBTI is a paper-and-pencil instrument which determines differing personality types.

Using Jung’s theory of Psychological Types (1921/1971), Myers and Briggs utilized three pairs of letters designed to represent Jung’s functions of S/N (Sensing / iNtuitive), T/F (Thinking/Feeling), with the attitude orientation of I/E (Introvert/Extrovert). To these three, Myers and Briggs added a fourth function that of J/P (Judging/Perceiving) based on the work they felt was implicit in Jung’s writing. The MBTI classifies each person into one of sixteen personality types based on that person’s preferences for one aspect over its opposite. Questions are forced-choice format because type theory is underpinned by theory postulating dichotomies. Each option of the dichotomy allows a choice between two equally valid opposite viewpoints. There are no intrinsically good or bad or better or worse answers. The questions deal with items that are self-reportable in the areas of: habits, reactions, social situations, and point-of-view. Questions are presented in a forced-choice dichotomous form. The MBTI inventory form consists of 50 items of questions having 2 responses, except the questions 7 & 25 having 3 responses only. There is divided into two parts, the first part has 26 items and the second part has 24 items. The aim is to determine which of the two valued or useful behaviours or attitudes is preferred by the respondent. The force-choice format has the advantage of avoiding social desirability bias in responses.

A copy of the MBTI is given Appendix : - VII.
Reliability

Reliability measures are an attempt to determine whether or not the measurement device consistently measures what it is supposed to measure over time. Using the split-half measure, the MBTI reliability coefficients for males and females across functions and types in general range from .70 to .92, with most coefficients > .85 as reported in Myers and McCaulley (1985). The Spearman-Brown prophecy formula, correction method is reported. (Robert Rex Walters, 1996)

Test-Retest

Reliabilities for the MBTI include corrections of continuous scores, the proportion of cases assigned the same letter, and the proportion of cases reporting on retest all four preferences the same, three preferences, two preferences, one preference, and no preference the same.

Test-retest reliability coefficients for Pearson product-moment correlations for continuous scores range from .45 to .91, with most coefficients >.80 (e.g., Parham, Miller, and Carskadon, 1984). For test-retest agreement of type categories, percent of agreement in each MBTI category ranged from 66% to 92% with most percentage over 80% with 6.25% expected to remain the same by chance. (eg. McCaully and Carskadon, 1983; or Myers, 1973). Test-retest agreement of type categories for different levels of strength of preference report percentage ranging from 35% to 100% with most greater than 85 %. (Robert Rex Walters, 1996)

Validity

Validity measures are an attempt to inquire as to whether or not the instrument in question accurately measures what it is intending to measure. The three most common types of validity are content validity, construct validity, and criterion validity.

Content validity-refers to whether or not the test in question actually measures the specific knowledge, skills, or abilities it is supposed to measure.

Construct validity-refers to whether or not the instrument actually
measures the underlying, unseen psychological constructs it is supposed to be measuring (e.g., intelligence or creativity).

Criterion validity- refers to whether or not the instrument compares favorably with other established instruments previously proven to measure the content or construct at issue. (Robert Rex Walters, 1996)

Types of MBTI

Two kinds of perception – Jung (1921/1971) - Sensing(S) and iNtuition(N): These he called irrational functions; irrational in the sense of non-rational; not bound or directed by reason (Myers and McCaully, 1985). This scale suggests how you take in information. It has the biggest impact on how we learn.

*Sensing(S)* refers to perception by way of and through the senses. Sensing students prefer organized, linear, and structured lectures. Recommend three methods for organizing a lecture: 1) the what must be known organizing strategy, 2) the application – theory – application organizing strategy, and 3) the advance organizer. They read the question several times before answering it to be certain they understand it.

*iNtuition (N)* refers to perception and knowing through meanings, relationships, insight, iNtuitive students prefer either the traditional Theory – Application-Theory approach or the A-T-A approach using discovery learning. They may not read a test question all the way through somethings missing a key part, because they act on their hunches.

Two Kinds of Judgement – Jung (1921/1971) – *Thinking (T)* and *Feeling (F)*: These two refer to the rational functions that are directed towards bringing life events into harmony with the laws of reason (Myers and McCaully, 1985), not necessarily in the contemporary sense of logical rational reason. This range tells how we make decisions.

