# INTERACTION EFFECT OF CONCEPT ATTAINMENT MODEL OF TEACHING AND STUDYING APPROACH ON ACHIEVEMENT IN PHYSICS OF SECONDARY SCHOOL STUDENTS

AMPILI ARAVIND

*Thesis submitted for the Degree of*
DOCTOR OF PHILOSOPHY
*in Education*

DEPARTMENT OF EDUCATION
UNIVERSITY OF CALICUT

2007

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# DECLARATION

I, Ampli Aravind, do hereby declare that this thesis **INTERACTION EFFECT OF CONCEPT ATTAINMENT MODEL OF TEACHING AND STUDYING APPROACH ON ACHIEVEMENT IN PHYSICS OF SECONDARY SCHOOL STUDENTS** has not been submitted by me for the award of a Degree, Diploma, Title or Recognition before.

Calicut University,
22.08.2007.

Ampili Aravind

**AMPILI ARAVIND**

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2007

**Dr. P. Usha**

Reader
Department of Education
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# CERTIFICATE

I, Dr. P. Usha, do hereby certify that this thesis **INTERACTION EFFECT OF CONCEPT ATTAINMENT MODEL OF TEACHING AND STUDYING APPROACH ON ACHIEVEMENT IN PHYSICS OF SECONDARY SCHOOL STUDENTS** is a record of bonafide study and research carried out by **Smt. Ampili Aravind** under my supervision and guidance. This report has not been submitted by her for the award of Degree, Diploma, Title or Recognition before.

Calicut University,
22.08.2007.

**Dr. P. Usha**
Supervising Teacher

# Acknowledgement

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**Ampili Aravind**

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CHAPTER 1

# INTRODUCTION

- Need and Significance of the Study
- Statement of the Problem
- Definition of Key terms
- Variables of the Study
- Design of the Study
- Objectives
- Hypotheses
- Procedure
- Scope and Limitations
- Organisation of the Report

A human being is a positive asset and a precious natural resource which needs to be developed properly. Education is a process of development. The rise and fall of a nation depends on the success of its educational system. Education is something more than a mere accumulation of knowledge and skills. It must be concerned with developing those skills and attributes that will promote self discipline, responsibility, self expression and confidence.

Educational systems in the developing countries are facing credibility crisis, especially in the manner in which classroom instruction is managed. Inappropriate teaching strategies prevalent in schools is a drawback of the educational system. In the conventional teaching strategy followed in schools, education process is unidirectional. Subjects are taught according to the will of the teacher and little attention is paid to the eagerness, curiosity and capability of the students.

The Secondary Education Commission (1952-53) has rightly remarked that ". . . Even the best curriculum and the most perfect syllabus remains dead unless quickened into life by the right methods of teaching . . . ." In order to make education a meaningful and exciting activity and to achieve the objectives of education, appropriate instructional strategies should be used keeping in view the content which has to be taught.

Science is the product of man's conscious effort to understand and control his environment. The teaching method of any particular discipline would be inadequate without considering the methods by which information is acquired in that discipline. Science has a structure which is provided by its basic principles, generalisations and concepts. The scientific and technological orientation of society has profound implications for methods of teaching science. The manner in which society uses the results of science changes very rapidly and the student with an adequate education must have a clear idea of the body of scientific knowledge. Science has influenced the culture of Nations in many ways both social and economic, has changed institutions and even man himself. Science and technology change and control values and ways of thinking. The dependence of Society upon Science and Technology has important implications for determining what aspects of science should be taught and how it should be taught.

Physics is a major science subject. Physics has contributed to bringing about changes in our ways of thinking, attitude, interest and outlook. Hence the Physics education in our schools play a vital role in the development of individuals. In terms of a general education involving Physics, the highly abstract nature of much of the thinking involved in the study of Physics is a problem associated with its teaching and learning.

Physics concepts might be learnt and manipulated without their relevance to real-life situations being explored. A Physics teacher has to search new innovative ideas, techniques and strategies to impart Physics Education. The teacher should not only communicate the matter in text books but also enable the students to ingest concepts and develop interest in learning the subject.

Models of teaching are prescriptive teaching strategies. They are designed to provide guidelines for designing educational objectives, activities and environment. Joyce and Weil (1980) developed more than twenty models of teaching. After the first research study relating to models of teaching by Chitriv (1983), a number of studies were conducted on teaching strategies and found that modern teaching strategies significantly improve Achievement (Sharma, 1986; Passi *et al.*, 1986; Kaur, 1991; Nelson and Pan, 1997; Shah, 2002; Padma, 2007).

Learning involves the integration of thinking, feeling, perceiving and behaving. Learning science is effective only when it develops rational thinking and learning abilities which form the basis of modern life. Learning that truly changes behaviour takes place only when the learner can interact with objects, events or situations (Renner and Stafford, 1972). The learner's approach towards learning is very crucial in the effectiveness of learning.

To improve the learning effectiveness of students, the teacher has to understand the ways in which an individual learns. It is widely accepted that while it is possible to identify common constituent elements of learning, the studying approaches varies at an individual level. Students will develop a way or style of learning and refine that style in response to three groups of factors: unconscious personal interventions by the individual, conscious interventions by the learner and interventions by some other external agent.

The qualitative approach in research on learning has been developed by Marton and Saljo (1976) and Svenson (1977). Students have stable motives and conceptions about what learning might be and they learn in a consistent way. This consistency of motives and strategies used in the learning process is student's learning approach (Entwistle, 1990).

A studying approach is an individual's predisposition to learn in a particular way. The term is used to describe broad, general characteristics of learning approach and it is likely that the preferred learning styles of any one learner will be manifested in all aspects of learning. The term 'studying approach' indicates an interest in the totality of the processes undertaken during learning. For better learning the student has to use techniques or strategies which covers his or her motives, conceptions and intensions and their relationship to distinct learning outcomes.

## 1.1. NEED AND SIGNIFICANCE

Science education has become an integral part of human life in today's world of 'Information exploration' and 'Information explosion'. Scientific literacy is an essential requirement. As Physics is made a compulsory science subject at secondary school level which decide the selection of many professional courses in future, it has become a dire need to Physics teachers to present it effectively in the classrooms.

There are different approaches to Science teaching propounded by different science educators. There are three approaches to science teaching viz., factual approach, conceptual approach and process approach as identified by Anderson (1965). The conceptual approach to science teaching is better than the factual approach because the students cannot understand the cumulative nature of science by pyramiding facts but by understanding new conceptual structures. Concepts are considered to be the building blocks of knowledge. According to Bruner (1975), attaining a concept is beneficial to the individual in several ways – in identifying the objectives around him, in reducing the necessity of constant learning and in reducing the complexity of environment. If the child does not learn concepts and principles which are lower in hierarchy, the learning of those higher in the hierarchy becomes difficult or impossible (Gange, 1970).

Rosenshine and Barak (1997) suggested that the role played by the individual students information processing capabilities may be a critical factor for improving learning and retention of concepts. The development of teaching models has successfully brought together a unique combination of theory constructions and empirical testing. Research studies of Kaur, (1991), Mahajan (1992), Mohanty (1992), Passi, *et al.* (1992) and Padma (2007) compared the relative effectiveness of different instructional strategies on Academic Achievement of the learner . Among the various new strategies of Instruction, the Concept Attainment Strategy is very important for science teaching especially physics teaching because it is very helpful in attaining scientific concepts by the learners.

Concept Attainment Model of teaching has been developed, based upon the studies made by Bruner and his associates mainly about the nature of concepts and the strategies of concept attainment. The Concept Attainment Model can be used with children of all ages and grade levels successfully. It is a relatively easy and intellectually powerful strategy of teaching which develops the student's thinking abilities and maximises learning. It is a powerful research-based programme that not only help students to attain essential concepts but also fosters natural thinking ability, allowing systematic and scientific decision in all aspects of life. The concept attainment model is an excellent evaluation tool when teachers want to determine whether important ideas introduced earlier have been mastered. It quickly reveals the depth of students understanding and reinforces their previous knowledge. This model can also be useful in opening up a new conceptual area by initiating a sequence of individual or group inquiries.

The basic theory of Concept Attainment Model of teaching and results of the research on the practical application of this model was studied carefully by the investigator to know whether this can be adopted to get better academic achievement in Physics in an ordinary school in Kerala. The essential features of Concept Attainment Model are described in Chapter II.

Classroom teaching and learning involve the interaction among teachers, pupils and the curriculum. Any attempt of improvement in the quality of education is ultimately dependent on the quality of instruction imparted in the classroom. Each student in the class differs in his/her studying approach and in dealing with a given situation.

Studying Approach theory had been put forward in 1976 in an attempt to interpret human differences and to design educational models around these differences. This theory had its root in the psycho analytic community. It emphasize the different ways in which people think and feel as they solve problems, create products and interact. It is concerned with the differences in the process of learning.

Research has helped to increase the awareness of teachers about the differences in the learning characteristics of students but the nature of relationship among studying approaches is not clear. Studying approaches are described as preferences which suggest that one dimension of studying approach is as good as the others. The idea that students have different studying approaches is enticing for educators. First, it highlights the importance of studying process rather than teaching techniques and it thereby raises questions concerning the ideal distribution of power among teachers and learners. Second, it is an egalitarian concept because it focuses on pupil strengths and weaknesses so that the operative term describing learners becomes different rather than 'poor', 'average', 'good' and 'very good'.

Fatini (1980) suggested that we are at a stage in which we should consider designing programmes to fit learners rather than attempting to fit learners to standard programmes. Experience in educational field reveals that students who understand these differences are better able to understand their own learning profiles, to develop flexibility and adaptability in their thinking and to set realistic goals about minimizing learning weaknesses and maximizing strengths.

From the studies surveyed it was found that Concept Attainment Model is worth experimenting in the secondary stage for attaining basic concepts in Physics in a conventional educational context. Most of the studies conducted in western countries and India were concentrating more on subjects like biology, chemistry and languages and the investigator could find inconsistency in the results also. Moreover, the investigator failed to identify any study in Indian conditions related to Physics.

The investigator felt that under the rigid classroom organisation of our schools, Concept Attainment Model can be experimented for maximum attainment of instructional objectives in Physics. It is suitable for attaining concepts in Physics at different levels of secondary school. Considering the above factors and being a Physics teacher it seems worthwhile to examine how good Concept Attainment Model (CAM) can be implemented on experimental basis in learning basic concepts in secondary school Physics.

Considering the above factors the investigator took up the present study as INTERACTION EFFECT OF CONCEPT ATTAINMENT MODEL OF TEACHING AND STUDYING APPROACH ON ACHIEVEMENT IN PHYSICS OF SECONDARY SCHOOL STUDENTS.

## 1.2. STATEMENT OF THE PROBLEM

The present study is entitled as 'INTERACTION EFFECT OF CONCEPT ATTAINMENT MODEL OF TEACHING AND STUDYING APPROACH ON ACHIEVEMENT IN PHYSICS OF SECONDARY SCHOOL STUDENTS'.

## 1.3. DEFINITION OF KEY TEMS

### 1.3.1. CONCEPT ATTAINMENT MODEL OF TEACHING

Concept Attainment is the search for and listing of attributes that can be used to distinguish exemplars from non exemplars of various categories (Bruner, Goodnow and Austin, 1967).

Concept Attainment Model of teaching is a model of teaching designed to teach concepts and to help students work together to learn information, build concept and solve problems (Joyce and Weil, 1990).

### 1.3.2. STUDYING APPROACH

Studying Approach refers to orientation of pupils in studying, into which different strategies of learning, styles of learning and associated forms of motivations are merged (Marton and Saljo, 1976, 1997).

Students have stable motives and conceptions about what learning might be and they learn in a consistent way. This consistency of motives and strategies used in learning process is known as Approaches to Studying (Entwistle, 1990).

### 1.3.3. ACHIEVEMENT IN PHYSCIS

Achievement in Physics refers to proficiency of performance in physics as measured by a standardized achievement test.

### 1.3.4. SECONDARY SCHOOL STUDENTS

Secondary School Students are students who are studying in standards VIII, IX and X in the schools managed directly/aided by Director of Public Instructions, Government of Kerala.

In the present study standard IX students are taken as representatives of Secondary School Students.

## 1.4. VARIABLES OF THE STUDY

Variables selected for the present study are the following.

### 1.4.1. Independent Variables

The following are the Independent Variables selected for the study.

1.4.1.1. Concept Attainment Model of Teaching

1.4.1.2 Objective Based Instruction

1.4.1.3. Studying Approach

The three studying approaches selected are

i) deep approach

ii) surface approach

iii) strategic approach

### 1.4.2. Dependent Variable

Achievement in Physics is considered as the dependent variable. Test to measure this variable comprised of Achievement test in Physics.

### 1.4.3. Control Variable

The following are the control variables selected for the present study.

1.4.3.1. Previous Knowledge of the Subject Matter

1.4.3.2. Non-verbal Intelligence

## 1.5. DESIGN

The Pre-test Post-test Equivalent Group Design was used for the study. Two groups were selected for treatment. Experimental Group was taught through Concept Attainment Model of teaching and Control Group was taught through Objective Based Instruction.

## 1.6. OBJECTIVES

The objectives formulated for the present investigation are given below.

1.6.1. To compare the mean scores of Achievement in Physics Post - Test I (tested immediately after the treatment) of the Control group and the Experimental group.

1.6.2. To compare the mean Gain scores of Achievement in Physics (Post-Test I minus Pre-Test) of the Control group and the Experimental group.

1.6.3. To compare the mean Retention scores of Achievement in Physics Post-Test II (tested two months after experimentation) of the Control group and Experimental group.

1.6.4. To compare the mean Gain scores of Achievement in Physics (Post-Test II minus Pre-Test) of the Control group and Experimental group.

1.6.5. To compare the mean scores of Achievement in Physics Post - Test I of the groups formed on the basis of Studying Approach.

1.6.6. To compare the mean Gain Scores of Achievement in Physics Post-Test I (Post-Test I minus Pre-Test) of the groups formed on the basis of Studying Approach.

1.6.7. To compare the mean Retention scores of Achievement in Physics Post-Test II of the groups formed on the basis of Studying Approach.

1.6.8 To compare the mean Gain Scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test) of the groups formed on the basis of Studying Approach.

1.6.9. To study the main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test I for total sample, Boys and Girls.

1.6.10. To study the main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test II for Total sample, Boys and Girls.

1.6.11. To study the main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test I for Total sample, Boys and Girls when initial differences in select variables namely Previous knowledge of Subject Matter and Non-verbal Intelligence are controlled one by one and in combination.

1.6.12. To study the main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test II for Total sample, Boys and Girls when initial differences in select variables namely Previous Knowledge of Subject Matter and Non-verbal Intelligence are controlled one by one and in combination.

## 1.7. HYPOTHESES

The hypotheses formulated and tested for the study are the following:

1.7.1. There will be significant difference in the mean scores of Achievement in Physics Post-Test I (tested immediately after the treatment) between Control group and Experimental group.

1.7.2. There will be significant difference in the mean Gain scores of Achievement in Physics (Post-Test I minus Pre-Test) between Control group and Experimental group.

1.7.3. There will be significant difference in the mean Retention scores of Achievement in Physics Post-Test II (tested two months after the treatment) between Control group and Experimental group.

1.7.4. There will be significant difference in the mean Gain scores of Achievement in Physics (Post-Test II minus Pre-Test) between Control group and Experimental group.

1.7.5. Students having Deep Approach to studying, Surface Approach to Studying and Strategic Approach to Studying will have significant difference in their mean scores of Achievement in Physics in Post-Test I.

1.7.6. Students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying will have significant difference in their mean Gain Scores of Achievement in Physics Post-Test I (Post-Test I minus Pre-Test).

1.7.7. Students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying will have significant difference in their mean Retention scores of Achievement in Physics Post-Test II.

1.7.8. Students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying will have significant difference in their mean Gain scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test).

1.7.9. There will be significant main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective

Based Instruction) and Studying Approach on Achievement in Physics Post-Test I for Total sample, Boys and Girls.

1.7.10. There will be significant main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test II for Total sample, Boys and Girls.

1.7.11. There will be significant main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test I for Total sample, Boys and Girls when initial differences in select variables namely Previous Knowledge of Subject Matter and Non-Verbal Intelligence are controlled one by one and in combination.

1.7.12. There will be significant main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test II for Total sample, Boys and Girls when initial differences in select variables namely Previous Knowledge of Subject Matter and Non-Verbal Intelligence are controlled one by one and in combination.

## 1.8. PROCEDURE

The various steps in the procedure for executing the study are summarised as given below.

### 1.8.1. Sample for the study

Intact groups of students from standard IX were selected as sample for the study. The groups were matched on the basis of Previous Knowledge of Subject Matter and Non-Verbal Intelligence. The experimental group was taught through Concept Attainment Model of teaching and the control group was taught through Objective Based Instruction. Each group consisted of 40 students.

### 1.8.2. Selection of the Topics for Treatment

A thorough analysis of the syllabus of Physics at Secondary level was done. Investigator made discussions with experts in the field of Physics, Physics teachers at secondary level and educational experts. A number of topics from the Physics syllabus of Secondary School students of Kerala state were found amenable for Concept Attainment Model of teaching and Objective Based Instruction. Due to constrain in time thirty basic concepts were finally selected for the present study.

### 1.8.3. Instructional materials and Tools used for the study

#### 1.8.3.1. Lesson Transcripts Based on Concept Attainment Model

The investigator prepared lesson transcripts for CAM as per the suggestions of Joyce and Weil (1992). Thirty lesson plans were prepared for teaching through CAM.

#### 1.8.3.2. Lesson Transcripts Based on Objective Based Instruction

Thirty lesson transcripts were prepared for Objective Based Instruction (OBI). The objectives of both type of lesson transcripts (CAM and OBI) were same. Lesson transcripts were prepared on the basis of Instructional Objectives of Bloom's Taxonomy adopted by NCERT.

#### 1.8.3.3. Studying Approach Inventory (Usha and Ampili, 2002)

A studying Approach Inventory prepared and standardised by the investigator was used for collecting data on Studying Approach of Students.

#### 1.8.3.4. Standard Progressive Matrices Test (Raven, 1958)

#### 1.8.3.5. Achievement Test in Physics (Usha and Ampili 2002)

An Achievement Test in Physics developed and standardised by Usha and Ampili (2002) was used as the Pre-Test. The same test was used as Post-Test I and Post-Test II.

### 1.8.4. Procedure for Data Collection

Procedure for collecting the required data are as follows.

#### 1.8.4.1. Administration of Pre-Test

Pre-Test was administered to the Experimental group and Control group before the treatment was given.

#### 1.8.4.2. Administration of Other tools

Data on Studying Approach was collected from each group by using Studying Approach Inventory and data on Non-Verbal Intelligence was collected from each group using Raven's Standard Progressive Matrices Test.

#### 1.8.4.3. Treatment

Experimental group was taught through CAM and Control group was taught through OBI.

#### 1.8.4.4. Administration of Post-Test I

Immediately after the treatment Post-Test I was administered to each group.

#### 1.8.4.5. Administration of Post-Test II

Post-Test II was administered to each group two months after the treatment.

### 1.8.5. Analysis of Data

The statistical techniques used for the analysis of data are the following.

1.8.5.1. Test of Significance of different between means

1.8.5.2. Two-way ANOVA with 2x3 factorial design

1.8.5.3. Scheffé Test of Multiple Comparison

1.8.5.4. Two-way ANCOVA with 2x3 factorial design.

## 1.9. SCOPE AND LIMITATIONS OF THE STUDY

The aim of the study was to find the Interaction Effect of Concept Attainment Model of Teaching and Studying Approach on Achievement in Physics of Secondary School students. The investigator tried to find out how far the learned materials are retained in pupils after each treatment. The study also examined whether changes could occur if the effect of Previous Knowledge of Subject Matter and Non-Verbal Intelligence were controlled.

Precautions were made to get valid and reliable results from the experimental study. The investigator hopes that the study will yield reliable results which can be generalised and it may help teachers and other educationists to modify the instructional programme. It is hoped that the learning materials prepared for this study will be beneficial to other group of students in successive years.

Even though maximum care and precautions were made, some limitations are anticipated by the investigator which are given as follows.

1. The accessible population of the study was confined to standard IX, the middle stage of secondary level.
2. The Selection of control variables was confined to only Previous Knowledge of Subject Matter and Non-Verbal Intelligence.
3. The Achievement Test in Physics was intended to measure instructional objectives of Cognitive domain only.
4. The items in the Achievement test in Physics were confined to objective type items only, for easy scoring and objective measurement.
5. The selection of topics was confined to thirty basic concepts of Secondary School Physics.
6. Selection of sample subjects were not state wide, but was confined to one revenue district of Kerala.
7. The study was confined to two intact class divisions of standard IX, as this is considered as the representative of Secondary School Students.

8. Same teacher taught both the control group and experimental group. Therefore effect of teacher variation was not studied.

9. Although there were several sophisticated experimental designs, the Pre-Test, Post-Test Equivalent Groups Design only was selected for the present study.

## 1.10. ORGANISATION OFTHE REPORT

Report of the present investigation is organised in the following pattern to get precision and clarity. Each chapter is explained using relevant sections and sub sections.

**CHAPTER I** **INTRODUCTION**

Need and Significance of the study
Statement of Problem
Definition of Key terms
Variables of the study
Design of the study
Objectives
Hypotheses
Procedure
Scope and Limitations
Organisation of the report

**CHAPTER 2** **REVIEW OF RELATED LITERATURE**

Theoretical Overview of the Variables
Review of Related Studies

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CHAPTER 2

# REVIEW OF RELATED LITERATURE

- *Theoretical Overview of the Variables*
- *Review of Related Studies*

# REVIEW OF RELATED LITERATURE

The review of related literature is done to get an awareness of the relevance of the study undertaken by the investigator. The present study was intended to examine the effect of Concept Attainment Model of teaching and Studying Approach on Achievement in Physics of secondary school students. Therefore attempt was made to review the theoretical outline as well as related studies of Concept Attainment Model of Teaching and Studying Approach. The reviewed literature are categorised and presented under the following subtitles.