*Thinking judgement (T)* is the function that links ideas together and makes connections among them. Thinking students like clear course and topic objectives. Clear course or topic objectives avoid vague words or expressions such as, “students will appreciate or be exposed to”. They must make decisions that negatively effect many individual lives are after Thinking types.
Feeling judgment (F) is the function that relies on an understanding of personal values and group values, and is, therefore, much more subjective than thinking. Feeling students like working in groups, especially harmonious groups. They enjoy small group exercises such as TAPPS and the National Group Method. They feel rewarded when they can help others.

Two kinds of Attitudes – Myers and McCaully (1985) – Introversion (I) and Extroversion (E): These two attitudes are seen as orientations towards life in general. This scale explains how we get our energy.

 Introversion (I) is an attitude which draws energy from the environment and consolidates it in an inner world of ideas and concepts. Introverted students want to develop frameworks that integrate or connect the subject matter. They like reading, lectures, written over oral work.

 Extroversion (E) is an attitude which directs energy out to the persons and objects in the environment. Extroverted students learn by explaining others. They do not know if they understand the subject until they try to explain it to themselves or others. They will find many college tasks challenging (reading, research, writing) because they are solitary endeavours.

Two kinds of orientation – Myers and Briggs (1985) – Judgement (J) and Perception (P): These two refer in terms of orientation to the outerworld (Myers & McCaully, 1985). This range suggests the type of life style and work habits we prefer.

The Judging (J) attitude is concerned primarily with making decisions, seeking closure, planning, and organizational. Their orientation towards perceptions are shut off as soon as they accumulate enough information to make a decision. Judging students often reach too-quick closure when analyzing cases. Recommend a second-look meeting, they meet deadlines, like planning, and prefer to work on only one thing at a time.

The Perceptive (P) attitude is oriented toward incoming information. Perceptive students often postpone doing an assignment until the very last minute. They are more lazy. Quite to the contrary, they seek information to the very last minute. They may make a calendar of things to do, but will probably lose it.
The MBTI is the most widely used personality assessment tool in the world. This personality type instrument is a reliable personality inventory. That sorts people into 16 individual personality types (eg. Devito, 1985, Furnham & Stringfield 1993; McCrac & Costa 1989). Your type is the combination of one preference from each of the four preference scale (Hirsh, 1985; Keirsey & Bates, 1978; McCaulley, 1990; and Roush, 1992) and is determined by the four preferences that you select when answering the question on the MBTI. It indicates your preference for using your mental functions and the order in which you like to use them. It examines the problem solving styles among mining personnel (Devey, 1993). It is especially useful due to its easy buy-in on the part of the client, and the Intuitive nature of its concepts. People bring differing perspectives to bear on a problem or task which will help prevent unidimensional thinking, or "group think".

Administration and Scoring of MBTI

The MBTI inventory questionnaire format (given in the Appendix:- VII) with proper instructions and directions can be administered individually. There is no time limit to complete the response. But usually the students take an hour to complete the test. The responses of the learners on MBTI format are entered in the individual (student's) blank scoring sheet (Appendix:- VII) using the points awarded in the scoring sheet (Appendix:- VII). The total points of the each personality type is measured viz. Extraversion, Introversion, Sensation, iNtuitive, Thinking, Feeling, Judging and Perception can be measured. From this scoring points, the four personality types of the learners are to be found by one from each pair of four MBTI pairs viz. E/I, or S/N, or T/F, or J/P using the instructions are given in the MBTI SCORING SHEET.

ESTIMATION OF RELIABILITY AND VALIDITY INDICES OF THE TOOLS USED IN THE STUDY

A test is said to be reliable to the degree that it measures accurately and consistently, yielding comparable results when administered a number of items. There are a number of ways of using the process of correlation to evaluate
reliability: 1. Test-retest: 2. Equivalent forms, and 3. Split halves. If the percentage and nature of responses are similar and the statistical analyses are same, the sample can be regarded as reliable.

A test is said to be valid to the degree that it measures what it claims to measure, or, in the case of predictive validity to the extent that it predicts accurately such types of behaviour as academic success or failure. Tests are usually validated by correlating test scores against some outside criteria, which may be scored on tests of accepted validity, successful performance or behaviour, or the expert judgement of recognized authorities. There are several types of validity, and different types of tests and uses of tests which need different types of validity. Some of these are content, construct and criteria. The content validity is particularly important for achievement tests whereas the construct validity is important for personality and aptitude tests. These two are not expressed by numerical way but only by judgement of the experts where as the criterion is expressed as the co-efficient of correlation.

Hence, a sieve question is one that shifts out from those who are unable to answer because they do not possess the necessary knowledge or experience. The sieve question may follow or precede the important question, but only those who possess the requisite knowledge will be counted. (William J. Goode and Paul K. Hatt, 1982)

Estimation of the reliability and validity indices of the two CRTs in Physics

Reliability

To establish the reliability of the two tests in physics, the spilt-halves method was adopted. By this method, two sets of scores of each student, one being odd and other even were computed. The marks obtained were noted and correlated. These were to be correlated by the application of the Spearman-Brown Prophecy Formula. The values of reliability of the two tests are \( r_s \) found to be \( r_{s1} = 0.87 \) and \( r_{s2} = 0.85 \) respectively and are significant at 0.01 level. Hence it is concluded that these two tests are found to be highly reliable.
Validity

To establish the validity of the two tests in physics, an attempt was made to find out the Correlation Co-efficient between the achievement scores of the students in Physics in these two tests and the scholastic achievement of the students in physics in the quarterly common examination conducted by the C.E.O. of the District by Pearson Product - Moment Correlation Co-efficient method. The values of ’r’ are found to be $r_1 = 0.85$ and $r_2 = 0.83$ respectively and are significant at 0.01 level. Hence, it is concluded that the two tests have high validity.

Estimation of the Reliability and Validity indices of the MBTI Inventory

Reliability

To estimate the reliability of the MBTI personality test, the split-halves method was adopted, to correlate the scores obtained from the test of the each student, on the odd numbered items of the test against the even numbered items. This can be correlated by the application of the Spearman-Brown Prophecy Formula. The reliability of test is found to be 0.89 and is significant at 0.01 level. Hence it is concluded that this test is highly reliable.

Validity

To estimate the validity of the MBTI personality test, an attempt was made to find out the three types of validity, viz. content validity, construct validity and criterion validity. The content validity is often assessed by a panel of experts in the field who judge its adequacy and it is not expressed in numerical way. This was established by the authors of the MBTI. The construct validity is the degree to which scores on a test can be accounted for by the explanatory constructs of a sound theory and is important for this type of personality test. It was also established by the team authors of the MBTI. Third and final type of validity, the criterion-validity is estimated by the co-efficient of correlation between the test scores and scores in another test or measure of known validity (John W.Best & James V. Kohn, 1996). The value of ‘r’ was found, between two
test, scores by Pearson Product Moment Correlation Co-efficient Method, to be 
\( r_p = 0.88 \) (\( p < 0.01 \)). Hence, it is concluded that this test has high degree of 
validity.

**EVALUATION OF SYLLABUS BASED COMPUTER SOFTWARE PACKAGES IN PHYSICS**

For the present education system, the preparation and evaluation of the 
educational software is a tedious and complex task. The evaluation has caught the 
attention of many curriculum design specialists, technical specialists, learners, etc.
What should be kept in mind is that when computer software packages are 
designed to teach, it can have a significant effect on instructional outcomes, and 
there is guarantee that the effect will be positive. Evaluating instructional software 
packages must be like evaluating a teacher, expect that the investigator has no 
initial screen device or preparatory program which screens out incompetence and 
low skills. If the investigator accepts the notion that the software packages 
program might replace some portion of a teaching program, then the evaluation 
should take on a more critical approach.