2.1. THEORETICAL OVERVIEW OF THE VARIABLES

2.2 REVIEW OF RELATED STUDIES

## 2.1. THEORETICAL OVERVIEW OF THE VARIABLES

A theoretical overview regarding Concept Attainment Model of Teaching and Studying Approach are presented in this section.

### 2.1.1 Concept Attainment Model of Teaching

In this section, a detailed theoretical outline of Concept Attainment and Concept Attainment Model of Teaching is presented.

### 2.1.1.1. Meaning and Significance of Concepts

Concepts form the basic elements of human knowledge. These represent, in a general way, the learner's categorization system. They are a means for the learner to impose order and meaning in the world. Concepts have been operationalised by instructional technologists to indicate type of classifying rules (Gagne, 1965; Anderson, 1973; Merill and Tennyson, 1977) that are used to facilitate the classification or identification of instances (Klausmeier, 1980).

Good (1973) defined a concept as "any general or abstract intellectual representation of a situation, state of affairs or object".

Concepts are set of objects, symbols and events that share common characteristics or defining attributes (Tennyson and Park, 1980).

Concepts are classes of instances that represent objects, symbols or events and enable the individual to discriminate a particular thing or class of things and also to relate it to other things or classes of things.

### 2.1.1.2. Elements of a Concept

Concept includes five elements.

*1. Name*

It is merely the term given to a concept.

*2. Exemplars (Positive and Negative)*

Exemplars are 'instances' (or items) that help make a category. This will include items that obey all the essential cues used for categorization and also related items that need not satisfy all the cues, but are essential for making the grouping.

*3. Attributes (essential or non essential)*

Attributes are the features or characteristics that help in facing a number of items into a particular group or class that represent the concept. A few of these will be essential and certain others are non-essential.

*4. Attribute Value*

Each attribute has its value range. Certain attributes are outside these values and certain attributes have no range at all. The purely non-essential attributes outside the range are said to be noisy attributes.

*5. Rules*

Rule is the definition formed on the basis of the essential attributes.

### 2.1.1.3. Type of Concepts

Attributes combine in three different ways to produce three types of concepts.

*1. Conjunctive Concepts*

In a conjunctive concept the appropriate values of several attributes are jointly present. They are often easiest to learn and teach because of the additive quality of their attributes and values. Simply attributes and values are added together to produce a conjunctive concept.

*2. Disjunctive Concepts*

Disjunctive concepts are defined by the presence of some attributes and the absence of others.

*3. Relational Concepts*

Relational concepts are those having a specific relationship between attributes.

**2.1.14. Concept Attainment**

Concept attainment does not merely mean acquisition of the concept in a restricted sense. It refers to the activity of discovering whether the instance belong to the category of formed concept or not. When the learner is able to extend the formed concept to other instances it can be said that the concept is attained.

Concept attainment is "the search for and listing of attributes that can be used to distinguish exemplars from non exemplars of various categories" (Bruner, Goodnow and Austin, 1967).

Concept attainment requires a student to figure out the attributes of a category that is already formed in another persons' mind by comparing and contrasting examples (exemplars) that contain the characteristics (attributes) of the concept with examples that do not contain those attributes (Joyce and Weil, 2004).

### 2.1.1.5. Levels of Concept Attainment

According to Agarwal (2000) there are four levels of concept attainment and certain mental operations are involved in learning each level. These levels of concept attainment are listed below.

***1. Concrete level***

A Concept is learned at the concrete level when the learner first recognises a particular example of a concept as being the same as one experienced earlier.

***2. Identity level***

A concept is learned at the Identity level when the learner recognises an object as the same one previously encountered when the object is observed in a different situational context or from a different spatio temporal perspective when it is sensed in a different modality.

*3. Classificatory level*

A concept is attained at a classificatory level when the learner recognises two different examples of the same concept as being equivalent.

*4. Formal level*

A concept is attained at the formal level when the learner can correctly identify examples and non examples of a concept, name of examples, discriminate and name the defining attributes of the concept, give a socially accepted definition of the word that represents the concept and evaluate how examples of the concept differ from examples of other concepts.

**2.1.1.6. Strategies of Concept Attainment**

Bruner (1967) identified four strategies of concept attainment.

***a) Simultaneous Scanning***

A simultaneous Scanner hypothesises more than one concept with the first instance and his choice of next instances to the first will be determined by the elimination of as many hypothetical concepts as possible per instance chosen.

### b) *Successive Scanning*

A successive scanner forms a concept hypothesis from the given positive instance and then tests it against other examples. The disadvantage here is that there is no assurance of giving maximum of information possible. The advantage is the relief from cognitive strain as limited interference is required.

### c) *Conservative focussing*

A student with conservative focussing strategy finds a positive instance and chooses instances that offer one attribute at a time. By choosing a particular instance as focus the person decreases the complexity and abstraction of the task of keeping of information he has encountered. Hence there is relatively more cognitive economy.

### d) *Focus gambling*

In the focus gambling strategy one uses a positive instance as a focus and changes more than one attribute at a time. The strategy makes use of fewer test choices but these may be equal chances of requiring more test choices and there is more risk involved

The major differences among these strategies are noted in terms of (a) use of attributes or hypotheses (b) the basis of searching and (c) in the numbers of hypotheses used at a time.

Tennyson and Cocchiarella (1986) as reported by Joyce and Weil (2004) concluded that students develop procedural knowledge of attaining concepts with practice, and also that they attain and can apply conceptual knowledge. Thus the analysis of thinking to facilitate learning the meta cognitions of concept attainment appears to be very important.

To understand the strategies students use to attain concepts, their approach to the information available in the exemplars should be analysed. Joyce and Weil (1992) identified two classes of strategies viz., holistic strategies and partistic strategies. If the learner concentrates on just certain aspects of the information it is called partistic strategy. If the learner keeps all or most of the information in mind it is called holistic strategy.

### 2.1.1.7. Models of Teaching

A number of models of teaching have been developed by various researchers as reported by Joyce and Weil (2004). A model of teaching consists of guidelines for designing educational activities and environments. Models are highly specific teaching strategies designed to accomplish certain goods.

A model of teaching is a description of a learning environment. Models of teaching are really models of learning. Models of teaching have many uses, ranging from planning curriculum, courses, units and lessons to designing instructional materials – books and workbooks, multimedia programmes and computer assisted learning programmes (Joyce and Weil, 2004).

### 2.1.1.8. Concept Attainment Model

Joyce and Weil (1992) have developed more than twenty models and grouped them on the basis of the way they approach educational goals and means. They have organized these models into four families viz., Information Processing Models, Social Interaction Models, The Personal Models and the Behaviour Modification Models.

Concept Attainment Model is a model of teaching belonging to the information processing family of models. This family of models aim to make the students learn to think. In these family of models curriculum is infused with intellectual activity so that learning to think is an important component of every activity (Joyce and Weil, 2004). Knowledge construction is of prime importance here.

The core of good thinking is the ability to solve problems. The essence of problem solving is the ability to learn in puzzling situations. In the information processing family of models learning how to learn pervades what is taught, how it is taught and the kind of place in which it is taught (Downey, 1967). The students gather around learning problems and study how they think and make a conscious effort to learn to think more effectively.

Concept Attainment Model is designed to teach students to attain concepts and analyse thinking strategies (Joyce and Weil, 2004). It has been developed based upon the studies made by Bruner and his associates (1967) about the nature of concepts and the strategies of concept attainment. The procedure of CAM has been described by Joyce and Weil (2004) as follows. Data are presented to the students in the form of sets of items called exemplars. These are labelled 'positive' if they have characteristics or attributes of the concept to be taught. The exemplars are labelled 'negative' if they do not contain the attributes of the concept.

By comparing the positive and negative exemplars, the students develop hypotheses about the nature of the category. They do not however, share their hypotheses at this point. When most of the students have developed a hypothesis, some unlabelled exemplars are presented to them and they indicate whether they can successfully identify positive exemplars. They may be asked to produce some of their own.

Then they are asked to share their hypotheses and describe the progression of their ideas during the process. When they have agreed on the hypotheses that appear most likely, they generate labels for them. Then the teacher supplies the technical label if there is one

To consolidate and apply the concept, the students then search for more items of the class and find which ones most closely match the concept they have learned.

### 2.1.1.9. Basic Procedure of Implementing Concept Attainment Model of Teaching

*1. Syntax*

The Concept Attainment Model of teaching consists of three phases of activity: Presentation of Data and Identification of concept, Testing Attainment of the Concept and Analysis of Thinking Strategies.

Phase one is the presentation of data and identification of a concept. The four steps in this phase are (1) Teacher presents labelled examples (2) students compare attributes in positive and negative examples (3) students generate and test hypotheses (4) students state a definition according to the essential attributes.

Phase two is testing attainment of the concept. The three steps in this phase are

(1) Students identify additional unlabelled examples as yes or no

(2) Teacher confirms hypotheses, names concept, and restates definitions according to essential attributes.

(3) Students generate examples.

The third phase is the analysis of thinking strategies. This phase has three steps (1) students describe thoughts (2) students discuss role of hypotheses and attributes 3) students discuss type and number of hypotheses.

## 2. *Social System*

The teacher carefully prepares in advance positive and negative examples, label them and arrange them in such a way that the attributes are clear. The teacher acts as a recorder and provides additional examples as needed. The functions of the teacher are to record, prompt (cue) and present additional data (Joyce and Weil, 2004). The system is highly structured.

## 3. *Principles of Reaction*

The Principles of Reaction of Concept Attainment Model of teaching as provided by Joyce and Weil, 2004 are (1) Give support but emphasize the hypothetical nature of discussion. (2) Help student balance one hypothesis against another. (3) Focus attention on specific features of examples (4) Assist students in discussing and evaluating their thinking strategies.

*4. Support System*

Support system of Concept Attainment Model consists of carefully selected and organized materials and data in the form of discrete units to serve as examples.

**2.1.1.10. Instructional and Nurturant Effect**

*1. Instructional Effect*

The Concept Attainment Model can accomplish several instructional goals depending on the emphasis of the particular lesson. The instructional effects can be listed as follows: (1) Getting clear notions about nature of concepts (2) Developing skills in using appropriate concept building strategies (3) Attaining the specific concepts (4) Developing skill in inductive reasoning.

*2. Nurturant Effects*

The nurturant effects of concept Attainment Model are (1) developing sensitivity to logical reasoning (2) developing tolerance of ambiguity and initial errors (3) developing a sense of using alternative perspectives.

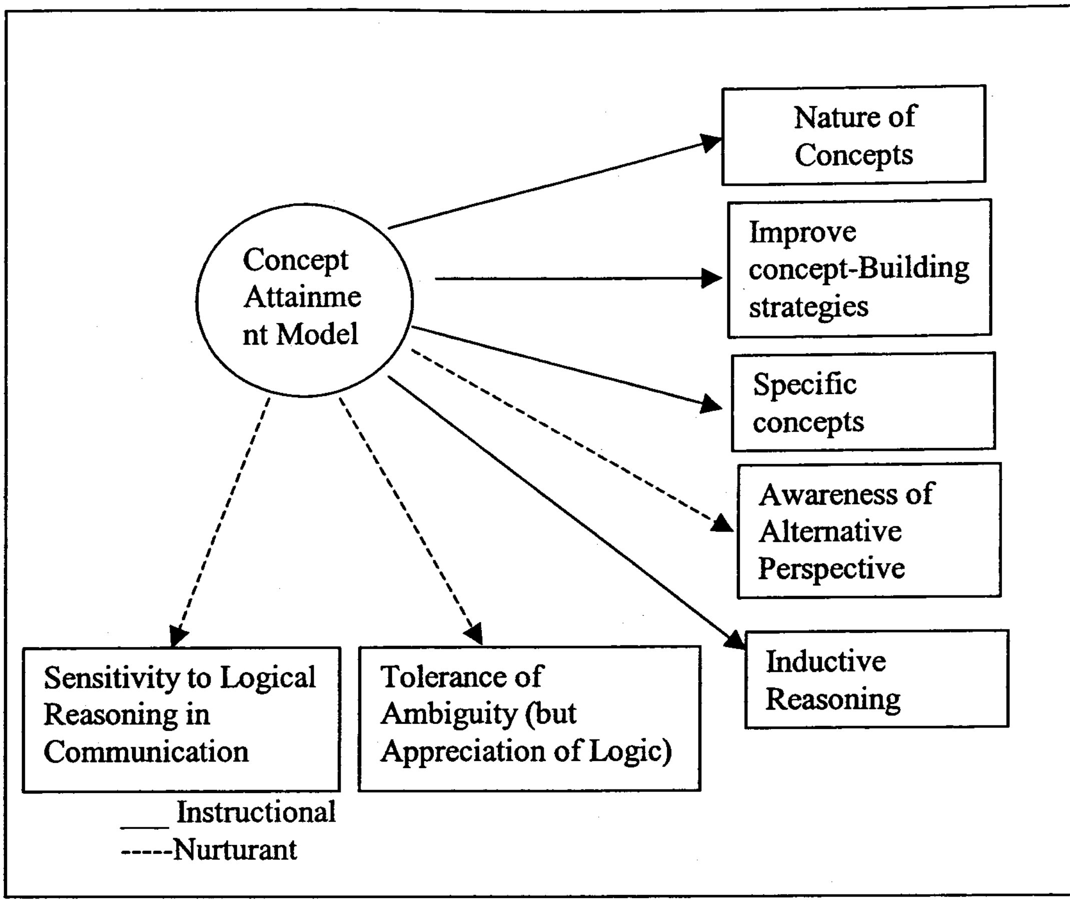


**FIGURE 2-1 Instructional and Nurturant Effects of Concept Attainment Model.**

### 2.1.1.11 Variations in Concept Attainment Model (CAM)

There are three variations in CAM that have been built from the basic study of Bruner and his associates. Each has a slightly different syntax but all are developed from a common conceptual base. These variations are discussed below.

**1. Reception Oriented CAM**

In this model, the students are more receptive than active. The teacher has a more dominant role, acts as recorder keeping track of the hypotheses and supplies additional examples.

**2. Selection Oriented CAM**

This model places responsibility of concept attainment and attribute tracking in the hands of the students. An example is not labelled until the students ask whether it is 'yes' or 'no'. Students control the sequence of the examples. The tracking and analysis of attributes is not as formal in this model as in Reception Oriented Model. It is less structured than the reception mode.

**3. Unorganised Model of Concept Attainment**

This model is much more a group discussion than an instructional game like the reception and selection strategies. The teacher's role is to facilitate discussion and ensure that it is focussed on the development of a concept.

### 2.1.2 STUDYING APPROACH

For a long time Educationists and Psychologists have been trying to analyse the process of learning. Qualitative methods were employed to assess students' experience of learning and the ways in which they made sense of the individual approach to the learning tasks. Studying approaches cover students' motives, conceptions, intensions and their inter relationship to distinct learning outcomes. (Marton, 1976)

Each student in the class differs in his/her approach to learning and in dealing with a given learning situation. Achievement in studies is associated with the 'style of learning' of the learner and in turn depends on the personality of the learner.

The word 'study habit' was coined by Wrenn (1930) for the student's way of dealing with a given task. Study habits are efficient means for using time and the mind (Pauk, 1962).

Entwistle (1978) proposed that ways the learner use to tackle a task can be referred to as 'learning style'.

**2.1.2.1. Meaning**

'Studying Approach' refers to orientation of pupils in studying, into which different strategies of learning and associated forms of motivations are merged (Marton and Saljo, 1976) (Svensson, 1977).

Students have stable motives and conceptions about what learning might be and they learn in a consistent way. This consistency of motives and strategies used in learning process is termed as students' 'Approaches to Studying' by Entwistle (1990).

Two approaches to learning viz., the deep approach and surface approach was identified by Marton and Saljo (1976) and Svensson (1977).

A deep approach entails looking for meaning in the matter being studied and relating it to other experiences and ideas with a critical approach. A deep approach is likely to result from relevance to students interests (Fransson, 1977), the interest, support and enthusiasm shown by the instructor (Ramsden, 1979) and where students have an opportunity to manage their own learning (Ramsden and Entwistle, 1981).

Going deep, a student focuses on what is signified (arguments and conclusions), relates new ideas to previous assumptions, sees concepts in everyday experience, distinguishes argument from evidence, organizes content into structure (Ramsden, 1988).

A deep Approach is described as meaning oriented transformations or internalising whereas the surface approach is surface oriented, emphasising more on mechanical reproducing (Speth and Brown, 1988).

A surface approach is described as a reliance on rote learning and memorization in isolation to other ideas. A surface approach results from assessment methods which reward reproducing information (Das and

Clark, 1991); anxiety (Svensson, 1977) or a heavy work load (Ramsden and Entwistle, 1981).

The individuals adopting surface approach will focus on the signs (the test itself) as discrete elements, memorize information for examinations, and associate concepts and facts without structure (Ramsden, 1988).

Research studies also has described another approach to learning which is related to the competitive form of motivation. This approach was described as Achieving by Biggs (1979) and Strategic Approach by Ramsden (1981).

Strategic Approach entails determination to excel, effort in studying, organized studying and time management. Students identified as using a strategic approach, perceive themselves as having clear goals related to their studies and being hard workers; they ensure that they have the appropriate resources and conditions and they are well organized (Biggs, 1987).

The distinction between deep, surface and strategic approaches to learning existed within a framework of three orientations to learning: Meaning, Reproducing and Achieving. These three orientations were supplemented by styles and pathologies of learning identified by Pask and

Scott (1972), who identified two general categories of learning strategy: the serialist and the holist approach.

The third approach to learning is not conceptualised as an alternative to deep and surface approach, but refers to shifts between Deep and Surface approaches to learning (Valet and Charlmers, 1992). Students adopt Deep and Surface Approach in combinations to achieve highest possible marks. But the use of well-planned and organised study methods are the distinctive feature of the Achieving or Strategic Approach (Kumar, 1993).

The basis for the concepts of Deep and Surface approach can be traced back to the thoughts of Walts (1810) and Dewey (1910). Surface achievers adopt rote learning and also select details to obtain high grades; on the other hand Deep achievers are organised and plan carefully in their search for meaning (Biggs, 1990).

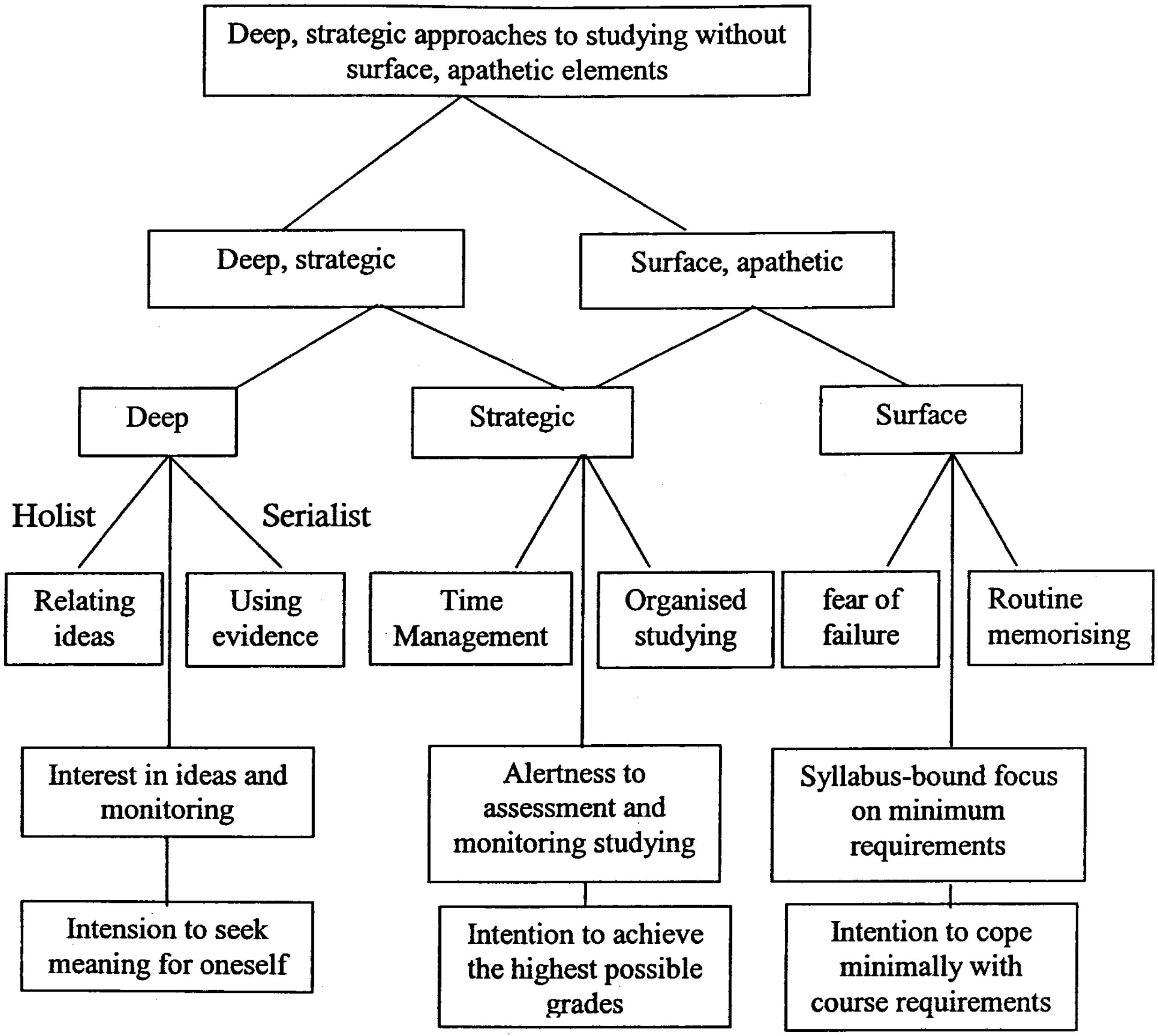


**FIGURE 2-2 Conceptual Mapping of Components of Studying Approach.**

### 2.1.2.2. Origin of the Term

Cognition can be though of as the way in which a person acquires, stores and uses knowledge. A large number of researchers have studied the differences in the level of information processing ability of the learners. One of the first groups of researchers to consider individual differences in information processing strategies was Bruner, Goodnow and Austin (1956). Later studies by Witkin *et al.* (1962) confirmed the existence of individual differences in information processing strategies. Such differences were consistently identified in a range of different problem solving situations and were referred to as cognitive style. (Witkin *et al.*, 1977). Learning style is regarded as a subset of cognitive style. A learning style is described as being ' . . . a description of the attitudes and behaviour which determine an individual's preferred way of learning'. (Honey and Mumford, 1992).

Educational researchers had employed qualitative methods to assess students' experience of learning. The work developed by these researchers had moved away from an assumption of stable personality characteristics and had placed greater emphasis on the choices an individual makes in selecting an approach to a learning task. The choice of learning approach is affected by the conditions in which individuals learn (Reynodls, 1997).

'Studying Approach' is derived from Marton and Saljo's (1996, 1997) ideas on learning approaches. They found that Scandinavian students used either a Deep approach or Surface approach.

### 2.1.2.3. Conceptual Overlaps

Because of the different methodologies used by different researchers, there are some conceptual overlaps in 'studying approach'.

Entwistle *et al.* (1979) sub-divided the two approaches into four categories viz., Deep Active, Deep passive, Surface Active and Surface Passive, based on the degree of activity, attention and involvement shown by the student.

Biggs (1978) developed a Study Process Questionnaire (SPQ) and suggested three strategies as Reproducing, Internalising and Achieving. Here the first two are similar to Deep and surface Approach to learning.

Entwistle *et al.*, (1979) reported three main orientations to studying viz., The Meaning (Deep approach and Comprehension learning), Reproducing (Surface Approach and Operation learning) and Achieving (Organised study and Achievement Motivation) Meaning and Reproducing are similar to Marton's Deep and Surface Approach.

Schmeck (1983) listed four orientations viz., Deep processing, Elaborate processes, Fact retention and Methodical study. Here deep processing and elaborate processes are equal to Deep Approach of Marton and Fact retention is similar to Surface Approach. Methodical study is similar to Achieving Strategy of Biggs.

### 2.1.2.4. Measurement of Studying Approach

Review of related studies show that Studying Approach can be measured from many angles. A number of instruments for assessing studying Approach have been developed by various researchers and some of them are briefly described in the following section.

#### a) Learning Style Inventory (Kolb and Fry, 1976)

Kolb and Fry (1976) prepared a learning style inventory to measure a person's relative position on the concrete experiences viz., abstract conceptualisation dimension and active experimentation v/s reflective observation dimension. It consisted of words which the respondent rank order to describe the learning style.

#### b) Self Report Inventory (Schmeck *et al.*, 1977)

Schmeck (1977) prepared a 62-item inventory of learning process which was derived from factor analysis of self-report items. He identified four main factors viz., surface processing, disorganised study methods, fact retention and elaborate process.

#### c) Study Process Questionnaire (SPQ)

Biggs (1978) developed a Study Process Questionnaire (SPQ) in which ten unidimensional scales were included to assess the study process of higher education students. When factor analysed, the SPQ showed a stable second order structure consisting of three dimensions namely, Reproducing, Internalising and Achieving.

**d) Approaches to Studying Inventory (ASI)**

Entwistle *et al.* (1979) developed an Approach to Studying Inventory (ASI). From an initial fifteen sub-scales they produced three orientations to study. The Meaning, Reproducing and Achieving.

**e) Revised Approaches to Studying Inventory (RASI)**

Entwistle and Ramsdon (1983) revised the original ASI by adding a new orientation termed as the Non-academic orientation to study. The new version consisted of sixty-four items and four orientations.

Entwistle and Ramsden (1992) again revised the original ASI, with a 60 item, 15 scale version measuring five dimensions: Deep Approach, Surface approach, Strategic Approach, Apathetic Approach and Academic Aptitude. A reduced version of this inventory appeared in 1994 with 38 items in 15 scales, measuring five dimensions labelled Deep Approach, Surface Approach, Lack of Direction and Academic Self-confidence. A later version, produced in 1995 used 44 items and 15 scales, identifying a sixth dimension: Meta Cognitive Awareness of Studying.

**f) Inventory of Learning Process (ILP)**

Schmech (1983) developed the Inventory of Learning Process (ILP) which consists of a series of behaviourally oriented statements and identified four orientations: Deep processing, Elaborate processes, Fact retention and Methodical Study.

**g) Learning and Study Strategy Inventory (LASSI)**

Weinsten *et al.* (1983) constructed the Learning And Study Strategy Inventory (LASSI) comprising of ten scales such as Anxiety, Attitude, Concentration, Information Processing, Motivation, Scheduling, Selecting the main idea, Self testing, Study aids and Text strategies.

**h) Learning and Studying Questionnaire (LSQ)**

The Learning and Studying Questionnaire was developed as a part of ETL Project (2001) of the school of Education, University of Edinburgh. This questionnaire consists of three sections, the first two of which contain items covering reasons for taking the degree programme. The third section is an inventory which produces five scale scores describing differences in students approaches to learning and studying.

**i) Experiences of Teaching and Learning Questionnaire (ETLQ)**

Experiences of Teaching and Learning Questionnaire was developed as part of the Enhancing Teaching Learning environment in

Undergraduate courses Project of University of Edinburgh. This questionnaire consists of four sections, the first of which is an inventory to explore students' approaches to learning and studying. The second section consists of a set of items designed to describe aspects of students perceptions of their teaching-learning environment in a particular course unit. The third and fourth sections respectively explore students' perceptions of the demands made on them by their course units and their perceptions of what they have learned in these course units.

## 2.2.2 REVIEW OF RELATED STUDIES

In this section a review of studies related to 'Concept Attainment Model of Teaching' and 'Studying Approach' are attempted. The related studies are categorised into and presented under the following headings.

### 2.2.1. Studies related to Concept Attainment Model of Teaching

Survey of related literature exposed a number of studies on Concept Attainment Model of Teaching and its effect on Academic Achievement.

#### 2.2.1.1. Studies Related to Concept Attainment Model and Academic Achievement

Several studies have been conducted to find out the effect of Concept Attainment Model on Academic Achievement.

***Studies which revealed a positive effect on academic achievement***

The study of Farks (1985) concluded that in the learning style by concept learning strategy formal interaction, field independent students scored significantly higher on the retention test with a counter type discrimination format than with the proto type-building format.

In an experimental study conducted by Gangrade (1987) it was established that Concept Attainment Strategy was significantly superior to Traditional Method of teaching in teaching science to class VII and Class VIII students. In this study, the experimental and control groups were matched in respect of intelligence, attitude towards science and Previous year achievement in science.

Sushama (1987) studied the relative effectiveness of Concept Attainment Model (CAM) Biological Science Inquiry Model (BSIM) and Traditional Method of Teaching on pupil achievement. She found that CAM was more effective than BSIM and traditional method when students' achievement in Biological science was taken.

Singh (1990) found that both Inquiry Training Model and Concept Attainment Model are equally effective in the teaching of physical science to class IX pupils.

Manocha (1991) studied the reception as well as selection strategies of Concept Attainment Model in comparison to the conventional method for the teaching of concepts in Biology. The findings indicated no significant difference between reception and selection strategies with respect to achievement scores.

Kahn and Siddiqui (1992) conducted a review study on the effectiveness of Concept Attainment Strategies and came up with the findings that (i) Concept Attainment Strategies were more effective over the traditional approach (ii) Personality factors had no significant effect on the concept attainment process (iii) these strategies were responsive to the needs of the disadvantaged learners and (iv) attainment of a disjunctive concept is more difficult than the attainment of conjunctive concepts.

Ramadevi (1998) conducted a study on the application of information processing models of teaching Chemistry at the secondary and higher secondary levels and found that information processing models of teaching are superior to the conventional method of teaching in bringing about achievement in Chemistry.

Shah (2002) conducted a study on Effectiveness of Concept Attainment Model (CAM) and Self-Learning Material (SLM) for the teaching of Concept of Mathematics and arrived at the following conclusions.

(i) The educational achievement of pupils studying through Concept Attainment Model was found to be higher than that of the students studied through Traditional Method.

(ii) The educational achievement of pupils studying through Self Learning Material was found to be higher than that of the students studied through Traditional Method.

(iii) The educational achievement of pupils studying through concept Attainment Model was found to be higher than that of the students studied through Self-Learning Material

Krishnakumari (2002) studied the effectiveness of Inquiry Training Model and Concept Attainment Model for learning Mathematics at secondary level. She found that pupils taught through CAM had significantly higher mean achievement in Mathematics than pupils taught through traditional method. The results also revealed that the Achievement in Mathematics of pupils taught CAM and ITM do not differ significantly.

Bindu (2002) conducted an experimental study on Effectiveness of CAM of teaching on Achievement in Chemistry of secondary school pupils. Result of the study revealed that CAM is more effective than conventional method in terms of Achievement in Chemistry of secondary school pupils.

Smitha (2007) studied the effectiveness of Concept Attainment Model of Teaching on Achievement in Biology of standard VIII pupils and found the superiority of Concept Attainment Model of teaching over the Constructivist method of teaching.

***Studies which revealed no achievement benefits with Concept Attainment Model when compared with other teaching strategies***

In a study Bodulas (1986) examined the use of concept mapping after narration as a strategy to facilitate meaningful learning based on a theoretical structure. He found that the experimental groups using the concept mapping process did only slightly better than the traditional group.

Sharma (1986) studied the effectiveness of CAM in terms of achievement of students on achievement test based on the concepts taught in chemistry and the effectiveness of CAM in terms of reactions of students towards the new method of teaching. He found that the mean performance of the experimental and control groups on achievement test is not significantly different from each other.

Vaidya (1990) compared Mastery Learning Strategy with Concept Attainment Strategy and the Traditional Method. The findings of the study indicated that Mastery Learning Strategy was more effective than Concept Attainment Strategy and Traditional Method in (i) facilitating learning and enhancing the achievement level and (ii) improvement in self-concept and attitude towards the subject.

In a study conducted by Kaur (1991) it was found that for teaching of concepts in Economics both the concept Attainment Model and Advance Organiser Model are effective and that Advance Organiser Model is more effective than Concept Attainment Model. The interaction between Teaching strategies, Intelligence and Creativity were not found to be Significant.

The study conducted by Taimin (1991) indicated that although both Advance Organiser Model and Concept Attainment Model were equally effective in fostering concept learning the Advance Organiser Model was comparatively more beneficial in concept learning to pupils with high divergent thinking while Concept Attainment Model was more beneficial to pupils with low divergent thinking. The Advance Organiser Model was found to be more effective than concept Attainment Model in the retention of concepts irrespective of the levels of divergent thinking of the pupils.

Mohanty (1992) compared Jurisprudential Inquiry Model with Concept Attainment Model in the development of moral concepts and judgment and the personal values of class VIII pupils. The findings of the study indicated that Jurisprudential Model was more effective for developing the moral judgements and personal values of students whereas concept Attainment Model was more effective in developing moral concepts.

Aishabi (1996) made an experimental study of teaching of Zoology through CAM at plus two level. The study with the post exposure design was conducted to compare the effect of CAM and traditional teaching method in ten selected topics in Zoology at the plus two level. The findings showed no difference in the attainment of concept in the selected topics between the experimental and control groups.

**2.2.1.2. Studies Related to Concept Attainment Model and Teaching Competence**

Bihari (1986) investigated the effect of three concept attainment training strategies on teaching competence and found that the three training strategies, viz., peer feed back and practice in guard, peer feedback and practice in pairs and demonstration followed by practice in guard were equally effective for developing teaching competence.

In the light of the study by Das (1986) it was revealed that Concept Attainment Model is effective in developing the teaching competencies of pre-service student teachers.

A study conducted by Chaudhary (1989) revealed that the teaching skills and competence developed among student teachers through the use of Concept Attainment Model are easily transferable in other teaching situations besides the teaching of concepts. This study also recommended the use of concept Attainment Model instead of spending much more time on the Micro teaching techniques to develop the teaching skills.

Mahajan's (1992) findings indicated that during the peer group sessions as well as classroom teaching sessions, the group taught by Concept Attainment Model was found to be superior to the group taught by Advance Organiser Model as well as the routine method as far as the teaching ability of student teachers were concerned.

#### 2.2.1.3. Studies related to Concept Attainment Model and Attainment of Concepts and Higher Order Thinking

Oeballos (1986) found that for the age group of fourth graders, inductive and deductive approaches are equally effective in prompting concept formation/concept attainment and in fostering the meta cognitive strategies that are critical to higher order thinking.

The results of the study conducted by Passi, Singh and Sansanwal (1986) consistently demonstrated that (i) teaching through CAM and ITM increased the students understanding of theoretical aspects of CAM and ITM (ii) It brought favourable changes in the teaching towards CAM and ITM and (iii) Students got differential competency. All students learned theoretical content of CAM and ITM equally well.

Pani (1988) compared concept attainment scores of groups of standard VIII students taught through Reception and selection strategies of CAM. He found that the reception strategy and selection strategy were equally effective in terms of attainment of science concept.

Agarwal and Mishra (1988) studied the effectiveness of the reception strategy of CAM in enhancing the attainment of science concepts and found it to be effective.

Bhaveja (1989a, 1989b) in her two studies compared the effectiveness of concept Attainment Model with Inductive Thinking Model in regard to the concept learning in Biology and also analysed the thinking strategies used by the learners. The findings were quite similar in the two studies supporting the role of inductive thinking processes in the process of conceptualisation and generalisation.

The study conducted by Sood (1990) on comparative effectiveness of Advance Organiser Model and Concept Attainment Model for acquisition of language concepts in relation to cognitive style, Intelligence and creativity revealed that Concept Attainment Model is more effective than Advance Organiser Model in teaching of concepts in Hindi.

Passi, Singh and Sansanwal (1992) found that training strategies (in the form of Lecture discussion, demonstration and peer practice) in Inquiry Training Model (ITM) and concept Attainment Model (CAM) enhanced teacher educators in understanding of the theoretical aspects of Inquiry Training Model and Concept Attainment Model. They also found that various training strategies brought significant positive changes in their willingness to complement the models.

As instructional programme constructed by Nelson and Pan (1995) integrated ideas about teaching thinking skills using computers. Hyper card and video disc images were used to develop a programme so that students could explore concepts based on the Concept Attainment Model. It was found that the Concept Attainment Model was appropriate for the elementary school curriculum.

Nelson and Pan (1997) investigated pre-service elementary teachers responses to a Concept Attainment task using video disc pictures and the life drawings. The study revealed that students using video disc pictures used inferences to construct patterns while students using live drawings in connection with pictures made more observations and developed fewer ideas to make viable patterns.

Liang and Gabel (2005) examined and found the effectiveness of a new instructional model in improving prospective teachers' understanding of science concepts in fostering a learning environment and in promoting positive attitude towards learning and teaching science and chemistry in particular.

**2.2.1.4. Other Studies related to Concept Attainment Model**

Result of the study of Al-Sulman (1987) revealed that concept attainment is more directly influenced by the parents educational background and the degree of mobility experienced by the students.

The study conducted by Deb (2003) revealed that concept formation is positively related to classroom climate. The result also revealed that concept formation among socially deprived children is positively related to involvement, encouragement and democracy.

Richard (2004) found that learning may be best supported by methods of instruction that involve cognitive activity rather than behavioural activity, instructional guidance rather than pure discovery and curricular focus rather than unstructured exploration.

## A Summary of Studies on Concept Attainment Model of Teaching

### *1. Studies related to Concept Attainment Model and Academic Achievement*

| *Sl. No.* | *Author* | *Variables* | *Result* |
|---|---|---|---|
| **Positive Relationship** | | | |
| 1. | Farks (1985) | Learning style, concept learning strategy, Academic Achievement (Retention) | Positive relation |
| 2. | Gangrade (1987) | Concept Attainment Strategy, Traditional Method of Teaching, Achievement in Science | Concept Attainment strategy significantly superior to Traditional Method of Teaching |
| 3. | Sushama (1987) | CAM, BSIM, Traditional Method of Teaching, Achievement in Biological Science | CAM more effective than BSIM and traditional method |
| 4. | Singh (1990) | Inquiry Training Model, Concept Attainment Model, Achievement in Physical Science | ITM and CAM equally effective in teaching Physical Science |
| 5. | Manocha (1991) | Reception and selection strategies of CAM, Conventional Method of Teaching, Achievement in Biology | CAM superior to the Conventional Method of Teaching. No significant difference between reception and selection strategies of CAM with respect to Achievement in Biology |

| *Sl. No.* | *Author* | *Variables* | *Result* |
|---|---|---|---|
| 6. | Kahn and Siddiqui (1992) | CAM, Traditional Method of Teaching, Academic Achievement | CAM more effective over traditional method of teaching |
| 7. | Ramadevi (1998) | Information Processing Models of Teaching, Conventional Method of Teaching, Achievement in Chemistry | Information Processing Models superior to Conventional Method of Teaching |
| 8. | Shah (2002) | CAM, Self Learning Material (SLM), Traditional Method, Achievement in Mathematics | CAM more effective than SLM and Traditional Method |
| 9. | Krishnakumari (2002) | CAM, ITM, Traditional Method, Achievement in Mathematics | CAM more effective than traditional method. CAM and ITM do not differ significantly. |
| 10. | Bindu (2002) | CAM, Traditional Method, Achievement in Chemistry | CAM more effective than traditional method. |
| 11. | Smitha (2007) | CAM, Constructivist Method of Teaching | CAM more effective than Constructivist method. |
| **No Achievement benefits** | | | |
| 12. | Bodulas (1986) | Concept mapping strategy, Traditional Method | Experimental group only slightly better than Control group |
| 13. | Sharma (1986) | CAM, traditional method, Achievement in Chemistry | Mean Achievement of Experimental group and Control group not significantly |

| Sl. No. | Author | Variables | Result |
|---|---|---|---|
| | | | different |
| 14. | Vaidya (1990) | Mastery Learning Strategy, Concept Attainment Strategy, Traditional Method | Mastery Learning Strategy more effective than CAM and Traditional Method |
| 15. | Kaur (1991) | CAM, Advance Organiser Model, Achievement in Economics, Intelligence, Creativity. | Advance Organiser Model more effective than CAM, no significant interaction between teaching strategies, Intelligence and Creativity. |
| 16. | Taimin (1991) | Advance Organiser Model, CAM, Academic Achievement | AOM more beneficial in concept learning to pupils with high divergent thinking, CAM more beneficial to pupils with low divergent thinking, AOM more effective than CAM in retention of concepts irrespective of level of divergent thinking of pupils. |
| 17. | Mohanty (1992) | Jurisprudential Inquiry Model, CAM, Moral concepts and Judgement and Personal Values | J.I.M. more effective for developing moral judgements and personal values, CAM more effective in developing moral concepts. |

| Sl. No. | Author | Variables | Result |
|---|---|---|---|
| 18. | Aishabi (1996) | CAM, Traditional Method, Concept Attainment in Zoology | No significant difference |

***2. Studies related to Concept Attainment Model and Teaching Competence***

| Sl. No. | Author | Variables | Result |
|---|---|---|---|
| 19. | Bihari (1986) | CAM, teaching competence | CAM effective for developing teaching competence. |
| 20. | Das (1986) | CAM, teaching competence | -do- |
| 21. | Chaudhary (1989) | CAM, teaching skills and competence | Teaching skills and competence developed through CAM easily transferable in other teaching situations besides teaching of concepts, CAM more effective than microteaching. |
| 22. | Mahajan (1992) | CAM, AOM, routine method, teaching ability | CAM superior to AOM and routine method in developing teaching ability of student teachers. |

***3. Studies related to Concept Attainment Model and Attainment of Concepts and Higher Order Thinking***

| *Sl. No.* | *Author* | *Variables* | *Result* |
|---|---|---|---|
| 23. | Oeballos (1986) | CAM, concept formation, meta cognitive strategies | CAM effective in concept formation and in fostering meta cognitive strategies critical to higher order thinking |
| 24. | Passi, Singh and Sansanwal (1986) | CAM, ITM | CAM and ITM increased understanding of theoretical aspects of CAM and ITM, brought favourable changes in the teaching towards CAM and ITM |
| 25. | Agarwal and Mishra (1988) | CAM, Attainment of Science Concepts | CAM effective in enhancing the attainment of Science concepts. |
| 26. | Pani (1988) | Reception and selection strategies of CAM, Attainment of Science Concept | Equally effective. |
| 27. | Bhaveja (1989a, 1989b) | CAM, Inductive Thinking Model, Concept learning in Biology | CAM and ITM effective in concept learning in Biology |
| 28. | Sood (1990) | AOM, CAM, Acquisition of language concepts. | CAM more effective than AOM in teaching of concepts in Hindi |

| Sl. No. | Author | Variables | Result |
|---|---|---|---|
| 29. | Passi, Singh and Sansanwal (1992) | Inquiry Training Model, CAM | ITM and CAM enhanced teacher educators in understanding of theoretical aspects of ITM and CAM, significant positive changes in willingness to complement the models. |
| 30. | Nelson and Pan (1995) | CAM, thinking skills | CAM enhanced thinking skills. |
| 31. | Nelson and Pan (1997) | CAM, thinking skills | CAM enhanced thinking skills. |
| 32. | Liang and Gabel (2005) | Instructional Strategy, Science Concept | Effective in understanding science concept, promotes positive attitude. |

### 4. *Other Studies Related to Concept Achievement Model*

| Sl. No. | Author | Variables | Result |
|---|---|---|---|
| 33. | Al-Sulman (1987) | CAM, Parents' Educational Background, Mobility of Students | CAM is directly influenced by parents educational background and degree of mobility experienced by students. |
| 34. | Deb (2003) | Concept formation, Classroom climate | Positive relation. |

| *Sl. No.* | *Author* | *Variables* | *Result* |
|---|---|---|---|
| 35. | Richard (2004) | Instructional strategy learning | Learning supported by instructional strategy involving cognitive activity. |

### 2.2.2. Studies Related to Studying Approach

In this part of the review, studies that are related to studying approach are presented.

#### 2.2.2.1. Studies related to Studying Approach and Learning Outcome/ Academic Achievement

***Studies which revealed positive influence of Studying Approaches on learning outcome***

Hattie and Watkins (1988) conducted a study of preferred classroom environment and approach to learning on a sample of 1266. Australian higher secondary students and found out a relationship between learning strategies and high quality learning outcomes.