The process of evaluation the software packages have become a multistep 
procedure in which we first attempt to eliminate the obvious poor software, 
followed by a more intense evaluation of that which passes the first screening and 
then field testing to estimate actual potential for classroom instruction. The 
screening software has two steps. They are: 1. to eliminate those programs which 
are obviously not suitable for the intended use and 2. to determine who will use 
the program and for what purpose. This process of the evaluation of the software 
packages may involve three phases, according to Lockard, Abrams, and Maney 

**Phase 1: Advice or recommendation**

Begin by asking colleagues for using advice. A critical aspect is how close 
to the needs and goals of their colleague and parallel to their own.
Phase 2: Professional Reviews

The software designer may be well served by published reviews of educational software. Today, most of the professional journals give least attention to computer materials. There are also many other specific resources. Along with advice, the main purpose of reviews is in identifying the product of possible merit. Only on few occasions reviews based on actual use with a sample of intended learners are published. Very rarely the standards and the assumptions of the reviewer are expressed clearly.

Phase 3: Hands on

Ultimately the designer wants to experience the quality, the utility of a product personality. He may try to use it on several levels—on a top student, on a weak student and on an average learner and as well as with a small group of learners of subject oriented standard. Then, both of their responses to the software and their learning at the time of screening are checked.

For evaluation of software, the general criteria to be adopted are stated by James Lockand (1992) as follows:-

**Content accuracy:** We have to establish whether the instructional materials that would be used in the software packages are accurate or not. In line with this, consider precision, topicality and objectivity of the software also.

**Objectives:** It is to establish whether the instructional objectives are appropriate to the students needs and the instructional material does appear to help them attain them.

**Languages Use:** The standard of language used should be within the reach of learners.

**Logical Sequence:** The order of presentation of the content should be in correct and logical sequence. The exercises which are the important part of the learning process of the students. They should also be checked by the experts.

**Clear, Concise Instructions:** The learners should never be in doubt about the instructions presented in the software. So, the designer should give the instructions in simple clear languages with proper logical sequences.
Appropriate reading level: The instructional materials should be at the appropriate reading level of the students. Hence, the students can comprehend the instructional materials with interest and motivation and without fatigue.

Appropriate Exercise: Presenting frequent and appropriate exercise with appropriate question and their attractive answers followed by the instructional content unit or text will be immensely helpful to the learners to master the content. Therefore exercises are more effective than the straight text.

Appropriate feedback: Presenting the appropriate feedback to the student to the correctness of his/her responses has a positive effect on retention. To be effective, feedback should be based on the type of error committed by the student.

Appropriate length of activity: To maintain the appropriate length of the activity of the students, the designer should consider the attention span of students, the available time slots in their environment, the ability to stop and restart to fit variable time frames.

Attraction: It should be appealing in terms of both layout and presentation.

Motivation: Motivation should appear in all aspects as and when needed and can take varied forms serving as continuous link, transmitting information or posing questions, unusual exercises, etc.

Social Acceptability: The software should be socially acceptable and there should be no stereotyping, violence, denigration, etc.

Supporting materials: To incorporate the software into your teaching process, supporting materials like computer and other related materials should be used. Hence, the student may know how to operate the computer and the software.

Value: The economical value of the software should be considered.
The packages used in the study were evaluated availing the following readily available evaluation pro forma: -


All the fifteen software packages, i.e. five software packages in each of the three modes viz. *Tutorial, Drill & Practice and Simulation*, were evaluated by fifty experts comprising practicing teachers, computer specialists, software developers and educational administrators. The responses made by the evaluators to the different features of the software packages as stated in the evaluation pro forma are given in the Appendix : - VIII.

From the analysis of the responses made by the evaluators to each of the different features of the software as stated in the pro forma, it is found that more than 90% of the features as identified and stated in the pro forma and questionnaire were reported to be "excellent" or "good" by most of the evaluators. Less than 10% of the features alone were reported to be "adaptable" or "acceptable". It is heartening to see that none of the feature was reported to be "no" or "poor". Hence, it is evident that the software packages developed for the study are quite good. Necessary modifications were made in the software packages as suggested by the evaluators. Finally, the software packages were written in a "CD-ROM" which has been given in a pouch at the end of thesis. A few print outs of the syllabus-based software packages are given in the Appendix:- IX.

**PROCEDURE**

*Introduction to Experimental Research*

In the field of science, the experiment is the basic tool for tracing cause and effect relationships and for verifying inferences. But, in the field of
education, its application is still last in its infancy but the percent century is very advanced and growing fast. Experimental studies have their purposes to test a hypothesis of a causal relationship between variables. Its stages of experimentation technique comprise of controlling the situation, defining items and words and bringing about greater definiteness. The field experiment type of the experimental research is the best suited one to education, which is theoretically oriented in some real educational setting.

The goal of this method is to discover and develop an organized body of knowledge. One of the essential characteristics of experiment is to determine to which cause of disturbance attention should be given and which ought to be deliberately ignored. The method has also been successfully followed in such non-laboratory situations as the classroom where certain variables can be controlled to some degree. Experimental and control groups are necessary since real life is both complex and changing. The purpose of these educational experiments is to predict events and to generalize the relationship between & among the control and experimental groups and their variables so that the findings might be applied universally. An important element in this kind of research is that the investigator sets up conditions deliberately so those different groups of subject undergo different experiences.

Experimental Design

Experimental Design is the blue print to the procedure that enables the research to test the hypotheses for reaching valid conclusions about relationships between independent and dependent variables. Selection of a particular design is based upon the purposes of the experiment, the type of variable to be manipulated, and the conditions or limiting factors under which it is conducted. The design deals with such practical problems as how subjects are to be assigned to experimental and control groups, the way variables are to be manipulated and controlled, the way entrances variables are to be controlled how observations are to be made, and the type of statistical analysis to be employed in interpreting data relation-ships (John W. Best James V. Kohn, 1996). There are three types experimental designs viz. Pre-Experimental Design, True-Experimental Design,
and Quasi-Experimental Design. The Quasi – Experimental design was adopted in this study.

Quasi-Experimental Designs

These designs provide control of when and to whom the measurement is to be applied, but because random assignment to control and experimental treatments has not been applied, the equivalence of the groups is not assured. The important quasi-experimental designs, only five are stated as follows:-

1. The Pretest-Posttest Nonequivalent –Groups Design.
2. The Time-Series Design.
3. The Equivalent Time-Samples Design.
4. The Equivalent Materials, Pretest, Posttest Design and
5. Counterbalance Design.

For this study, only the Pretest-Posttest Nonequivalent Groups Design was adopted which is described as follows:

The Pretest-Posttest Nonequivalent-Groups Design

This design is often used in classroom experiments when control and experimental groups are such naturally assembled groups as intact classes, which may be similar. The difference between the mean of the pretest scores and the differences between the means of the posttest scores (mean gain scores) are tested for statistical significance. Analysis of Covariance can also be used. (John W. Best & James V. Kahn 1996).

<table>
<thead>
<tr>
<th>Group</th>
<th>Pretest</th>
<th>Method</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>&gt; 0</td>
<td>x1</td>
<td>&gt; 0</td>
</tr>
<tr>
<td>B</td>
<td>&gt; 0</td>
<td>x2</td>
<td>&gt; 0</td>
</tr>
<tr>
<td>C</td>
<td>&gt; 0</td>
<td>x3</td>
<td>&gt; 0</td>
</tr>
<tr>
<td>D</td>
<td>&gt; 0</td>
<td>x4</td>
<td>&gt; 0</td>
</tr>
</tbody>
</table>

Sampling

The sample of this study was comprised of (35 x 4=) 140 students studying at Std. XI in four different Matriculation Higher Secondary Schools situated at Erode in the Erode District of Tamilnadu, India. One of the schools with 35
students as intact, viz. Ashram was taken as the control group while the other three schools each with 35 students as intact were treated as experimental groups. The distribution of the sample is given in the Table: - 3.

**TABLE: 3 DISTRIBUTION OF THE SAMPLE CHOSEN FOR THE EXPERIMENTATION**

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of the School</th>
<th>Group</th>
<th>No. of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Boys</td>
</tr>
<tr>
<td>1.</td>
<td>Ashram Matriculation Higher Secondary School, Erode-638 002.</td>
<td>C.G.</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>86</td>
</tr>
</tbody>
</table>

C.G. – Control Group, E.G. – Experimental Group.

The subjects of the control and experimental groups were urban students belonging to similar socio-economic status. All of them hailed from upper middle-class families and were second generation learners. They were all of the same age group. All of them had English as the medium of instruction.

The identify among the control and experimental groups was established by finding out the variance among the subjects pertaining to their scores in Physics as measured by the Pretest.