In a study conducted by Pokay (1988) it was revealed that motivation and learning strategy influenced performance of high and low achievers.

Nist (1990) investigated the use of LASSI to assess cognitive and affective growth of University students after a study strategy course. Result showed that LASSI was significantly predictive of the subjects GPA in regular course.

Trigwell and Prosser (1991) studied the relationship of Approaches to studying and learning outcomes on a sample of 122 first years nursing students and identified a positive relationship between a deep approach and qualitative differences in learning outcome.

Carter (1992) studied the relation of Learning Strategies and Academic Achievement and reported that partially the improved Academic Achievement would be facilitated by the teaching of learning strategies.

Kumar (1994) in his study the Interaction of Approaches to Studying and Achievement Motivation on Achievement in Biology of secondary school pupils found significant main effect of Deep/Surface approaches to study on Achievement in Biology for the total sample. But no significant main effect was found for the sub-sample of boys and girls. The study also revealed that there is no significant main effect of organised/disorganised method of study on Achievement in Biology.

Kumar (1998) studied the impact of Approaches to Studying and Cognitive Style on Achievement in Biology of 700 secondary school pupils. Result indicated that Approaches to Studying has significant main effect on Achievement in Biology.

Hassankoya (2002) studied the influence of learning style, approaches to studying and achievement motivation on achievement in biology of secondary school pupils and found that approaches to studying yielded significant main effect on achievement in biology. The findings also indicated that students differ in their approaches to studying.

Shanmugha Das (2002) studied the interaction effect of learning style, approaches to studying and classroom climate on achievement in Social Sciences of secondary school pupils and found significant main effect of approaches to studying on achievement in Social Sciences (Objective wise and Total score) for the total sample and subsamples of girls, rural, urban and private. But this effect was not found for the subsamples of boys and Government.

***Studies which revealed no influence of studying approach on learning outcome***

Andre (1987) investigated the study approach used by 118 first year science undergraduates at the University of Papus and found that academic achievement scores did not correlate with study approach scores.

"Approaches to studying and Academic Performance in a Traditional Psychology Course" was conducted by Provost and Bond (1997) by administering a short version of the Approaches to studying Inventory on 169 college psychology students in early semester. The findings revealed that scores for meaning orientation did not predict academic performance in any way, where as there was a very small negative correlation between reproducing orientation and academic achievement.

**2.2.2.2. Studies comparing different types of Studying Approaches**

In a study Biggs (1987) found out that there are three main approaches to studying viz. deep approach, surface approach and achieving approach.

Ramsden (1988) in a study reported that if students are taught separate study skills through study skill courses they are able to adopt a surface approach more strategically.

In a study, Harper and Kember (1989) factor analysed the data from Approach to studying Inventory and reported that students who score highly on the surface approach factor probably show a negative learning outcome and students who score high on the deep approach factor show a deep outcome which result from deep processing.

The study conducted by Ramsden *et al.*, (1989) revealed that examination performances are negatively correlated with surface approach and positively but very weakly correlated with deep approach of studying.

Stiernborg (1997) conducted a study on nursing students' approaches to studying. The purposes of the study was to ascertain the orientations to studying. The approaches to study inventory was completed by 316 of a sample of 473 Australian nursing students. The findings supported two orientations to study: meaning (deep learning) and reproducing (surface learning) and lack of change in orientation from the first to the third year suggested a need to nurture deep level learning

A study conducted by Hambleton *et al.* (1998) dealt with improving student learning using Personalised System of Instruction. College mathematics and computer science students in two math courses (conventional lecture based, and a multimedia variant of the personalized system of instruction) were asked to compete the approaches to studying inventory. The results showed that students in the latter course obtained higher scores on meaning orientation and the effect was significant in computer science students and in mathematics students only when using a between subject comparison.

Heinstrom (2003) studied the influence of personality traits and approaches to studying on students information seeking behaviour with a specific focus on use of Information Technology. Three information seeking patterns emerged from analyses of 305 college students. 'Fast surfers, Board Scanners and Deep Divers'. Findings point to the importance of customizing information services to meet individual needs.

Macbean (2004) investigated whether students approaches to studying their main honours degree subject differs from how they approach studying mathematics as a service subject. Two groups of students from different subject disciplines took part in the study enabling a comparison of contexts to be made. The results revealed significant differences between the two groups of students, both in terms of their approaches to studying mathematics and their conceptions of mathematics. No difference was found in their approaches to studying their main degree subject.

Minbashian *et al.* (2004) in their study investigated why a deep approach to studying, which has been shown to result in a higher quality of learning, does not consistently result in higher examination grades. The results showed that the deep study approach was linearly related to the quality of examination responses but quadratically related to the quantity of information reproduced. The use of the deep approach was no more effective in facilitating high examination marks for questions that emphasised understanding of the study material than for questions that emphasised reproduction of it. These findings suggest that students who use high levels of the deep approach fail to consistently achieve higher examination grades because of deficiencies in the quality of their responses, rather than because of the insensitivity of examinations to students understanding the study material.

Mingthang (2004) undertook a study to identify the constructs in Approaches to studying in a Malaysian higher education context by using factor analysis. The study was undertaken in a Malaysian Public University and the subjects of the study were distance learners and on campus learners from three disciplines: social sciences, sciences and business administration. A questionnaire comprising items taken mainly from the Revised Approaches to Studying Inventory (RASI) was used. The results indicated the presence of the two main orientations to studying (a meaning orientation and a reproducing orientation) in the Malaysian distance and on-campus learners.

Elias (2005) examined the way in which students approach studying introductory accounting courses. In general he found that GPA and expected course grade were correlated positively with using the deep approach to studying. Compared with other business majors, accounting and non-business majors used more deep and fewer surface approaches to studying. In addition women and students who were more mature and senior employed the deep approach more often than did other students.

Andreou *et al.*, (2006) conducted a study with the purpose to assess the factor structure of an existing measure of students approaches to studying (RASI) in a sample of Greek Undergraduate students, investigating the effects of gender, age, academic discipline and handedness on approaches to studying. The sample consisted of 452 undergraduate students from a medium sized university in Greece. A factor analysis of 30 item version of RASI indicated 5 factors; surface approach, strategic approach, deep approach, meta cognitive awareness and academic self-confidence. Mixed design analysis of variance (MANOVA) was computed for each of the scales of RASI. The results of the MANOVAs showed statistically significant main effects for sex on strategic approach and faculty on academic self-confidence. There was a statistically significant two-way interaction of sex and handedness on strategic approach, and a three-way interaction of sex x age x faculty on deep approach.

Wilding *et al.* (2006) in their study investigated factors contributing to the choice of preferred study approach at university and relations between these factors and academic performance. Consistent relations were found between general life goals and approaches to studying, with the deep approach being associated with altruistic life goals and the surface approach being associated with wealth and status life goals. The achieving approach was related to both types of life goal, but more strongly to wealth and status life goals. Study approaches became more surface oriented and less deep and achieving oriented over the first year of study, but these changes were unrelated to academic performance. Conclusions of the study are as follows.

(i) Approaches to studying formed part of a wider approach to life in general

(ii) Students adopting the achieving approach to studying performed better.

(iii) Though the achieving approach tended to weaken as the course proceeded, this change was unrelated to performance.

**2.2.2.3. Studies conducted in the field of Distance Education / Adult education**

Gordon (1992) conducted a study to analyse the construct of 'deep' and 'surface' approaches to study using a sample of 1,843 distance education students. The results of the study indicated that students were memorizing within a deep approach and noted the absence of 'questioning' from deep approach sub scale. The study pointed to somewhat different meaning of 'deep approach' than had previously been perceived. The findings gave rise to questions and potential concerns about the curriculum, teaching methods and assessment regimes experienced by these students and the nature of distance learning context and how this context was constructed by distance learners.

Hayes (1997) investigated the approaches to learning of adult students in nine United Kingdom Colleges of further education. Findings of this study revealed a significant difference in approaches to learning of adult students and traditional students. Results suggested that adult education courses may inculcate an educational culture inconsistent with the dominant culture in mainstream higher education

Richardson (1999) in his study investigated the study approaches of students in upper-division distance learning courses at Britain's open university. He found that study approaches of upper-division students were affected by background variables and were more closely related to the avowed aims of higher education than to those found among lower-division distance education students.

Richardson *et al.* (2002) administered an adapted Course Experience Questionnaire (CEQ) and Approaches to Studying Inventory (ASI) to Open University students in U.K. They found that approaches to studying in distance education are strongly associated with students perceptions of the academic quality of their courses.

#### 2.2.2.4. Studies Conducted on Deaf Students

Richardson *et al.*, (2000) in their study compared 144 deaf and 121 hearing college students on the Approaches to studying Inventory. It was found that the impact of deafness was relatively slight. Discriminant analysis indicated deaf students, especially those who preferred sign communication had more difficulty in relating ideas on different topics although they were more likely to adopt a critical approach and analyse a topic's internal structure.

Richardson *et al.*, (2001) examined approaches to studying among deaf distance education students in Briton who preferred either sign language or spoken language. Findings included that deaf students seemed just as capable as hearing students of adopting a meaning orientation and that there were no differences in approaches to studying related to students preferred mode of communication.

#### 2.2.2.5. Studies analysing determinants of Studying Approach

Abouserie (1995) conducted a study of 135 undergraduate students on self-esteem and achievement motivation as determinants of students approaches to studying. The findings of the study suggests that students' personality traits in general, and their self-esteem and achievement motivation in particular, had a substantial influence on their approaches to study and to levels of knowledge processing.

### 2.2.2.6. Studies showing Cultural Effects on Studying Approach

The study of "Cultural specificity of approaches to studying in Higher Education" (Richardson, 1994) suggested that these vary systematically from one culture to another. The study distinguished two common orientations: comprehension of meaning of learning materials, and reproduction of them. It also suggested that while former was consistent and coherent, the latter fragmented and varied according to cultural context.

A study conducted by Watkins and Regmi (1996) involving 302 Nepalese undergraduates supported the cross-cultural validity of the Approaches to Studying Inventory (ASI) and provided evidence of meaningful learning process underlying ASI responses. It was found that self-esteem correlated significantly with a more versatile approach to learning.

### 2.2.2.7. Studies showing Gender Variation on Studying Approach

Richardson (1993) conducted two studies using different forms of the Approaches of Studying Inventory to investigate possible gender variation in approaches to studying. No consistent evidence of significant difference between men and women on individual items, subscales or learning orientations was found.

In an investigation done by Hayes and Richardson (1995) approaches to studying were measured in male and female students taking Arts and Sciences degree at three British Colleges. It was found that students taking science courses had greater reproducing orientation than those in arts courses. Females had greater meaning orientation in arts courses taken in a "female" learning environment and when taking science courses in a "male environment.

Rogers and Hallam (2006) explored gender differences in approaches to studying for GCSE among high achieving pupils. The sample comprised 310 tenth and eleventh grade pupils from two single-sex schools. Pupils completed a self-reported questionnaire designed to assess approaches to studying for GCSE, including statements relating to course work, examinations, research, study strategies and homework. Boys gained a higher score overall in the questionnaire indicating a more effective approach to studying for GCSE. Gender differences were found in approaches to examinations and study but not in approaches to course work. The boys reported doing less homework than the girls. The findings suggest that overall high-achieving boys have better studying strategies than high-achieving girls. Approaches to studying among high achieving girls may be mediated by anxiety that manifests itself in surface approaches to studying for examinations.

### 2.2.2.8. Studies showing the Relation between Studying Approach and Perception of Teaching Strategy/Learning Environment

Entwistle and Tait (1993) made an attempt to explore the relationship between approaches to studying and students preferences for different types of learning environments. The study also examined the relationship with students' evaluations of their courses and the reasons for choosing that course. The findings were:

(i) For failing students there was a substantial incoherence between their approaches to studying and their patterns of preference for different kinds of teachings and courses.

(ii) Students, who adopted deep or surface approaches to studying also preferred methods of teaching and assessing that encouraged their own approaches to learning.

(iii) Students are likely to rate and define good teaching differently based on their approaches to studying.

Tait and Entwistle (1995) drawing on a number of studies of college student learning, reported that students in different disciplines develop characteristic ways of learning based on their perceptions of what is required in their academic work. They suggested that within a discipline, effective learning involves an inter play between the characteristics of the student and the learning environment provided by teacher and department.

Pimparyon *et al.* (2000) in a study examined the relationship among student's approaches to learning, their perceptions of educational environment and their Academic Achievement. The study used the Approaches to Studying Questionnaire (S-ASQ) and reported on the usefulness of using this instrument as a diagnostic measurement tool to enhance learning outcomes at a health care professions institution.

Karaquannopoulou *et al.* (2005) investigated the relationship between university students' perceptions of their academic environment, their approaches to studying and academic outcomes. The factor analysis gave two factors which reflect the deep and surface approach to studying. There was a pattern of relationship between deep approach, perceptions of the learning environment which encourage this approach and outcomes.

Richardson (2005) in his study attempted to demonstrate a relationship between students approaches to studying in higher education and their perceptions of their academic context. The extended version of the course Experience Questionnaire (CEQ) and the Revised Approaches to Studying Inventory (RASI) were adapted for the study. The tools were administered to students taking seven courses by distance learning with the open university of U.K. Usable responses were obtained from over 2100 students. Results showed that students perceptions of the academic quality of courses in distance education are strongly associated with the approaches to studying that they adopt in those courses.

Struyven *et al.* (2006) in their study investigated the effects of the learning/teaching environment on students approaches to learning and compared a lecture based to a student activating setting within the first year of elementary teacher education. Results showed that though students approaches were similar at the start of the course, a clear distinction was found after experiencing the lecture based and student activity teaching/learning environments. However the direction of the change was opposite to the premise that student activating instruction deepens student learning. Instead, the latter pushed students towards a surface approach to learning and students strategic approaches suffered significant lowering.

Mimirinis and Bhattacharya (2007) conducted a study with an aim to explore the relationship between approaches to learning and studying and perceptions of use of a Visual Learning Environment (VLE) in a higher education taught module. Results showed relationship between approaches to learning and studying and use of VLE. Recommendation were aiming to highlight the importance of specific elements in the design and delivery of online courses though VLEs. Reflection, Inquiry Analysis and Synthesis are key characteristics which play a crucial role in the demonstration of desirable approaches to learning in an online context.

**A Summary of Studies on Studying Approach**

***1. Studies related to Studying Approach and Learning Outcome/ Academic Achievement***

| *Sl. No.* | *Author* | *Variables* | *Result* |
|---|---|---|---|
| **Positive influence** | | | |
| 1. | Hattie and Watkins (1988) | Approach to learning, Classroom environment | Positive relationship between learning strategies and learning outcomes |
| 2. | Pokay (1988) | Learning strategy, motivation, Academic Achievement | Motivation and learning strategy influenced performance of high and low achievers |
| 3. | Nist (1990) | Studying Approach, Academic Achievement | Positive relationship |
| 4. | Trigwell and Prosser (1991) | Approaches to studying, learning outcome | Positive relationship |
| 5. | Carter (1992) | Learning strategy, Academic Achievement | Teaching of learning strategies facilitated Academic Achievement |

| *Sl. No.* | *Author* | *Variables* | *Result* |
|---|---|---|---|
| 6. | Kumar (1994) | Approaches to Studying, Achievement Motivation, Achievement in Biology | Significant effect of independent variables on Achievement in Biology |
| 7. | Kumar (1998) | Approaches to studying, Cognitive style, Achievement in Biology | Significant effect of Approaches to Studying on Achievement in Biology |
| 8. | Hassankoya (2002) | Approaches to Studying, Learning style, Achievement motivation, Achievement in Biology | -do- |
| 9. | Shanmughadas (2002) | Approaches to Studying, Learning Style, Classroom Climate, Achievement in Social Science | -do- |
| **No influence** | | | |
| 10. | Andre (1987) | Study Approach, Academic Achievement | No correlation between Study Approach and Academic Achievement |
| 11 | Provost and Bond (1997) | Approaches to Studying, Academic Performance | No correlation between meaning orientation and Academic Achievement, very small negative correlation between reproducing orientation and academic achievement |

**2. *Studies comparing different types of Studying Approaches***

| *Sl. No.* | *Author* | *Variables* | *Result* |
|---|---|---|---|
| 12. | Biggs (1987) | Studying Approaches | There are three main approaches to studying viz., deep approach, surface approach and achieving approach |
| 13. | Ramsden (1988) | Studying Approaches, Study Skills | Teaching of study skills help students to adopt Surface Approach more strategically. |
| 14. | Harper and Kember (1989) | Studying Approaches, learning outcome | Students having Surface Approach show negative learning outcome, students having deep approach show positive learning outcome. |
| 15. | Ramsden *et al.* (1989) | Studying Approaches, examination performance | Examination performance negatively correlated with surface approach and positively but very weakly correlated with deep approach |
| 16. | Stiernborg (1997) | Approaches to Studying | There are two orientations to study: meaning (deep learning) and reproducing (surface learning). |

| Sl. No. | Author | Variables | Result |
|---|---|---|---|
| 17. | Hambleton *et al.* (1998) | Studying Approach, Personalised System of Instruction, lecture method | Studies in P.S.I. obtained higher scores on meaning orientation. |
| 18. | Heinstrom (2003) | Personality traits, Approaches to studying, Information seeking behaviour of students | There are three information seeking patterns: Fast surfers, Board scanners and Deep divers. |
| 19. | Macbean (2004) | Approaches to Studying Optional subject of degree course | Significant difference between optional groups in terms of approaches to studying, service subject but no difference in approaches to studying main degree subject |
| 20. | Minbashian *et al.* (2004) | Studying Approach, Academic Achievement | Deep approach to studying result in higher quality of learning but does not consistently result in higher examination grades. |
| 21. | Mingthang (2004) | Approaches to Studying; optional disciplines | Indicated the presence of two main orientations to studying; meaning orientation and reproducing orientation. |

| *Sl. No.* | *Author* | *Variables* | *Result* |
|---|---|---|---|
| 22. | Elias (2005) | Studying Approach, Academic Performance, Optional subjects. | GPA and expected course grade positively correlated with deep approach |

***3. Studies conducted in the field of distance education / adult education***

| *Sl. No.* | *Author* | *Variables* | *Result* |
|---|---|---|---|
| 23. | Gordon (1992) | Studying Approaches | Students were memorizing within a deep approach, absence of 'questioning' from deep approach subscale was noted. |
| 24. | Hayes (1997) | Approaches to learning | Significant difference in approaches to learning of adult students and traditional students. |
| 25. | Richardson (1999) | Study Approaches | Study Approaches of upper division students affected by background variables than that of lower division students |
| 26. | Richardson *et al.* (2002) | Approaches to Studying, Course Experience | Approaches to Studying strongly associated with student's perceptions of academic quality of courses. |

### 4. *Studies conducted on Deaf Students*

| *Sl. No.* | *Author* | *Variables* | *Result* |
|---|---|---|---|
| 27. | Richardson *et al.* (2000) | Studying Approach Deafness | Impact of deafness on Studying Approach relatively slight. |
| 28. | Richardson *et al.* (2001) | -do- | No impact of deafness on Studying Approaches. |

### 5. *Studies analysing Determinants of Studying Approach*

| *Sl. No.* | *Author* | *Variables* | *Result* |
|---|---|---|---|
| 29. | Abouserie (1995) | Approaches to Studying, Self-esteem, Achievement Motivation | Student's personality in general and self-esteem and Achievement Motivation in particular had a substantial influence on their Studying Approaches. |
| 30. | Andreou *et al.* (2006) | Approaches to Studying, gender, age, academic discipline, handedness. | Significant main effects and interaction effects of the variables on deep approach and strategic approach |
| 31. | Wilding *et al.* (2006) | Studying approach, life goals, academic performance | Consistent relations between general life goals and |

| Sl. No. | Author | Variables | Result |
|---|---|---|---|
| | | | approaches to studying, Students adopting achieving approach to studying performed better. |
| 32. | Richardson (1994) | Studying Approach, Cultural context | Studying Approaches vary systematically from one culture to another. |
| 33. | Watkins and Regmi (1996) | Studying Approach, Cultural Content | Supported cross-cultural validity of Approaches to Studying Inventory (ASI). |

7. ***Studies showing Gender Variation on Studying Approaches***

| Sl. No. | Author | Variables | Result |
|---|---|---|---|
| 34. | Richardson (1993) | Approaches to Studying, Gender | No significant difference in approaches to studying among men and women |
| 35. | Hayes and Richardson (1995) | Approaches to Studying, Gender, Optional Subjects | Science students had greater reproducing orientation than art students, females had greater meaning orientation in arts courses taken in a 'female' learning |

| *Sl. No.* | *Author* | *Variables* | *Result* |
|---|---|---|---|
| | | | environment and when taking science courses in a 'male' environment. |
| 36. | Rogers and Hallan (2006) | Approaches to Studying, Gender | Gender differences in approaches to examinations and study but not in approaches to course work. |

***8. Studies showing the relation between Studying Approach and Perception of Teaching Strategy / Learning environment***

| *Sl. No.* | *Author* | *Variables* | *Result* |
|---|---|---|---|
| 37. | Entwistle and Tait (1993) | Approaches to studying preference for learning environment | Positive relationship |
| 38. | Tait and Entwistle (1995) | Approaches to studying, perceptions of learning environment | -do- |
| 39, | Pimparyon *et al.* (2000) | Approaches to learning, Perception of educational environment, Academic achievement. | -do- |
| 38. | Karaquannopoulou *et al.* (2005) | Approaches to studying, perceptions of academic environment | -do- |
| 38. | Richardson (2005) | -do- | -do- |

| *Sl. No.* | *Author* | *Variables* | *Result* |
|---|---|---|---|
| 39. | Struyven *et al.* (2006) | Approaches to learning, teaching/ learning environment | -do- |
| 40. | Mimirinis and Bhattacharya (2007) | Approaches to Studying, Perception of Visual Learning Environment (VLE) | -do- |

## CONCLUSION

Survey of the literature relating to Concept Attainment Model shows that there is a rich base of empirical research incorporating Concept Attainment Model as a method of teaching developing teacher efficiency and academic skills and improving student performance especially for elementary and secondary school students. An analysis of the literature reviewed reveals the following.

Concept Attainment Model is helpful in improving the achievement of the learner. Almost all the studies were conducted in India and a few studies in other developing countries. Out of the research studies many studies show positive effect of Concept Attainment Model on the academic achievement of the subjects but some studies do not show any significant gain from the programme. Several studies revealed that influence of Concept Attainment Model on teaching competence of the learner. The investigator could identify only a few studies in the Kerala context these studies were about the comparison of different models of teaching and their effect on achievement. The remaining studies were all carried out in the north Indian context and foreign countries.

Survey of the literature relating to studying Approach shows that a large number of studies and research have been done on studying approach and related variables especially in United Kingdom and other developed countries. A few studies were conducted in Malaysia and India. Out of the research studies many studies show relation between studying approach and student performance.

Several studies investigated the factors influencing the selection of a particular studying approach by students. A few studies analysed the gender differences in studying approaches by learners. Several studies investigated the relation between studying approach and perception of teaching strategy/learning environment by the student. Most of the studies in foreign countries were conducted on samples of undergraduate and higher education students. A few studies were conducted on Open University students and deaf students.

Out of the studies located, the investigator could find only seven studies showing relationship between studying approaches and perception of teaching/learning environment. Most of these studies were conducted in Britain and other developed countries.

Studies reviewed mostly indicate that Concept Attainment Model is helpful in improving the academic achievement of the learner. Review of related studies also indicated that studying approaches significantly influence the examination performance of the learner. Most of the studies on Concept Attainment Model and Achievement yielded achievement benefits to the sample studied. But some studies indicated no achievements benefits when compared to other teaching strategies. In the case of studying Approaches majority of studies yielded a strong positive influence. At the same time some studies found no relation of Studying Approach with learning outcome. In short the over all research findings with regard to Concept Attainment Model and Studying Approaches with Academic Achievement are not conclusive in nature. The investigator could not locate any study showing the combined effect of concept Attainment Model and Studying Approach on Achievement.

Curriculum offered for general education in Kerala is fixed and overloaded. Activity oriented method of instruction has been implemented recently but in a rigid organisational school set-up. In the curriculum transaction a fixed duration for each subject is recommended with a uniform standard of evaluation using a common textbook and learning materials. Necessity of empirical studies on modern techniques of teaching especially methods like Concept Attainment Model of teaching is therefore felt imperative by the investigator. The investigator also felt the necessity of studying how the studying approach of the learner and the teaching method will jointly influence the academic achievement of the learner.

Considering the above points the investigator proceeded with the objective of studying "INTERACTION EFFECT OF CONCEPT ATTAINMENT MODEL OF TEACHING AND STUDYING APPROACH ON ACHIEVEMENT IN PHYSICS OF SECONDARY SCHOOL STUDENTS'.

I

# INTERACTION EFFECT OF CONCEPT ATTAINMENT MODEL OF TEACHING AND STUDYING APPROACH ON ACHIEVEMENT IN PHYSICS OF SECONDARY SCHOOL STUDENTS

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*in Education*

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2007

CHAPTER 3

# METHODOLOGY

- *Selection of Variables*
- *Objectives*
- *Hypotheses*
- *Procedure*

# METHODOLOGY

The methodology followed at the various phases of the investigation is described in this chapter and is presented under the following sections.

3.1 SELECTION OF VARIABLES

3.2 OBJECTIVES

3.3 HYPOTHESES

3.4 PROCEDURE

## 3.1 SELECTION OF VARIABLES

The review of related studies provided the investigator a clear idea of the theoretical outline of Concept Attainment Model of Teaching and Studying Approach. It helped the investigator to identify the independent variables, the dependent variable and the variables to be controlled. The methods of teaching and the studying approach of the learner are directly related to academic achievement. The academic achievement of the learner is also influenced by his/her intelligence and previous knowledge of the subject matter. In order to find out the exact effect of methods of teaching and studying approach on academic achievement, the effect of these variables should be controlled. Considering all the above points, variables which are related to achievement in physics were selected and categorised for the study. A brief description of the variables selected for the study is given below.

### 3.1.1. Independent Variables

Two sets of variables based on methods and paradigms of teaching and a set of variables based on studying approaches were selected as independent variables.

The independent variables based on teaching paradigms are the two methods of teaching. They are as follows:

(i) Concept Attainment Model of Teaching

(ii) Objective Based Instruction

The independent variables based on approaches to studying are the three studying approaches as given below.

(i) Deep Approach

(ii) Surface Approach

(iii) Strategic Approach

#### 3.1.1.1. Concept Attainment Model of Teaching

Concept Attainment Model is a model of teaching belonging to the information processing family of models. It has been developed based upon the studies made by Bruner and his associates (1967) about the nature of concepts and the strategies of concept formation. It develops the ability of concept formation without any error. According to Siddiqui and Khan (1991), the concept attainment strategy, as a model of teaching, is concerned with two separate but related ideas: the nature of concepts themselves and the thinking process used by individual to learn concepts. Concept Attainment Model has been designed to enrich the students on specific concepts and the nature of concepts. They also provide practice in inductive reasoning and opportunities for altering and improving students' concept-building strategies. Specially with abstract concept, the model makes the learners aware of alternative perspectives, sensitive to logical reasoning in communication and tolerate of ambiguity. Many studies in India and abroad reveal that the concept Attainment Model as an instructional strategy helps in fostering information processing abilities of the learner and helps the slow learners and backward students in getting higher achievement.

**3.1.1.2. Objective Based Instruction**

The second method of instruction used for the study was Objective Based Instruction. It is based on Bloom's Taxonomy of Educational Objectives modified and adopted by National Council of Educational Research and Training. It was one of the methods adopted by

Government of Kerala in the primary and secondary schools and was recommended by Department of Public Instruction.

#### 3.1.1.3. Studying Approach

Studying Approach refers to the individual approach of the students to the tasks prescribed by their course of study. Approaches to studying cover students' motives, conceptions, intensions and their interrelationship to distinct learning outcomes (Marton, 1976). The choice of studying approach is affected by the conditions in which the individuals learn. 'Studying approach' refers to orientation of pupils in studying, into which different strategies of learning and associated forms of motivations are merged (Marton and Saljo, 1976; Svensson, 1977). Measuring students' studying approach had been seen as a means of encouraging a more systematic approach to academic teaching (Katz and Henry, 1988). Tait and Entwistle (1996) had investigated the importance of measurement of studying approaches in identifying students at risk through ineffective study strategies.

### 3.1.2. Dependent Variable

Dependent variable selected for the present study is Achievement in Physics. The focus of the present study was to explore the combined effect of Concept Attainment Model and Studying Approach on Achievement in Physics and retention over a period of time. Achievement in the cognitive domain was only considered for the study. All the categories under cognitive domain were included in the study. The categories are listed below: (i) Knowledge (ii) Comprehension (iii) Application (iv) Analysis (v) Synthesis (vi) Evaluation.

### 3.1.3 Control Variables

Control variables selected for the present study are the following:

(i) Previous Knowledge of the Subject Matter

(ii) Non-Verbal Intelligence

## 3.2. OBJECTIVES

The present investigation was intended to explore whether Achievement in Physics vary when concept Attainment Model of teaching is adopted in conventional classrooms without disturbing very much the usual classroom organisastional set up. The study was therefore designed as a quasi-experimental study. The design adopted was Pre-Test-Post-Test Equivalent Groups design.

'Concept Attainment Model' has been selected as the Experimental Variable. The changes in Achievement in Physics if any have been explored in comparison with 'Objective Based Instruction'. Other variables namely 'Previous Knowledge of the Subject Matter' and 'Non-

Verbal Intelligence' had been treated as Control Variables. One group was treated as Experimental Group, taught through concept Attainment Model only, the second group was treated as Control Group, taught through Objective Based Instruction only.

The objectives formulated for the present investigation are given below.

3.2.1. To compare the mean scores of Achievement in Physics Post-Test I (tested immediately after the treatment) of the Control group and the Experimental group.

3.2.2. To compare the mean Gain scores of Achievement in Physics (Post-Test I minus Pre-Test) of the Control group and the Experimental group.

3.2.3. To compare the mean Retention scores of Achievement in Physics Post-Test II (tested two months after experimentation) of the Control group and Experimental group.

3.2.4. To compare the mean Gains cores of Achievement in Physics (Post-Test II minus Pre-Test) of the Control group and Experimental group.

3.2.5. To compare the mean scores of Achievement in Physics Post-Test I of the groups formed on the basis of Studying Approach.

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3.2.6. To compare the mean Gain Scores of Achievement in Physics Post-Test I (Post-Test I – Pre-Test) of the groups formed on the basis of Studying Approach.

3.2.7. To compare the mean Retention scores of Achievement in Physics Post-Test II of the groups formed on the basis of Studying Approach.

3.2.8. To compare the mean Gain Scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test) of the groups formed on the basis of Studying Approach.

3.2.9. To study the main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test I for total sample, Boys and Girls.

3.2.10. To study the main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test II for Total sample, Boys and Girls.

3.2.11. To study the main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics

Post-Test I for Total sample, Boys and Girls when initial differences in select variables namely Previous Knowledge of Subject Matter and Non-Verbal Intelligence are controlled one by one and in combination.

3.2.12. To study the main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test II for Total sample, Boys and Girls when initial differences in select variables namely Previous Knowledge of Subject Matter and Non-Verbal Intelligence are controlled one by one and in combination.

## 3.3. HYPOTHESES

The hypotheses formulated and tested for the study are the following:

3.3.1. There will be significant difference in the mean scores of Achievement in Physics Post-Test I (tested immediately after the treatment) between Control group and Experimental group.

3.3.2. There will be significant difference in the mean Gain scores of Achievement in Physics (Post-Test I minus Pre-Test) between Control group and Experimental group.

3.3.3. There will be significant difference in the mean Retention scores of Achievement in Physics Post-Test II (tested two months after the treatment) between Control group and Experimental group.

3.3.4. There will be significant difference in the mean Gain scores of Achievement in Physics (Post-Test II minus Pre-Test) between Control group and Experimental group.

3.3.5. Students having Deep Approach to studying, Surface Approach to Studying and Strategic Approach to Studying will have significant difference in their mean scores of Achievement in Physics in Post-Test I.

3.3.6. Students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying will have significant difference in their mean Gain Scores of Achievement in Physics Post-Test I (Post-Test I minus Pre-Test).

3.3.7. Students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying will have significant difference in their mean Retention scores of Achievement in Physics Post-Test II.

3.3.8. Students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying will have significant difference in their mean Gain scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test).

3.3.9. There will be significant main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test I for Total sample, Boys and Girls.

3.3.10. There will be significant main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test II for Total sample, Boys and Girls.

3.3.11. There will be significant main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test I for Total sample, Boys and Girls when initial differences in select variables namely Previous Knowledge of Subject Matter and Non-Verbal Intelligence are controlled one by one and in combination.

3.3.12. There will be significant main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in

Physics Post-Test II for Total sample, Boys and Girls when initial differences in select variables namely Previous Knowledge of Subject Matter and Non-Verbal Intelligence are controlled one by one and in combination.

## 3.4. PROCEDURE

The research design adopted for the study, procedure of selection of sample, conduct of experimentation, data collection procedure and techniques used for processing the data are described in this section.

### 3.4.1. The Research Design

The experimental design used in this study was Pre-Test – Post-Test Equivalent Groups Design. The design is illustrated as follows:

$G_1$ $O_1$ X $O_2$

$G_2$ $O_3$ C $O_4$

$O_1$, $O_3$ - Pre test

$O_2$, $O_4$ - Post test

$$\left.\begin{matrix} O_2 - O_1 \\ O_4 - O_3 \end{matrix}\right\} \text{Gain Score}$$

$G_1$ – Experimental Group

$G_2$ – Control Group

X – Application of the Experimental Treatment

C – Application of the Control Treatment

#### 3.4.1.1. Sample of the Study

The population of the present study covers the secondary school students of Kerala. But the investigator decided to confine the study to students of standard IX since they can be considered as representatives of secondary school students. Care was taken to ensure that the subjects selected were equivalent in many respects. It was decided to select a co-educational school for the present study. It was also ensured that almost equal number of boys and girls were included in the sample. Instructional efficiency of the school was ascertained on the basis of the examination results of the previous years in the common Secondary School Leaving Certificate examination. For the smooth conduct of the experiment and for practical reasons it was decided to select a school from urban area. It was also ensured that the school is easily accessible and amenable for the conduct of the experiment. Based on these criteria, a school from the Palakkad district was selected for the present study. The school selected was N.S.S.K.P.T.H.S.S. Ottappalam.

Assuming that each class of the select school consists of approximately forty-five students, two English medium class divisions were selected. It was also decided to select the sample for the experiment consisting of ninety students (forty-five students were treated as experimental group and forty-five students were treated as control group).

The actual number of sample in each group at the entry stage of the experiment is shown in the following breakup.

| | Experimental Group | Control Group | Total |
|---|---|---|---|
| Boys | 22 | 22 | 44 |
| Girls | 23 | 23 | 46 |
| Total | 45 | 45 | 90 |

### 3.4.1.2. Allocation of Experimental Group and Control Group

It would be difficult to carry out an experimental study on a large sample. Since the random assignment to subjects in Experimental and Control groups will not be plausible in an organised set up of the schools and to get a more natural setting for the conduct of the study it was decided to select intact class groups. Two classes were therefore considered as the unit of study. The Experimental and Control groups were randomly selected by taking a lot.

### 3.4.1.3. Selection of the Topic for Treatment

The investigator carefully examined the syllabus and text books on Physics prescribed for the secondary schools of Kerala. It was felt that topics which require mastery of basic essential concepts that have carry over value, are worthwhile for experimentation. The investigator consulted subject experts of Teacher Education Institutions, SCERT and Physics teachers of secondary level for this purpose. A number of topics from the basic units in the Physics syllabus of Secondary School Students of Kerala State were found amenable for Concept Attainment Model of Teaching and Objective Based Instruction. It had been pointed out that nine basic subunits in the secondary school Physics text books of Kerala syllabus are having maximum application in day-to-day life and linkage with other subjects. These sub units are listed below:

(i) Light

(ii) Force

(iii) Gravitation

(iv) Motion

(v) Work and Energy

(vi) Fluids

(vii) Sound

(viii) Magnetism and Electricity

(ix) Heat

The investigator could identify a number of topics from these basic subunits amenable for Concept Attainment Model of Teaching and

Objective Based Instruction. Due to constrain in time thirty topics were altogether selected finally for the present study. Details of the selected topics are given in the following break-up.

| Sl. No. | Topic selected | Basic Sub unit |
|---|---|---|
| 1. | Scattering of light | Light |
| 2. | Dispersion of light | |
| 3. | Fluorescence | |
| 4. | Force | Force |
| 5. | Momentum | |
| 6. | Inertia of rest and Inertia of motion | |
| 7. | Action and Reaction | |
| 8. | Impulsive force and Impulse | |
| 9. | Frictional force | |
| 10. | Gravitational force | Gravitation |
| 11. | Acceleration due to gravity | |
| 12. | Mass and weight | |
| 13. | Uniform Circular Motion | Motion |
| 14. | Centripetal force and Centrifugal force | |
| 15. | Work and Energy | Work and Energy |
| 16. | Kinetic Energy and Potential Energy | |
| 17. | Viscosity | Fluids |
| 18. | Surface Tension | |
| 19. | Cohesion and Adhesion | |
| 20. | Capillarity | |
| 21. | Density and relative density | |
| 22. | Transverse wave and Longitudinal wave | Sound |
| 23. | Sound | |
| 24. | Sources of Sound | |
| 25. | Resonance | |
| 26. | Electrostatic force and Magnetic force | Magnetism and Electricity |
| 27. | Magnetic Induction | |
| 28. | Conductors and Insulators | |
| 29. | Change of state and latent heat | Heat |
| 30. | Evaporation | |

### 3.4.1.4. Preparation of Instructional Materials

The investigator prepared separate instructional materials for Experimental and Control Groups for topics selected for treatment.

#### 3.4.1.4.1. Lesson Transcripts for Concept Attainment Model

*A. Planning of lesson formats*

The investigator prepared lesson transcripts for Concept Attainment Model as per the suggestions of Joyce and Weil (1992). Thirty lesson transcripts for Concept Attainment Model have been prepared for thirty periods each of forty five minutes duration. The topic selected and the specific objectives set for each learning unit is the same for the Experimental and Control Treatments. In each Lesson Transcript there are three consecutive phases.

***Phase One : Presentation of Data and Identification of Concept***

Labelled examples will be presented to the students. Students will compare attributes in positive and negative examples and will generate and test hypotheses. Finally they will arrive at a definition of the concept according to the essential attributes.

***Phase two : Testing Attainment of the Concept***

Here students are supposed to identify additional unlabelled examples as 'Yes' or 'No'. Teacher will confirm hypotheses, name concept and will restate definitions according to essential attributes. Finally students will generate examples.

***Phase three : Analysis of Thinking Strategies***

Here students will describe their thought process in analysing the examples and non examples. They will discuss the role of hypotheses and attributes. They will discuss the type and number of hypotheses.

***B. Try out***

Three lesson plans were prepared initially for try out. It was decided to try out the lesson plans to ensure the time required for the completion of teaching that topic covering all the phases of teaching. The difficulties faced while implementing this method in the usual classroom set-up was noted. The concerned Physics teacher for that class and an expert in the field of Physics education were also present as observers throughout the classes during try out. Based on the reactions and responses by the students and the opinions of teachers observations were noticed. The lesson formats were further scrutinised and revised by the investigator based on the suggestions and observations. Slight modifications were made on the lesson plans. These lesson plans were again scrutinised by experts in Physics and the supervising teacher. Thus lesson plans for Concept Attainment Model were finalised. Two lesson plans based on Concept Attainment Model together with the format for observation lesson is presented as Appendix IA, IB and IC respectively.

### 3.4.1.4.2. Lesson Transcripts for Objective Based Instruction

For Control group thirty lesson plans were prepared on the basis of Instructional Objectives of Bloom's Taxonomy adopted by NCERT. For this purpose the content was thoroughly analysed on the basis of the objectives that are to be attained in the cognitive domain. These objectives were again analysed into observable and measurable behavioural changes (spcifications) that are to be taken place in the learner. These specifications acted as the basis for planning lessons for control group. The terminal behaviours were then identified and written as instructional objectives. Based on the blue print of the lesson format, lessons were prepared.

The format of Objective Based Instruction is given below.

*Preparation*

- Reviewing the previous knowledge.
- Motivating the learner to learn the new ideas.
- Why he/she is going to learn these ideas.

*Presentation*

- Presenting the new materials.
- Providing provisions for students for activity.
- Active participation of students.
- Evaluation at appropriate time.

*Application*

- Applying the newly learned content or skill in different situation.

*Reviewing and Assignments*

- Reviewing newly learned materials.
- Drill work and home assignments.

Two sample lesson plans are given as Appendix IIA and IIB.

### 3.4.1.5. Studying Approach Inventory

A Studying Approach Inventory was prepared and standardised by the investigator.

#### *3.4.1.5.1. Construction and Standardisation of Studying Approach Inventory*

Research work on Studying Approach identified a number of different Studying Approaches employed by students. Two studying approaches – deep approach and surface approach – was identified by

Marton and Saljo (1976) and Svensson (1977). Deep approach is based on intrinsic motivation, learning with an aim to understand the material presented. Surface approach is based on extrinsic motivation, learning as rote memorization and an aim to achieve only course requirements. Some research studies described another approach to learning related to the competitive form of motivation. This approach was described as Achieving by Biggs (1979) and Strategic Approach by Ramsden (1981). Strategic Approach involves an intention to obtain highest possible marks by strategic management of time and efforts. According to Valet and Chalmere (1992) it refers to shifts between Deep and Surface Approaches.

Measuring student's studying approach has been seen as a means of observing the outcomes (Biggs and Collins, 1982) and experience of learning (Marton *et al.*, 1984) and for evaluating the quality of student learning (Meyer and Muller, 1990). A number of tools for assessing Studying Approach have been developed by various researchers.

For constructing this tool, the investigator analysed a number of important Studying Approach Inventories like ASI, RASI, LASSI, ETLQ, LSQ and the like. After a thorough analysis of theoretical constructs three approaches were selected for the study. The selected studying approaches are given below: (i) the deep approach (ii) the surface approach (iii) the strategic approach.

After a thorough analysis and consultation with experts, a number of items were pooled under each studying approach sub-scale. The core components of each category of studying approaches and corresponding activities were analysed thoroughly and the items in the inventory were prepared in accordance. The inventory was distributed to subject experts and their suggestions were taken into account. Incorporating all the necessary factors, and after thorough scrutiny 58 items were finally taken for the draft version of the Studying Approach Inventory. Out of these 58 items 20 items comes under deep approach subscale, 18 items under surface approach subscale and 20 items under strategic approach subscale.

The detailed description of the studying approach inventory is given in the following sections.

**The Deep Approach Sub Scale**

The core aspect of a fully developed deep approach is the intention to form a personal understanding of the topic under study. This is then combined with a range of conceptually related learning processes. The elements of the Deep Approach to Studying are listed below:

(i) Intention to understand.

(ii) Active interest and personal engagement

(iii) Relating ideas

(iv) Gaining an overview

(v) Creating outlines and structures

(vi) Questioning and using evidence critically.

(vii) Seeking the central point

(viii) Drawing conclusions

(ix) Seeking the purpose of a task or seeing it in its wider context.

These elements can be categorised into four basic categories as follows:

(i) Seeking meaning

(ii) Relating and organizing ideas

(iii) Using evidence and logic

(iv) Interest in ideas.