**Administration of the Pretest**

A pretest in the areas meant for instruction, i.e., atomic physics & electronics was administrated to the control and the experimental groups before experimentation.
EXPERIMENTATION

This study adopts “Pretest, Posttest Nonequivalent-Group Design”. As already stated, four identical groups each of 35 students studying at Std. XI were formed. The homogeneity among the four groups was established by ANOVA pertaining to their scores on instructional content areas viz. Atomic physics & Electronic in Physics as measured by the pretest. One of the groups was formed as the control group while the other three were formed as the Experimental Group I, Experimental Group II and Experimental Group III respectively. Lecture method was adopted for the control group while the three selected modes viz. Tutorial, Drill & Practice and Simulation as individualized instructional strategy were introduced as experimental treatments to the Experimental Group I, the Experimental Group II, and the Experimental Group III respectively. The instructional process carried out in the control and the experimental groups are explained as follows:-

The Control Group

The control group received instruction in the said content areas through Lecture Method. Being a P.G. Teacher in Physics, the investigator himself engaged the control group. Using the blackboard, charts, models, flash cards, matching cards, etc. the said content areas were covered one after another in five consecutive days. Each content area was covered per day for about 45 minutes prescribed as a period by the Directorate of School Education, Chennai. It was seen that better interaction was maintained among the teacher and the students throughout the period of instruction. Tests in the respectively content areas were administered as posttest immediately after the completion of the instruction.

The Experimental Group

This group received instruction through the specially developed CAI software packages in the Tutorial mode individually with the help of a computer. For this, the investigator arranged 20 terminals in the computer centre where he acted as a facilitator. These terminals were connected with a main server system (LAN) of configuration 450 kHz with Pentium processor. Thirty-five subjects of
this group were divided into two groups. The first group of 18 were allowed to the first session of the forenoon and the second group of 17 were allowed to the second session of the forenoon at the computer centre.

Those who needed tutorial on computer operation, were given the some before they actually started to study the instructional packages.

The software packages in the said content areas were covered one after another in five consecutive days. On an average of 45 minutes were taken by the learners to cover a topic. Tests in the respective content topics were administered as posttest immediately after the completion of the computer assisted instruction was over.

The Experimental Group II

This group also received instruction through the specially developed CAI software packages in the Drill & Practice mode individually with the help of a computer. This mode slightly differs from Tutorial and Simulation modes. This mode is similar to the test mode because in this mode the number of exercises are doubled as that of Tutorial and Simulation with two different levels of difficulty. For this group also, the investigator followed the same procedure as that of the experimental group I.

The software packages in the said content areas were covered one after another in five consecutive days. On an average of an hour was taken by the learners to cover a topic. Tests in the respective content topics were administered as posttest immediately after the completion of the computer assisted instruction was over.

The Experimental Group III

This group also received instruction through the specially developed CAI software packages in the Simulation mode individually with the help of a computer. In this mode, the exercises slightly differ from the other two modes i.e., here the responses of the learners are reinforced by the simulation factor like realistic imitations (the exercise with proper question along with related static figure). For this group also, the investigator followed the same procedure as that
of the experimental groups I & II.

The software packages in the said content areas were covered one after another in five consecutive days. On an average of 45 minutes were taken by the learners to cover a topic. Tests in the respective content topics were administered as posttest immediately after the completion of the computer assisted instruction was over. The scores obtained by the students of the control and experimental groups in the pretest and posttest are given in the Appendix:- X.

The above said control and experimental groups learners’ personality types were also measured using MBTI immediately after the fifth posttest was over. The scores of the subjects of control and experimental groups as measured by MBTI after experimentation is given in the Appendix:- XI.

ADMINISTRATION OF THE RETENTION TEST

The same CRTs administered as Posttest were re-administered to the subjects of control and experimental groups as Retention Test one month after the completion of the experimentation.

The scores obtained by the students of the control and experimental groups in the retention test is given in the Appendix:- XII. The Mean and S.D. of these scores were computed and the spelt-out hypotheses were tested using appropriate statistical techniques.

The analysis and interpretations of data along with a description of testing of hypotheses are given in the next chapter.