The twenty items that make up the deep approach sub scale of the studying approach inventory relate to the above four categories. The illustrative items under each category are given in the following break-up.

| Sl. No. | Item No. | Item Statement | Basic element |
|---|---|---|---|
| 1 | 1 | While studying, I try to find out for myself the meaning of the prescribed lessons. | Seeking meaning |
| 2 | 50 | I try to relate the learning materials with other topics studied | Relating and organising ideas |
| 3 | 4 | I like to analyse the reason behind things | Using evidence and logic |
| 4 | 29 | While reading a text book I think a lot about ideas presented in them | Interest in ideas |

**The Surface Approach Sub-scale**

The surface approach refers to a type of ineffective studying method. The major factor identified with surface approach is 'lack of purpose'. It is also called 'surface apathetic'. This approach brings together syllabus boundedness and lack of understanding with both lack of purpose and fear of failure. The elements of the surface approach to studying are listed below.

(i) memorising without understanding.

(ii) unreflective studying

(iii) fragmented knowledge

(iv) unthinking acceptance

(v) lack of purpose

(vi) syllabus boundedness

(vii) fear of failure.

These elements can be categorised into four basic categories as follows:

(i) Lack of purpose.

(ii) Unrelated memorising.

(iii) Syllabus boundedness

(iv) Fear of failure

The eighteen items that make up the surface approach subscale of the studying approach inventory relate to relying on memorisation, difficulty in making sense, unrelatedness and concern about coping. The illustrative items under each category are given in the following break-up.

| Sl. No. | Item No. | Item Statement | Basic element |
|---|---|---|---|
| 1 | 37 | I wonder what prompted me to go to school | Lack of purpose |
| 2 | 17 | While studying I can easily remember bits and pieces but cannot present it as a whole concept | Unrelated memorising |
| 3 | 23 | I like teachers to give guidelines while assigning the projects or duties | Syllabus boundedness |
| 4 | 52 | I am anxious whether I will be able to attain the expected standard while doing the assigned work | Fear of failure |

**The Strategic Approach Subscale**

The strategic approach to studying include an aspect of meta cognition and self regulation – monitoring effectiveness. Achievement motivation is strongly associated with the organized studying and time management. Determination to excel and alertness to assessment demands are the basic characteristics of strategic approach. Elements of Strategic Approach to Studying are listed below:

(i) Monitoring study effectiveness

(ii) Monitoring understanding

(iii) Monitoring generic skills

(iv) Study organisation

(v) Time management

(vi) Effort management

(vii) Achievement Motivation

(viii) Alertness to assessment demands.

These elements can be categorised into five basic categories as follows:

(i) Organised studying

(ii) Time management

(iii) Alertness to Assessment demands

(iv) Achievement motivation

(v) Monitoring effectiveness

The twenty items that make-up the Strategic Approach subscale of the Studying Approach Inventory relate to the above five basic categories. The illustrative items under each category are given in the following break-up.

| Sl. No. | Item No. | Item Statement | Basic element |
|---|---|---|---|
| 1 | 42 | I am in the habit of planning my work in advance | Organized studying |
| 2 | 25 | I follow a time table while revising for examinations | Time management |
| 3 | 28 | While writing an assignment, I try to incorporate the viewpoints of the teacher who is going to value it | Alertness to assessment demands |
| 4 | 34 | I study really hard because I am determined to do well. | Achievement motivation |
| 5 | 20 | I am in the habit of going over my work again and again to find out whether there are any mistakes. | Monitoring Effectiveness. |

### 3.4.1.5.2. Administration and Scoring

The draft version of Studying Approach Inventory was administered on a stratified sample of four hundred students. A separate response sheet was given for answering. A covering letter with instructions for answering the items were given along with it. The inventory was prepared on a three point scale 'Agree', 'Disagree' and 'Not sure' with scores 2, 1, 0 respectively. The draft version of Studying Approach Inventory and the Response Sheets are given in Appendix IIIA and IIIB respectively.

**3.4.1.5.3. Item Analysis**

From the 400 response sheets, incomplete sheets were discarded and by random rejection some more sheets were discarded to get the final number of response sheets as 370. The total score of each respondent was calculated for conducting item analysis. The procedure suggested by Edwards (1957) was used to find out the discriminating power of items. The scored answer sheets are arranged in ascending order and top 100 students (27 percent) and bottom 100 students (27 percent) were taken as the high group and low group respectively. Then the 't' value of 58 items were calculated and tabulated. Items which have 't' value of 2.58 and above were selected with an inference that such item discriminate between high group and low group students. The item analysis details are given as Appendix IIIC.

Six items were omitted after item analysis and the remaining 52 items were selected. Thus the final version of the Studying Approach

Inventory have 52 items. The final version of the Studying Approach Inventory is given as Appendix IIID.

The number of selected items falling under each approach and break up of the number of questions are as follows:

**Break up of Number of Questions of Deep Approach**

| Sl. No. | Basic Elements | Question No. | No. of Questions |
|---|---|---|---|
| 1 | Seeking meaning | 1, 31, 44, 45 | 4 |
| 2 | Relating and organising ideas | 29, 30, 46, 48, 49, 50 | 6 |
| 3 | Using evidence and logic | 2, 4, 11, 27, 38, 47 | 6 |
| 4 | Interest in Ideas | 5, 13, 22, 36 | 4 |

**Break up of Number of Questions of Surface Approach**

| Sl. No. | Basic Elements | Question No. | No. of Questions |
|---|---|---|---|
| 1 | Lack of purpose | 37, 58 | 2 |
| 2 | Unrelated memorising | 6, 12, 17, 19, 24, 33 | 6 |
| 3 | Syllabus boundedness | 23, 35 | 2 |
| 4 | Fear of failure | 52, 55 | 2 |

**Break up of Number of Questions of Strategic Approach**

| Sl. No. | Basic Elements | Question No. | No. of Questions |
|---|---|---|---|
| 1 | Organised studying | 9, 10, 21, 42, 57 | 5 |
| 2 | Time management | 25, 32, 41, 56 | 4 |
| 3 | Alertness to assessment demands | 14, 28, 39 | 3 |
| 4 | Achievement motivation | 20, 26 | 2 |
| 5 | Monitoring Effectiveness | 15, 34, 40, 43, 53, 54 | 6 |

### 3.4.1.5.4. Validity of Studying Approach Inventory

The Studying Approach Inventory was prepared after studying all the theoretical construct of the variable Studying Approach in depth. The core components of each category of Studying Approaches and their corresponding activities were analysed thoroughly and the items of the inventory were prepared in accordance. Thus the content validity was established.

Criterion validity was established by correlating the scores on Studying Approach inventory obtained by forty students of class IX with their scores obtained on Science Studying Approach Inventory developed by Pillai *et al.* (1992). Pearson's product moment coefficient of correlation was used for this purpose. The correlation coefficient was found to be 0.68.

The inventory was distributed to subject experts and their suggestions were taken into account. Hence the tool ensures high face validity.

#### *3.4.1.5.5. Reliability of Studying Approach Inventory*

Cronbach Alpha method was used to find out the reliability. The coefficient was found to be 0.92 which indicates a very high reliability. Gutman's split half method was also used to establish the reliability. The reliability coefficient obtained was found to be 0.88.

### 3.4.1.6. Standard Progressive Matrices Test (Raven, 1958)

Non-Verbal Intelligence of the subjects were measured by administering the standard form of the Raven's Progressive Matrices test. This non-verbal test, developed by Raven (1958) was used to estimate the subjects' ability to discern and utilize a logical relationship presented by non-verbal materials. The test consists of five subsets of twelve items each. In each item a part of the geometrical design is missing. Six or eight alternatives are given for each design. All of those fit the missing part, but only one logically belongs to it. The test is a popular measure of the 'g' factor of Intelligence.

Validity of the test has been estimated in a variety of usual ways. When Stanford-Binet Test was used as the criterion, correlation coefficient varied from 0.5 to 0.86. The reliability coefficient of the test vary from 0.80 to 0.90 as reported by Raven. In a study conducted by Nair (1972) in Kerala, the reliability coefficient was found to vary from 0.70 to 0.86 by split-half method and from 0.84 to 0.91 by test-retest method.

Response sheet of Raven's Progressive Matrices Test is given as Appendix IV.

### 3.4.1.7. Achievement Test in Physics

An Achievement Test in Physics developed by the investigator was used as the pre-test. The same test was used as the post-test also. Steps in the construction of the test are described in the following sections.

*(i) Planning of the Test*

The curriculum, syllabus and text books of Physics for secondary classes have been thoroughly studied by the investigator for preparing the achievement test in Physics. The investigator also consulted with subject experts and experienced teachers in Physics for guidance. The books referred for preparing the test are given below.

(i) G.C.S.E. Science Double Award Physics (Foulds, 1996).

(ii) Nuffield Physics (Dorling, 1988).

(iii) Physics: A Window on Your World – Fourth Edition (Bolemon, 2001).

(iv) Kerala Reader Physics – Standard IX, 2002.

(v) Kerala Reader Physics – Standard IX, 2003.

The test consists of objective type items only. The duration of the test has been fixed for two hours. The test was intended to measure abilities of cognitive domain only. In order to achieve maximum objectivity, only multiple choice items were included in the test. The maximum marks fixed for the test was 75.

***(ii) Preparation of the Test***

Items for the Achievement Test in Physics were prepared on the basis of the major objectives in the cognitive domain namely Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation.

In the preparation of the test, due weightage was given to the objectives and content. Weightage to level of difficulty was considered while selecting the items.

***(iii) Preparation of Blue Print***

A blue print ensuring weightage to objectives and content was prepared. The form of questions was already fixed as to include only the multiple choice items.

**Weightage to Objectives**

| Sl. No. | Objectives | Marks | Percentage |
|---|---|---|---|
| 1 | Knowledge | 18 | 24 |
| 2 | Comprehension | 29 | 39 |
| 3 | Application | 12 | 16 |
| 4 | Analysis | 7 | 9 |
| 5 | Synthesis | 5 | 7 |
| 6 | Evaluation | 4 | 5 |
| | Total | 75 | 100 |

**Weightage to Content**

| Sl. No. | Objectives | Marks | Percentage |
|---|---|---|---|
| 1 | Light | 9 | 12 |
| 2 | Force | 14 | 19 |
| 3 | Gravitation | 3 | 4 |
| 4 | Motion | 5 | 7 |
| 5 | Work and Energy | 4 | 5 |
| 6 | Fluids | 20 | 26 |
| 7 | Sound | 9 | 12 |
| 8 | Magnetism and Electricity | 5 | 7 |
| 9 | Heat | 6 | 8 |
| | Total | 75 | 100 |

A two-way grid specifying weightage to objective and content was prepared as a blue print for the final test and is given in Table 3.1.

TABLE 3.1

**Blue Print for Achievement Test in Physics**

| Content | Know-ledge | Compre-hension | Applica-tion | Analysis | Syn-thesis | Evalua-tion | Total |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 7 | -- | -- | -- | 1 | 9 |
| 2 | 3 | 5 | 3 | 3 | -- | -- | 14 |
| 3 | -- | 1 | -- | 1 | -- | 1 | 3 |
| 4 | 1 | 1 | 1 | -- | 1 | 1 | 5 |
| 5 | 2 | 1 | 1 | -- | -- | -- | 4 |
| 6 | 6 | 8 | 4 | 2 | -- | -- | 20 |
| 7 | 1 | 4 | 2 | 1 | 1 | -- | 9 |
| 8 | 2 | 1 | -- | -- | 2 | -- | 5 |
| 9 | 2 | 1 | 1 | -- | 1 | 1 | 6 |
| Total | 18 | 29 | 12 | 7 | 5 | 4 | 75 |

***(iv) Item Writing***

Based on the design of the test the investigator pooled initially 100 multiple choice items to be included in the draft test so as to get enough number of items of proved psychometric properties in the final test. For each item four answers were given of which only one is the correct answer and other three are distractors. The items were scrutinised by experienced physics teachers and teacher educators. On the basis of their suggestions, some items were omitted and some were modified. After editing, the number of items for the draft test was 75. Necessary instructions for responding to the items were also prepared.

*(v) Pilot Testing*

The draft test consisting of 75 items with general instructions and specific instructions for answering the questions was administered to 25 students of standard IX. Oral instructions were also given besides the written instruction whenever necessary to clear doubts. Time taken for completion of test by each student was also noted. Scoring was done on the basis of already prepared scoring key. By observing students taking test and analysing the problems faced by students who took the test, slight changes were made in the instructions.

Illustrations of items under each objective is given below.

**Knowledge Category**

Qn. No. 2 The property of a body by which it continues in its state of rest is:

A. Momentum

B. Inertia of rest

C. Inertia of motion

D. Weight

**Comprehension Category**

Qn. No. 70. 'Action and Reactions are equal and opposite'.

Considering the above statement which of the following are correct?

A. They cancel each other because they are equal and opposite.

B. They do not cancel each other because they are equal and opposite.

C. They cancel each other because they are acting on the same object.

D. They do not cancel each other because they are acting on different objects.

**Application Category**

Qn.No. 58. When a person gets electric shock, his heart tends to stop. This is because:

A. He is having tension.

B. Viscosity of blood increases.

C. Viscosity of blood decreases.

D. Pressure of blood decreases.

**Analysis Category**

Qn. No. 47. In an experiment, a scientist placed an object at the equator and found its weight. Then he placed it at the poles and found its weight. From the data he found the weight of the object when it is placed at the centre of the earth. He concluded that the object had different weights in the three instances.

Which of the following assumptions is implicit in this experiment?

A. The weight of the object is negligible at the centre of the earth.

B. Acceleration due to gravity is the same at all places on the earth's surface.

C. Acceleration due to gravity is different at different places.

D. Weight is not determined by acceleration due to gravity.

**Synthesis Category**

Qn.No. 52. You are to conduct an experiment to determine whether the rate of evaporation of a liquid is affected by an increase in the amount of heat given. You have the relevant apparatus to conduct the experiment.

If the increase in the amount of heat have an observable effect on the rate of evaporation in liquids, almost immediately after increasing the amount of heat you would expect to observe a notable change in the:

A. temperature of liquid molecules.

B. motion of liquid molecules.

C. amount of liquid vapour over the liquid surface.

D. pressure of the liquid.

**Evaluation Category**

Qn.No. 35. A book is placed on a table. It was observed that the book rotates when the table is rotated. In this experiment centripetal force for rotation of the book is given by frictional force between the book and the table. The book was found to be thrown away when the speed of rotation of the table was increased.

Which of the following conclusions can be justified based on the above experiment?

A. The book rotates slowly when the table is rotated faster.

B. The book rotates faster when the table is rotated slowly.

C. The book was thrown away because the cenripetal force was balanced by friciton.

D. The book was thrown away because beyond a speed limit centripetal force cannot be balanced by friction.

***(vi) Try-out of the Draft Test***

The draft test consisting of 75 items were administered to a sample of 400 students of standard IX. Before administering the test the investigator approached the administrators and students to make clear the purpose of the test. The test together with response sheet was given to subjects. General guidelines were given before the test started. Specific guidelines and additional information were given whenever necessary.

The response sheets were collected and scored using the already prepared scoring key. One score was given for the correct answer and no score was given to wrong answers.

***(vii) Item Analysis***

Item analysis was undertaken using the method suggested by Ebel and Frisbie (1991). 370 response sheets complete in all respects were taken for item analysis. Incomplete sheets and manipulated sheets were discarded. For the analysis the response sheets were arranged in the descending order of total marks obtained by the subjects. The top 100 students (27 percent) and bottom 100 students (27 percent) were taken as the high group and low group respectively. The response for each item by the two groups was noticed. The index of difficulty and discriminating power of each item were computed using the formula suggested by Ebel and Frisbie (1991).

$$\text{Difficulty Index of item, } D_i = \frac{U+L}{2N}$$

$$\text{Discriminating power of item } D_p = \frac{U-L}{N}$$

where,

U = Number of right responses in the upper group.

L = Number of right responses in the lower group.

N = Number of subjects in any of the group.

The difficulty index and discriminating power of each item was calculated.

Difficulty index ranging between 0.30 and 0.80 with discriminating power above 0.30 were readily selected for the final test. Thus final test with 60 items was prepared with necessary instructions to respond. This test was then put to test for validity and reliability.

Draft Achievement Test in Physics, Scoring Key, Response Sheet, Details of Item Analysis and Final version of Achievement Test in Physics are given as Appendices VA, VB, VC, VD and VE respectively.

*(viii) Validity*

The validity of the Achievement Test in Physics was established in two different ways.

Subjecting the test items for experts criticism, content validity of the test was ensured. As per the evaluation of experts, the test content agrees with the treatment content in both the dimensions objective basedness and comprehensiveness.

Criterion validity was established by correlating the scores on Achievement test in Physics obtained by 40 students of standard IX with their marks obtained in Physics in the previous terminal examination. Pearson's product moment formula was used for this purpose. The correlation coefficient was found to be 0.70.

***(ix) Reliability***

The split half reliability was established by correlating the odd and even sets of scores and the obtained value is 0.84.

The indices of validity and reliability indicated that the Achievement test in Physics has acceptable psychometric properties to measure the Achievement in Physics of standard IX students.

### 3.4.1.8. Data Collection Procedure

After finalising the selection of the school for the present investigation, the head of the school was contacted through proper channel for getting permission for conducting the experiment. The investigator appraised the principal of the school regarding the importance of the study and a schedule was fixed for experimentation. The experimentation commenced in the month of July and completed in October, 2005.

#### 3.4.1.8.1. Administration of Pre-test

Prior to the introduction of treatment in the selected school, data on previous knowledge of subject matter directly linked with the experiment, Non-Verbal Intelligence, and Studying Approaches of the subjects were collected. For this purpose Achievement Test in Physics (Pre-Test), Ravens Progressive Matrices Test and Studying Approach Inventory were administered. The procedure suggested in the manual for the administration was followed especially for Ravens Progressive Matrices Test. The data thus collected ensured the entry status of the students in terms of Achievement in Physics, Non-Verbal Intelligence and Studying Approach.

### 3.4.1.8.2. Procedure of Treatment

The Experimental and Control group were given different treatments. The control group was taught through Objective Based Instruction and the Experimental group was taught through Concept Attainment Model of Teaching.

#### *3.4.1.8.2.1. Control Group*

The treatment procedure in the control group is described below.

Students of standard IX $A_I$ division of N.S.S.K.P.T.H.S.S. formed the control group. Without altering the organisational set up of the classroom the investigator herself taught the lessons through Objective Based Instruction (OBI). Only conventional teaching aids were used during the treatment. Thirty lessons were taught. No formative/unit test was administered during the treatment.

***(i) Introduction***

For each class the first seven minutes was spent for the introduction stage. During this stage the previous lesson was reviewed and also few introductory questions relevant to the new lesson were asked to motivate the students and create interest in the class. Thus a favourable situation was created for learning.

*(ii) Development*

The second stage was the development stage. At this phase the investigator tried to develop the new concepts in an expository manner. It was done mostly through pupil activity or through illustrative talk. Though there were pupil activities they were mostly teacher directed and uniform for all students. Appropriate blackboard work was given by the teacher as visual supplement or summary of the lesson. Proper generalisation and discrimination were done through several examples.

In this group, students were mostly passive observers and there was more teacher activity. Occasionally mass answering was aloud. Students did not get enough opportunity to participate actively in the learning process. About fifteen minutes was spent for this stage.

*(iii) Application*

The third stage is application stage. Here the subjects applied the newly learned concepts in new and day-to-day situations. At first it was done with the help of the teacher and then subjects were allowed to do it by themselves.

***(iv) Review and Recitation***

This was the last stage. About eight minutes was spent for this stage. Teacher-directed evaluation was done during this stage. Class assignments and procedure for home assignments were also given.

Thirty lessons were taken in thirty periods. No remedial teaching was attempted during treatment. But doubts were cleared during review stage.

***3.4.1.8.2. Experimental Group***

Students of standard IX $A_2$ division of NSSKPTHSS formed the experimental group. Thirty lesson plans based on Concept Attainment Model were already prepared for Experimental group.

The procedure of treatment given to Experimental group is described below.

***(i) Presentation of data and identification of concept***

This is the first phase of the Concept Attainment Model. The classes were started with an orientation to the students by the investigator to motivate the students. Then the investigator presented labelled examples. Students were allowed to compare the attributes in positive and negative examples. Finally the students were able to state a definition of the concept according to the essential attributes. This was mostly done with the help of the teacher and with proper directions. The investigator provided cues and prompts wherever necessary.

*(ii) Testing Attainment of the Concept*

This is the second phase of the Concept Attainment Model. The teacher presented unlabelled examples during this phase. The students identified these unlabelled examples as 'Yes' or 'No'. The teacher analysed and modified and confirmed the hypotheses formed by the students. Then the teacher named the concepts and restated the definition of the concept according to essential attributes. Finally the students were allowed to generate examples. Active student participation was ensured during this period.

*(iii) Analysis of Thinking Strategies*

This is the last phase of Concept Attainment Model. It is like the review session in OBI. Here the students were allowed to describe their thoughts while formulating hypotheses. Subjects discussed the role of hypothesis and attributes. Subjects discussed the type and number of hypotheses formed. Here an opportunity was given to each subject to analyse their thought process. If students were not accurate, they went through a correction procedure with the help of the investigator.

### *Social System*

The positive and negative examples were carefully prepared by the investigator well in advance. They were labelled and arranged in such a way that the attributes were clear. Additional examples were provided wherever needed. The investigator acted as a recorder. Points and cues were provided wherever necessary. The social system of the classroom was highly structured. It can be noted that the learning environment of the classroom was learner centred and not authoritarian. The teacher provided appropriate instructions and guidance during the activities carried by the learners.

### Principles of Reaction

The investigator supported the discussions by the subjects but at the same time emphasized the hypothetical nature of discussion. The students were helped to balance one hypothesis against another and to focus attention on specific features of examples. They were assisted in discussing and evaluating their thinking strategies. This ensured the principles of reaction inherent in Concept Attainment Model.

### Support System

The sequential and logical arrangement of the learning tasks, carefully selected and organized materials and data in the form of discrete units to serve as examples, meaningful learning experiences, scripted lesson plans and motivation from teacher acted as the support system of Concept Attainment Model.

*Instructional Effect*

The highly structured instructional approach accelerated the learning. Students were able to get clear notions about nature of concepts. Subjects developed skills in using appropriate concept building strategies and attained the specific concepts. The most important instructional effect is that it helped in developing the skill of inductive reasoning among subjects.

***3.4.1.8.3. Administration of Post-Test I***

To quantify the terminal characteristics of the subjects in terms of Achievement in Physics the investigator administered a Post-Test. The post-test data from the subjects in the Control group and Experimental group were gathered the next day after the completion of the treatments. The test was conducted simultaneously for the Experimental and Control groups inorder to ensure objectivity by the test. All necessary guidelines and purpose of the test were explained to the subjects in each group.

#### *3.4.1.8.4. Administration of Post-Test II*

Two months after the treatment the investigator administered the Post-Test once again to Control group and Experimental group. The aim of this test was to explore the extent of retention of Achievement in Physics of standard IX students.

### 3.4.2. Scoring and Consolidation of Data

The response sheets were scored according to the already prepared scoring key. The investigator strictly followed the specific directions given in the manual for Raven's Progressive Matrices Test. Incomplete score sheets and data obtained from students who had not regularly attended the experimental class sessions were not included for the analysis. Cases, which were complete in all respects were taken into consideration. The break up of the actual number of subjects falling under different category is given in Table 3.2.

TABLE 3.2

**The Final Break-up of Subjects Falling Under Different Categories**

| Name of Group | Boys | Girls | Total |
|---|---|---|---|
| Experimental Group | 20 | 20 | 40 |
| Control Group | 20 | 20 | 40 |
| Total | 40 | 40 | 80 |

### 3.4.3. Procedure Used for Analysis of Data

The hypotheses of the present study were tested by employing appropriate statistical techniques. The entire statistical processing was done using computer facility.

Statistical techniques employed in the study are given below:

**A. Test of Significance of Difference between Means of Large and Small Independent Samples**

To test the first five hypotheses the test of significance of difference between means of large and small independent sample were used. Control group and Experimental group were compared with respect to their mean Post-Test I, Post-Test II and Gain scores for Total sample, Boys and Girls. Pupils having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying were also compared with respect to their mean Post-Test I, Post-Test II and Gain scores.

The difference between means was tested using two-tailed test of significance and the results were interpreted using appropriate degrees of freedom.

## B. Correlation Analysis

The present experiment was conducted with intact classroom groups for practical reasons. Therefore in order to ensure the equivalence of the groups before the treatment, variables were introduced. The variables selected for determining the equivalence of the groups were 'Previous Knowledge of the Subject Matter' and 'Non-Verbal Intelligence'. Analysis of Covariance was used to equate the pre-experimental status of the treatment groups in terms of 'Previous Knowledge of the Subject Matter' and 'Non-Verbal Intelligence'. The assumption implicit in the meaningful use of Analysis of Covariance is that a direct causal relation exist between the co-variates and the dependent variable (Ferguson, 1981). In order to find out the nature of the relationship between the Control Variables and Achievement in Physics (Post-Test I and Post-Test II), correlation analysis was used.

Correlation is the relationship between two or more paired variables or two or more sets of data. The degree of relationship is measured and represented by the co-efficient of correlation. The most often used and most precise coefficient of correlation is the Pearson Product Moment Correlation denoted by the symbol 'r'. Pearson Product Moment Correlation was used to find out the degree of relationship between the Control Variables and the Achievement in Physics (Post-Test I & II).

Verbal Interpretation of 'r' was done according to the method provided by Garret (1981). The coefficient of correlation between two variables is described as 'high', 'marked' or 'substantial', 'low' or 'negligible' depending upon the numerical index of 'r'. The interpretation is as shown below.

(i) 'r' from .00 to $\pm$ 0.20 - denotes indifferent or negligible relationship.

(ii) 'r' from 0.20 to $\pm$ 0.40 - denotes low or slight relationship.

(iii) 'r' from 0.40 to $\pm$ 0.70 - denotes substantial or marked relationship.

(iv) 'r' from 0.70 to $\pm$ 1.00 - denotes high to very high relationship.

**C. Two-way Analysis of Variance (ANOVA) with 2x3 Factorial Design**

To study the main effect and interaction effect of Methods of teaching (Concept Attainment Model of teaching and Objective Based Instruction) and Study Approaches (deep, surface and strategic) on Achievement in Physics, Two way Analysis of Variance with 2x3 factorial design was employed. By this method one can study the single effect of each of the Independent variable on the Dependent variables and interaction effect of the Independent variables on the Dependent variable. Interpretation of the analysis was done on the basis of F-values – whether

F-ratio is significant or not at 0.01 level or 0.05 level for appropriate degrees of freedom.

**D. Scheffé Test for Multiple Comparison**

Scheffé Test for Multiple Comparison (Ferguson, 1981) was applied to compare the relevant category of the independent variables (when more than two categories are made) in relation to the mean scores of Achievement in Physics Post-Test I and Achievement in Physics Post-Test II.

**E. Analysis of Covariance (ANCOVA)**

In the present study, Two factor ANCOVA employing two co-variates (singly and in combination) was used to confirm the effectiveness of Concept Attainment Model of Teaching over Objective Based Instruction. Through Analysis of Covariance one can control or adjust the effects of one or more uncontrolled variables and thereby permit a valued evaluation of the outcome of experiment. It is applied when there are one or more correlated variables existing with the Dependent Variable. In the present study the co-variates are Previous Knowledge of the Subject Matter and Non-Verbal Intelligence. ANCOVA was used to remove statistically the effects of Previous Knowledge of Subject Matter and Non-Verbal Intelligence separately and in combination.

# INTERACTION EFFECT OF CONCEPT ATTAINMENT MODEL OF TEACHING AND STUDYING APPROACH ON ACHIEVEMENT IN PHYSICS OF SECONDARY SCHOOL STUDENTS

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CHAPTER 4

# ANALYSIS

- *Preliminary Analysis*
  - *Preliminary Analysis of Statistical Constants*
  - *Equivalence of Groups*
  - *Correlation Analysis*
- *Major Analysis*
  - *Mean Difference Analysis*
  - *Analysis of Variance*
  - *Post-hoc Analysis of Group Differences*
- *Analysis of Covariance*
- *Conclusions and Interpretations*

# ANALYSIS

The purpose of the present study is to find out the Interaction Effect of Concept Attainment Model of Teaching and Studying Approaches on Achievement in Physics of Secondary School Students. The experimental design used for the study was Pre-Test Post-Test Equivalent Groups Design. The collected data was analysed using the statistical techniques namely, Test of Significance of difference between Means, Correlation Analysis, Analysis of Variance and Analysis of Co-variance.

The analysis of the data is presented under the following sections.

4.1. PRELIMINARY ANALYSIS

4.2. MAJOR ANALYSIS

## 4.1. PRELIMINARY ANALYSIS

In order to know the basic properties of the test scores for the total sample and relevant subsamples, a preliminary analysis of the scores of the select variables was attempted. The present experiment was conducted with intact classroom groups for practical reasons. Therefore in order to ensure the equivalence of the groups before the treatment, variables were introduced. The groups were matched with regard to select variables using Test of Significance of Difference between Means. The variables selected for determining the equivalence of the groups were 'Previous Knowledge of the Subject Matter' and 'Non-Verbal Intelligence'. Analysis of Covariance was used to equate the pre-experimental status of the treatment groups in terms of 'Previous Knowledge of the Subject Matter' and 'Non-Verbal Intelligence'. The assumption implicit in the meaningful use of Analysis of Covariance is that a direct causal relation exist between the covariates and the dependent variables. In order to find out the nature of the relationship between the control variables and the dependent variables correlation analysis was used.

The Preliminary analysis of the data is presented under the following sections.

4.1.1. INVESTIGATION OF IMPORTANT STATISTICAL CONSTANTS FOR THE SCORE DISTRIBUTION OF SELECT VARIABLES.

4.1.2. INVESTIGATION OF TEST OF SIGNIFICANCE OF DIFFERENCE BETWEEN MEANS FOR DETERMINING THE EQUIVALENCE OF GROUPS.

4.1.3. CORRELATION ANALYSIS.

### 4.1.1. INVESTIGATION OF IMPORTANT STATISTICAL CONSTANTS FOR THE SCORE DISTRIBUTION OF SELECT VARIABLES

A preliminary analysis was taken up to get an appropriate set of statistics which may provide a quick impression of the main features of the data which in turn may provide some guidance as to how the analysis and interpretation should proceed. The mean, median, mode, standard deviation, skewness and kurtosis of the scores were calculated for the total sample, boys and girls and are presented in Table 4.1, 4.2 and 4.3 respectively.

TABLE 4.1

**Important Statistical Constants for the Score Distribution of Select Variables for the Total Sample (N=80)**

| Sl. No. | Variables | Mean | Median | Mode | Standard deviation | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|
| 1. | Previous Knowledge | 7.34 | 5 | 3 | 6.01 | 0.67 | -0.80 |
| 2. | Non-verbal Intelligence | 33.75 | 35 | 20 | 10.30 | -0.03 | -1.14 |
| 3. | Achievement in Physics | 37.19 | 33.50 | 28 | 12.07 | 0.27 | -1.2 |
| 4. | Retention in Physics | 25.30 | 22.00 | 20 | 11.33 | 0.52 | 0.27 |

TABLE 4.2

**Important Statistical Constants**
**for the Score Distribution of Select Variables for Boys (N=40)**

| Sl. No. | Variables | Mean | Median | Mode | Standard deviation | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|
| 1. | Previous Knowledge | 10.33 | 10 | 10 | 5.74 | 0.29 | -1.20 |
| 2. | Non-verbal Intelligence | 35.88 | 36 | 20 | 9.58 | -0.06 | -1.14 |
| 3. | Achievement in Physics | 38.95 | 34 | 28 | 12.62 | 0.26 | -1.57 |
| 4. | Retention in Physics | 27.58 | 23 | 22 | 11.00 | 0.55 | -1.06 |

TABLE 4.3

**Important Statistical Constants**
**for the Score Distribution of Select Variables for Girls (N=40)**

| Sl. No. | Variables | Mean | Median | Mode | Standard deviation | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|
| 1. | Previous Knowledge | 4.35 | 3.00 | 3 | 4.68 | 1.42 | 0.96 |
| 2. | Non-verbal Intelligence | 31.63 | 31.50 | 18 | 10.67 | 0.10 | -1.23 |
| 3. | Achievement in Physics | 35.42 | 33.00 | 20 | 11.38 | 0.22 | -1.93 |
| 4. | Retention in Physics | 23.03 | 20.50 | 9 | 11.33 | 0.62 | -0.57 |

The statistical constants presented in Tables 4.1, 4.2 and 4.3 indicate that the values are close approximations to the values expected for normal distribution. The values of skewness and kurtosis for the distribution also show that the distribution fairly approximate to what is expected for normal curves. The near normal distribution obtained suggests that the sample chosen for the study can be considered as a fair representative of the population.

### 4.1.2. INVESTIGATION OF TEST OF SIGNIFICANCE OF DIFFERENCE BETWEEN MEANS FOR DETERMINING THE EQUIVALENCE OF GROUPS

The variables selected for determining the equivalence of the groups were 'Previous Knowledge of the Subject Matter' and 'Non Verbal Intelligence'. The Mean and Standard Deviation of each variable for Total Sample, Boys and Girls were calculated. The result of the test of significance of difference between means for Control group and Experimental group are summarised and presented in Table 4.4.

TABLE 4.4

**Data and Results of the Test of Significance of Difference in the Scores of Previous Knowledge of Subject Matter and Non-Verbal Intelligence between Control Group and Experimental Group (Total Sample, Boys and Girls)**

| Variable | Sample | Total | | | | Boys | | | | Girls | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | M | S.D | N | t | M | S.D | N | t | M | S.D | N | t |
| Previous Knowledge of Subject Matter | Control Group | 7.15 | 6.02 | 40 | 0.28 | 9.9 | 5.99 | 20 | 0.46 | 4.4 | 4.75 | 20 | 0.07 |
| | Experimental Group | 7.53 | 6.06 | 40 | | 10.75 | 5.58 | 20 | | 4.3 | 4.73 | 20 | |
| Non-Verbal Intelligence | Control Group | 33.18 | 10.05 | 40 | 0.50 | 35.20 | 9.05 | 20 | 0.44 | 31.15 | 10.80 | 20 | 0.28 |
| | Experimental Group | 34.33 | 10.64 | 40 | | 36.55 | 10.27 | 20 | | 32.10 | 10.79 | 20 | |

Table 4.4 reveals that the critical ratios obtained for the difference between mean scores of the variables Previous Knowledge of the Subject Matter and Non-Verbal Intelligence are found to be not significant even at 0.05 level for appropriate degrees of freedom. This result indicates that no significant difference exists in the mean Previous Knowledge of Subject Matter and Non-Verbal Intelligence Scores between Experimental Group and Control Group.

The t-test values reveal that the Experimental Group and Control Group are equivalent with regard to the Previous Knowledge of Subject Matter and Non-Verbal Intelligence for Total Sample, Boys and Girls.

### 4.1.3. CORRELATION ANALYSIS

In order to find out the nature of the relationship between the control variables and the dependent variables, correlation analysis was used. The degree of relationship between the Control variables and the Dependent variables were estimated by using Pearson's Product Moment Co-efficient of Correlation denoted by the symbol 'r'.

Twenty correlation coefficients were found out to compare the relationship between different sub groups. The correlation analysis is given under the following sections.

4.1.3.1. Correlation between Previous Knowledge of the Subject Matter and Achievement in Physics (Post-Test I) for Total Sample, Boys, Girls, Control Group and Experimental Group.

4.1.3.2. Correlation between Previous Knowledge of the Subject Matter and Achievement in Physics (Post-Test II) for Total Sample, Boys, Girls, Control Group and Experimental Group.

4.1.3.3. Correlation between Non-Verbal Intelligence and Achievement in Physics (Post-Test I) for Total Sample, Boys, Girls, Control Group and Experimental Group.

4.1.3.4. Correlation between Non-Verbal Intelligence and Achievement in Physics (Post-Test II) for Total Sample, Boys, Girls, Control Group and Experimental Group.

### 4.1.3.1. Correlation between Previous Knowledge of the Subject Matter and Achievement in Physics (Post-Test I) for Total Sample, Boys, Girls, Control Group and Experimental Group

Data and Results showing the correlation between Previous Knowledge of the Subject Matter and Achievement in Physics (Post-Test I) for Total Sample, Boys, Girls, Control Group and Experimental Group are represented in Table 4.5.

TABLE 4.5

**Data and Results Showing Correlation between Previous Knowledge of the Subject Matter and Achievement in Physics (Post test I) for Total Sample, Boys, Girls, Control Group and Experimental Group**

| Sample | N | r |
|---|---|---|
| Total Sample | 80 | 0.82 |
| Boys | 40 | 0.93 |
| Girls | 40 | 0.80 |
| Control Group | 40 | 0.94 |
| Experimental Group | 40 | 0.78 |

The results clearly shows that all the correlation coefficients obtained are above 0.70 which denotes high to very high relationship. The result indicates that there is very high Correlation between Previous Knowledge of the Subject Matter and Achievement in Physics (Post-Test I) for Total Sample, Boys, Girls, Control Group and Experimental Group.

**4.3.1.2. Correlation between Previous Knowledge of the Subject Matter and Achievement in Physics (Post-Test II) for Total Sample, Boys, Girls, Control Group and Experimental Group**

Data and Results showing the correlation between Previous Knowledge of the Subject Matter and Achievement in Physics (Post-Test

II) for Total sample, Boys, Girls, Control Group and Experimental Group are represented in Table 4.6.

TABLE 4.6

**Data and Results Showing Correlation between Previous Knowledge of the Subject Matter and Achievement in Physics (Post-Test II) for Total Sample, Boys, Girls, Control Group and Experimental Group**

| Sample | N | r |
|---|---|---|
| Total Sample | 80 | 0.75 |
| Boys | 40 | 0.82 |
| Girls | 40 | 0.71 |
| Control Group | 40 | 0.93 |
| Experimental Group | 40 | 0.81 |

The results of Table 4.6 clearly shows that all the correlation coefficients obtained are above 0.70 which denotes high to very high relationship. The result indicates that there is very high correlation between Previous Knowledge of the Subject Matter and Achievement in Physics (Post-Test II) for Total sample, Boys, Girls, Control Group and Experimental Group.

#### 4.1.3.3. Correlation between Non-Verbal Intelligence and Achievement in Physics (Post-Test I) for Total sample, Boys, Girls, Control Group and Experimental Group

Data and Results showing the correlation between Non-Verbal Intelligence and Achievement in Physics (Post-Test I) for Total sample, Boys, Girls, Control Group and Experimental Group are represented in Table 4.7.

TABLE 4.7

**Data and Results Showing Correlation between Non-Verbal Intelligence and Achievement in Physics (Post-Test I) for Total Sample, Boys, Girls, Control Group and Experimental Group**

| Sample | N | r |
|---|---|---|
| Total Sample | 80 | 0.92 |
| Boys | 40 | 0.93 |
| Girls | 40 | 0.92 |
| Control Group | 40 | 0.92 |
| Experimental Group | 40 | 0.95 |

The results reveal that all the correlation coefficients obtained are above 0.90 which denotes very high relationship. The result indicates that there is very high correlation between Non-Verbal Intelligence and Achievement in Physics (Post-Test I) for Total sample, Boys, Girls, Control Group and Experimental Group.

### 4.1.3.4. Correlation between Non-Verbal Intelligence and Achievement in Physics (Post-Test II) for Total sample, Boys, Girls, Control Group and Experimental Group

Data and results showing the correlation between Non-Verbal Intelligence and Achievement in Physics (Post-Test II) for Total Sample, Boys, Girls, Control Group and Experimental Group are represented in Table 4.8.

TABLE 4.8

**Data and Results Showing Correlation between Non-Verbal Intelligence and Achievement in Physics (Post-Test II) for Total Sample, Boys, Girls, Control Group and Experimental Group**

| Sample | N | r |
|---|---|---|
| Total Sample | 80 | 0.84 |
| Boys | 40 | 0.84 |
| Girls | 40 | 0.82 |
| Control Group | 40 | 0.91 |
| Experimental Group | 40 | 0.95 |

Table 4.8 clearly shows that all the correlation coefficients obtained are above 0.80 which denotes very high relationship. The results indicate that there is very high correlation between Non-Verbal Intelligence and Achievement in Physics (Post-Test II) for Total Sample, Boys, Girls, Control Group and Experimental Group.

The Correlation Analysis shows that there is high relationship between the Control variables and the Dependent variables for the Total sample and all the relevant Subsamples. Hence the assumption implicit in the meaningful use of Analysis of Covariance that a direct relationship exist between the co-variates and the dependent variable, is highly satisfied.

## 4.2. MAJOR ANALYSIS

The major analysis of the data are presented in the following sections:

4.2.1. INVESTIGATION OF DIFFERENCE IN MEAN SCORES OF ACHIEVEMENT IN PHYSICS OF EXPERIMENTAL GROUP AND CONTROL GROUP

4.2.2. INVESTIGATION OF DIFFERENCE IN MEAN SCORES OF ACHIEVEMENT IN PHYSICS OF STUDENTS HAVING DIFFERENT STUDYING APPROACHES

4.2.3. INVESTIGATION OF THE MAIN EFFECT AND INTERACTION EFFECT OF METHODS OF TEACHING AND STUDYING APPROACH ON ACHIEVEMENT IN PHYSICS (POST-TEST I AND POST-TEST II) FOR TOTAL SAMPLE, BOYS AND GIRLS

### 4.2.4. POST-HOC COMPARISON OF GROUP DIFFERENCES

### 4.2.5. INVESTIGATION OF THE MAIN EFFECT AND INTERACTION EFFECT OF METHODS OF TEACHING AND STUDYING APPROACH ON ACHIEVEMENT IN PHYSICS (POST-TEST I AND POST-TEST II) FOR TOTAL SAMPLE, BOYS AND GIRLS WHEN INITIAL DIFFERENCES IN PREVIOUS KNOWLEDGE OF THE SUBJECT MATTER AND NON-VERBAL INTELLIGENCE ARE CONTROLLED ONE BY ONE AND IN COMBINATION

### 4.2.1. INVESTIGATION OF DIFFERENCE IN MEAN SCORES OF ACHIEVEMENT IN PHYSICS OF EXPERIMENTAL GROUP AND CONTROL GROUP

Analysis of data by comparing Achievement in Physics between Experimental Group and Control Group for Total sample, Boys and Girls are presented in this section. To examine whether significant changes exist, if any, in the Mean Scores of Achievement in Physics between Experimental Group and Control Group after introducing the treatment variable, four comparisons were undertaken.

The comparison of Mean scores was undertaken for Total sample, Boys and Girls. Two-tailed test of significance of difference between means was used to interpret the results. Analysis and interpretation of data are presented in the following sub-sections.

4.2.1.1. Comparison of Mean Scores of Achievement in Physics Post-Test I of Experimental Group and Control Group for Total sample, Boys and Girls.

4.2.1.2. Comparison of Mean Gain Scores of Achievement in Physics Post Test I (Post-Test I minus Pre-Test) of Experimental Group and Control Group for Total sample, Boys and Girls.

4.2.1.3. Comparison of Mean Retention Scores of Achievement in Physics Post-Test II of Experimental Group and Control Group for Total sample, Boys and Girls.

4.2.1.4. Comparison of Mean Gain Scores of Achievement in Physics in Post-Test II (Post-Test II minus Pre-Test) of Experimental Group and Control Group for Total sample, Boys and Girls.

#### 4.2.1.1. Comparison of Mean Scores of Achievement in Physics Post-Test I of Experimental Group and Control Group for Total sample, Boys and Girls

The mean and standard deviation of scores on Achievement in Physics Post-Test I of Experimental Group (taught through Concept Attainment Model of Teaching) and Control Group (taught through

Objective Based Instruction) and the t-values for Total Sample, Boys and Girls are presented in Table 4.9.

TABLE 4.9

**Data and Results of t-test for the Mean Scores of Post-Test I between Control Group and Experimental Group (Total Sample, Boys and Girls)**

| Sample | Control Group | | | Experimental Group | | | t-value | Level of Significance |
|---|---|---|---|---|---|---|---|---|
| | $M_1$ | $SD_1$ | $N_1$ | $M_2$ | $SD_2$ | $N_2$ | | |
| Total (N=80) | 34.20 | 10.05 | 40 | 40.18 | 13.26 | 40 | 2.27 | 0.05 |
| Boys (N=40) | 36.25 | 11.46 | 20 | 41.65 | 13.43 | 20 | 1.37 | NS |
| Girls (N=40) | 32.15 | 8.21 | 20 | 38.70 | 13.26 | 20 | 1.88 | N.S |

As per Table 4.9 the t-values obtained for the comparison of Mean Achievement in Physics Post-Test I for Experimental Group and Control Group for Total Sample is found to be significant at 0.05 level for appropriate degrees of freedom. The results obtained for the comparison of Mean Achievement in Physics Post-Test I for the Sample of Boys and Sample of Girls are not significant even at 0.05 level.

The result indicate that the mean scores of Achievement in Physics Post-Test I of Experimental Group and Control Group for Total sample are significantly different suggesting that the groups are not identical.

In the case of Boys and Girls no significant difference is found to exist in the mean Achievement in Physics suggesting that the sub groups of Boys and Girls are not significantly different with respect to their Achievement in Physics Post-Test I.

From the analysis of mean scores it can be noted that high mean Achievement in Physics are associated with the Experimental Group for the Total sample, Boys and Girls.

### 4.2.1.2. Comparison of Mean Gain Scores of Achievement in Physics Post-Test I of Experimental Group and Control Group for Total Sample, Boys and Girls

The mean gain scores of Achievement in Physics Post-Test I (Post Test I minus Pre-Test) of Experimental Group and Control Group were compared using the Test of Significance of difference between means. Data and Results are presented in Table 4.10.

TABLE 4.10

**Data and Results of t-test for the Mean Gain Score (Post-Test I-Pre-Test) between Control Group and Experimental Group (Total Sample, Boys and Girls)**

| Sample | Control Group | | | Experimental Group | | | t-value | Level of Significance |
|---|---|---|---|---|---|---|---|---|
| | $M_1$ | $SD_1$ | $N_1$ | $M_2$ | $SD_2$ | $N_2$ | | |
| Total (N=80) | 27.05 | 4.89 | 40 | 32.65 | 9.30 | 40 | 3.37 | 0.01 |
| Boys (N=40) | 26.35 | 5.58 | 20 | 30.90 | 8.74 | 20 | 1.96 | NS |
| Girls (N=40) | 27.15 | 4.13 | 20 | 34.40 | 9.74 | 20 | 2.81 | 0.01 |

As per Table 4.10 the t-values obtained for the comparison of mean gain score in Physics (Post-Test I minus Pre-Test) of Experimental Group and Control Group for Total Sample and Girls are found to be significant at 0.01 level for appropriate degrees of freedom. For Boys the t-value is not significant even at 0.05 level.

The results indicate that there exist significant difference in the mean gain score of Achievement in Physics Post-Test I between Experimental Group and Control Group for Total Sample and Girls. Boys are not significantly different in their mean gain scores of Achievement in Physics Post-Test I.

High mean gain scores are found to be associated with Experimental Group suggesting the advantage of Experimental Group over Control Group for Total Sample, Boys and Girls.

**4.2.1.3. Comparison of Mean Retention Scores of Achievement in Physics Post-Test II of Experimental Group and Control Group for Total Sample, Boys and Girls**

To compare the mean retention scores of Achievement in Physics Post-Test II, two-tailed test of significance of difference between means was used. The data and results are presented in Table 4.11.

TABLE 4.11

**Data and Results of t-test for the Mean Retention Scores of Post-Test II between Control Group and Experimental Group (Total Sample, Boys and Girls)**

| Sample | Control Group | | | Experimental Group | | | t-value | Level of Significance |
|---|---|---|---|---|---|---|---|---|
| | $M_1$ | $SD_1$ | $N_1$ | $M_2$ | $SD_2$ | $N_2$ | | |
| Total (N=80) | 20.38 | 6.90 | 40 | 30.23 | 12.75 | 40 | 4.30 | 0.01 |
| Boys (N=40) | 22.80 | 7.12 | 20 | 32.35 | 12.23 | 20 | 3.02 | 0.01 |
| Girls (N=40) | 17.95 | 5.89 | 20 | 28.10 | 13.21 | 20 | 3.14 | 0.01 |

As per table 4.11, the t-values obtained for the comparison of mean Retention Scores of Achievement in Physics Post-Test II of Experimental

Group and Control Group for Total Sample, Boys and Girls are found to be significant at 0.01 level for appropriate degrees of freedom.

The results indicate that the Experimental Group and Control Group are significantly different with respect to the mean Retention Scores of Achievement in Physics Post-Test II for Total Sample, Boys and Girls.

The high retention scores of Achievement in Physics of Experimental Group suggest the superiority of this group over Control Group for the Total Sample, Boys and Girls.

### 4.2.1.4. Comparison of Mean Gain Scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test) of Experimental Group and Control Group for Total Sample, Boys and Girls

To find out the difference in the mean gain scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test) of Experimental Group and Control Group for the Total Sample, Boys and Girls, two-tailed test of significance of difference between means was used. The data and results are presented in Table 4.12.

TABLE 4.12

**Data and Results of t-test for the Mean Gain Scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test) between Control Group and Experimental Group (Total Sample, Boys and Girls)**

| Sample | Control Group | | | Experimental Group | | | t-value | Level of Significance |
|---|---|---|---|---|---|---|---|---|
| | $M_1$ | $SD_1$ | $N_1$ | $M_2$ | $SD_2$ | $N_2$ | | |
| Total (N=80) | 13.23 | 2.56 | 40 | 22.70 | 8.59 | 40 | 6.68 | 0.01 |
| Boys (N=40) | 12.90 | 2.49 | 20 | 21.60 | 7.50 | 20 | 4.92 | 0.01 |
| Girls (N=40) | 13.55 | 2.65 | 20 | 23.80 | 9.63 | 20 | 4.59 | 0.01 |

As per Table 4.12 the mean gain scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test) for Experimental Group and Control Group were found to be significantly different at 0.01 level for the Total Sample, Boys and Girls, as the obtained t-values are well beyond the t-values accepted for 0.01 level with appropriate degrees of freedom.

The results indicate that the Experimental Group and Control Group are significantly different with respect to the mean gain scores of Achievement in Physics Post-Test II for Total Sample, Boys and Girls.

The high mean gain scores of Achievement in Physics Post-Test II of Experimental Group suggest the superiority of this group over Control Group for the Total Sample, and Sample of Boys and Girls.

### 4.2.1.5. Summary and Discussion of Mean Difference Analysis of Achievement in Physics of Experimental Group and Control Group

Difference in mean Achievement in Physics between Experimental Group and Control Group was compared with regard to Post-Test I scores, Retention scores and Gain-scores in Post-Test I and Post-Test II. Mean difference analysis was done for Total Sample, Boys and Girls. The t-values obtained are summarised and are presented in Table 4.13.

TABLE 4.13

**Summary of the Results of Mean Difference Analysis of Achievement in Physics of Experimental Group and Control Group**

| Dependent Variable | Sample | t-value | Level of Significance |
|---|---|---|---|
| Achievement in Physics Post-Test I | Total | 2.27 | 0.05 |
| | Boys | 1.37 | NS |
| | Girls | 1.88 | NS |
| Gain Scores (Post-Test I minus Pre-Test) | Total | 3.37 | 0.01 |
| | Boys | 1.96 | NS |
| | Girls | 2.81 | 0.01 |
| Achievement in Physics Post-Test II | Total | 4.30 | 0.01 |
| | Boys | 3.02 | 0.01 |
| | Girls | 3.14 | 0.01 |
| Gain scores (Post-Test II minus Pre-Test) | Total | 6.68 | 0.01 |
| | Boys | 4.92 | 0.01 |
| | Girls | 4.59 | 0.01 |

t-values presented in Table 4.13 indicate that there exist a significant difference in the scores of Post-Test I, Post- Test II, (Retention Score) and Gain scores in Post- Test I and Post-Test II for the Total Sample when Experimental Group and Control Group were compared. For Boys significant difference was found for scores in Post-Test II and Gain scores in Post-Test II. For Girls significant difference was found for scores in Post- Test II and Gain scores in Post-Test I and Post-Test II. On the whole Experimental Group taught through Concept Attainment Model of Teaching is superior to Control Group taught through Objective Based Instruction in the Mean Achievement in Physics.

### 4.2.2. INVESTIGATION OF DIFFERENCE IN MEAN SCORES OF ACHIEVEMENT IN PHYSICS OF STUDENTS HAVING DIFFERENT STUDYING APPROACHES

Analysis of data by comparing Achievement in Physics between students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying are presented in this section. To examine whether significant difference exist, if any, in the mean scores of Achievement in Physics between students having different Studying Approaches, twelve comparisons were done. Two-tailed test of significance of difference between means for small independent samples was used to interpret the result. The means, standard deviations and t-values were computed for all the comparisons. Analysis and Interpretation of data are presented in the following sub-sections.

4.2.2.1. Comparison of Mean Scores of Achievement in Physics Post-Test I for Students having Deep Approach to Studying and Surface Approach to Studying.

4.2.2.2. Comparison of Mean Scores of Achievement in Physics Post-Test I for Students having Deep Approach to Studying and Strategic Approach to Studying.

4.2.2.3. Comparison of Mean Scores of Achievement in Physics Post-Test I for Students having Surface Approach to Studying and Strategic Approach to Studying.

4.2.2.4. Comparison of Mean Gain Scores of Achievement in Physics Post-Test I (Post-Test I minus Pre-Test) for Students having Deep Approach to Studying and Surface Approach to Studying.

4.2.2.5. Comparison of Mean Gain Scores of Achievement in Physics Post-Test I (Post-Test I minus Pre-Test) for Students having Deep Approach to Studying and Strategic Approach to Studying.

4.2.2.6. Comparison of Mean Gain Scores of Achievement in Physics Post-Test I (Post-Test I minus Pre-Test) for Students having Surface Approach to Studying and Strategic Approach to Studying.

4.2.2.7. Comparison of Mean Retention Scores of Achievement in Physics Post-Test II for Students having Deep Approach to Studying and Surface Approach to Studying.

4.2.2.8. Comparison of Mean Retention Scores of Achievement in Physics Post-Test II for Students having Deep Approach to Studying and Strategic Approach to Studying.

4.2.2.9. Comparison of Mean Retention Scores of Achievement in Physics Post-Test II for Students having Surface Approach to Studying and Strategic Approach to Studying.

4.2.2.10. Comparison of Mean Gain Scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test) for Students having Deep Approach to Studying and Surface Approach to Studying.

4.2.2.11. Comparison of Mean Gain Scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test) for Students having

Deep Approach to Studying and Strategic Approach to Studying.

4.2.2.12. Comparison of Mean Gain Scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test) for Students having Surface Approach to Studying and Strategic Approach to Studying.

### 4.2.2.1. Comparison of Mean Scores of Achievement in Physics Post-Test I for Students having Deep Approach to Studying and Surface Approach to Studying

The mean and standard deviation of scores on Achievement in Physics Post-Test I for students having Deep Approach to Studying and Surface Approach to Studying were calculated and t-values were found out. The data and results are presented in Table 4.14.

TABLE 4.14

**Data and Results of t-test for the Mean Scores of Achievement in Physics Post-Test I between Students having Deep Approach to Studying and Surface Approach to Studying**

| Sample | Mean | Standard deviation | N | t-value | Level of Significance |
|---|---|---|---|---|---|
| Students having Deep Approach to Studying | 51.68 | 5.97 | 22 | 33.95 | 0.01 |
| Students having Surface Approach to Studying | 25.66 | 4.03 | 32 | | |

From Table 4.14 it is observed that the obtained t-value for comparison of Achievement in Physics Post-Test I between students having Deep Approach to Studying and Surface Approach to Studying is significant at 0.01 level for appropriate degrees of freedom. The result indicate that the mean scores of Achievement in Physics Post-Test I of Students having Deep Approach to Studying and Surface Approach to Studying are significantly different suggesting that the groups are not identical.

From the results it can be noted that high Mean Achievement in physics is associated with students having Deep Approach to studying suggesting the superiority of this group over the sample of students having Surface Approach to studying.

#### 4.2.2.2. Comparison of Mean scores of Achievement in Physics Post-Test I for students having Deep Approach to Studying and Strategic Approach to Studying

To find out the difference in mean scores of Achievement in Physics Post-Test I for students having Deep Approach to studying and Strategic Approach to studying, two-ailed test of significance of difference between means was used. The data and results are presented in Table 4.15.

TABLE 4.15

**Data and Results of t-test for the Mean Scores of Achievement in Physics Post-Test I between Students having Deep Approach to Studying and Strategic Approach to Studying**

| Sample | Mean | Standard deviation | N | t-value | Level of Significance |
|---|---|---|---|---|---|
| Students having Deep Approach to Studying | 51.68 | 5.97 | 22 | 6.63 | 0.01 |
| Students having Strategic Approach to Studying | 39.12 | 7.16 | 26 | | |

As per Table 4.15 the t-value obtained for comparison of Achievement in Physics Post-Test I between students having Deep Approach to Studying and Strategic Approach to studying is significant at 0.01 level for appropriate degrees of freedom. The result indicates that the mean scores of Achievement in Physics Post-Test I of students having Deep Approach to studying and Strategic Approach to studying are significantly different.

High Mean scores for Achievement in Physics Post-Test I is associated with sample of students having Deep Approach to studying suggesting the superiority of this group over the sample of students having Strategic Approach to studying.

### 4.2.2.3. Comparison of Mean Scores of achievement in Physics Post-Test I between students having Surface Approach to Studying and Strategic Approach to Studying

The t-values were obtained when the Mean Scores of Achievement in Physics Post-Test I for students having Surface Approach to studying and Strategic Approach to studying were compared. The data and results are presented in Table 4.16.

TABLE 4.16

**Data and Results of t-test for the Mean Scores of Achievement in Physics Post-Test I between Students having Surface Approach to Studying and Strategic Approach to studying**

| Sample | Mean | Standard deviation | N | t-value | Level of Significance |
|---|---|---|---|---|---|
| Students having Surface Approach to Studying | 25.66 | 4.03 | 32 | 8.55 | 0.01 |
| Students having Strategic Approach studying | 39.12 | 7.16 | 26 | | |

Table 4.16 reveals that the t-value obtained for comparison of means scores of Achievement in Physics Post-Test I between students having Surface Approach to Studying and Strategic Approach to studying is significant at 0.01 level for appropriate degrees of freedom. The result indicates that the mean scores of Achievement in Physics Post-Test I of

students having Surface Approach to studying and Strategic Approach to studying are significantly different.

High mean score of Achievement in Physics Post-Test I is associated with sample of students having Strategic Approach to studying indicating the superiority of this group over the sample of students having Surface Approach to studying.

#### 4.2.2.4. Comparison of Mean Gain Scores of Achievement in Physics Post-Test I (Post-Test I minus Pre-Test) for students having Deep Approach to studying and Surface Approach to studying

The t-values were found out to compare the mean gain scores of Achievement in Physics Post-Test I (Post-Test I minus Pre-Test) for students having Deep Approach to studying and Surface Approach to studying. The date and results are presented in Table 4.17.

TABLE 4.17

**Data and Results of t-test for the Mean Gain Scores of Achievement in Physics (Post-Test I minus Pre-Test) between students having Deep Approach to studying and Surface Approach to studying**

| Sample | Mean | Standard deviation | N | t-value | Level of Significance |
|---|---|---|---|---|---|
| Students having Deep Approach to Studying | 36.86 | 4.44 | 22 | 39.11 | 0.01 |
| Students having Surface Approach to Studying | 22.84 | 3.63 | 32 | | |

As per Table 4.17 the t-value obtained for comparison of mean gain scores of Achievement in Physics Post-Test I between students having Deep Approach to studying and Surface Approach to studying is significant at 0.01 level for appropriate degrees of freedom. The result indicates that the mean gain scores of Achievement in Physics Post-Test I of students having Deep Approach to Studying and Surface Approach to studying are significantly different.

High mean Gain scores of Achievement in Physics Post-Test I is associated with sample of students having Deep Approach to studying indicating the superiority of this group over the sample of students having Surface Approach to studying.

### 4.2.2.5. Comparison of Mean Gain scores of Achievement in Physics Post-Test I (Post-Test I minus Pre-Test) for students having Deep Approach to Studying and Strategic Approach to studying

The mean gain scores of Achievement in Physics Post-Test I (Post-Test I minus Pre-Test) of students having Deep Approach to studying and Strategic Approach to studying were compared to study the difference, if any exist, using the test of significance of difference between means. The data and results are presented in Table 4.18.

TABLE 4.18

**Data and Results of t-test for the Mean Gain Scores of Achievement in Physics (Post-Test I minus Pre-Test) between students having Deep Approach to studying and Strategic Approach to studying**

| Sample | Mean | Standard deviation | N | t-value | Level of Significance |
|---|---|---|---|---|---|
| Students having Deep Approach to Studying | 36.86 | 4.44 | 22 | 2.56 | 0.05 |
| Students having Strategic Approach to Studying | 32.54 | 7.13 | 26 | | |

Table 4.18 reveals that the t-value obtained for comparison of mean gain scores of Achievement in Physics Post-Test I between students having Deep Approach to studying and Strategic Approach to studying is

significant at 0.05 level for appropriate degrees of freedom. The result indicates that the mean gain scores of Achievement in Physics Post-Test I for students having Deep Approach to studying and Strategic Approach to studying are significantly different.

The results show that students having Deep Approach to studying have high mean gain scores than students having Strategic Approach to studying. But the difference is only at 0.05 level of significance.

#### 4.2.2.6. Comparison of Mean Gain Scores of Achievement in Physics Post-Test I (Post-Test I minus Pre-Test) for students having Surface Approach to studying and Strategic Approach to studying

The mean gain scores of Achievement in Physics Post-Test I (Post-Test I minus Pre-Test) of students having Surface Approach to studying and Strategic Approach to studying were compared to study the difference, if any exist, using the test of significance of difference between means. The data and results are presented in Table 4.19.

TABLE 4.19

**Data and Results of t-test for the Mean Gain Scores of Achievement in Physics (Post-Test I minus Pre-Test) between Students having Surface Approach to Studying and Strategic Approach to Studying**

| Sample | Mean | Standard deviation | N | t-value | Level of Significance |
|---|---|---|---|---|---|
| Students having Surface approach to Studying | 22.84 | 3.63 | 32 | 6.3 | 0.01 |
| Students having Strategic Approach to Studying | 32.54 | 7.13 | 26 | | |

As per Table 4.19, the t-value obtained for comparison of Mean Gain Scores of Achievement in Physics Post-Test I between students having Surface Approach to studying and Strategic Approach to studying is significant at 0.01 level for appropriate degrees of freedom. The result indicates that the mean gain scores of Achievement in Physics Post-Test I for students having Surface Approach to studying and Strategic approach to studying are significantly different.

High mean gain score of Achievement in Physics Post-Test I is associated with students having Strategic Approach to studying indicating the superiority of this group over the students having Surface Approach to studying.

### 4.2.2.7. Comparison of Mean Retention Scores of Achievement in Physics Post-Test II for students having Deep Approach to studying and Surface Approach to Studying

The Mean Retention Scores of Achievement in Physics Post-Test II of students having Deep Approach to studying and Surface Approach to studying were compared to study the difference, if any exist, using the test of significance of difference between means. The data and results are presented in Table 4.20.

TABLE 4.20

**Data and Results of t-test for the Mean Retention Scores of Achievement in Physics Post-Test II between students having Deep Approach to Studying and Surface Approach to Studying**

| Sample | Mean | Standard deviation | N | t-value | Level of Significance |
|---|---|---|---|---|---|
| Students having Deep Approach to Studying | 36.73 | 8.97 | 22 | 27.07 | 0.01 |
| Students having Surface Approach to Studying | 15.25 | 4.10 | 32 | | |

As per Table 4.20, the t-value obtained for comparison of Mean Retention scores of Achievement in Physics Post Test II between students having Deep Approach to studying and Surface Approach to studying is significant at 0.01 level for appropriate degrees of freedom. The result indicates that the Mean Retention Scores of Achievement in Physics Post-Test II for students having Deep Approach to studying and Surface Approach to studying are significantly different.

The table reveals that students having Deep Approach to studying have high mean Retention scores than students having Surface Approach to studying. The difference is very high indicating that the students having Deep Approach to studying is far superior to students having Surface Approach to studying.

**4.2.2.8. Comparison of Mean Retention Scores of Achievement in Physics Post-Test II for students having Deep Approach to Studying and Strategic Approach to Studying**

Test of significance of difference between means was used to compare the mean Retention Scores of Achievement in Physics Post-Test II of students having Deep Approach to studying and Strategic Approach to studying. The data and results are presented in Table 4.21.

TABLE 4.21

**Data and Results of t-test for the Mean Retention Scores of Achievement in Physics Post-Test II between students having Deep Approach to Studying and Strategic Approach to Studying**

| Sample | Mean | Standard deviation | N | t-value | Level of Significance |
|---|---|---|---|---|---|
| Students having Deep Approach to Studying | 36.73 | 8.97 | 22 | 3.51 | 0.01 |
| Students have Strategic Approach to Studying | 28.00 | 8.08 | 26 | | |

As per table 4.21 the t-value obtained for comparison of mean Retention scores of Achievement in Physics Post-Test II between students having Deep Approach to studying and Strategic Approach to studying is significant at 0.01 level for appropriate degrees of freedom. The result indicates that the mean Retention scores of Achievement in Physics Post-Test II for students having Deep Approach to studying and Strategic Approach to studying are significantly different.

The results reveal that students having Deep approach to studying have high mean Retention Scores of Achievement in Physics Post-Test II than students having Strategic Approach to studying. This indicates that students having Deep approach to studying is superior to students having Strategic Approach to studying.

### 4.2.2.9. Comparison of Mean Retention Scores of Achievement in Physics Post-Test II for students having Surface Approach to Studying and Strategic Approach to Studying

Test of significance of difference between means was used to compare the Mean Retention scores of Achievement in Physics Post-Test II of students having Surface Approach to studying and Strategic Approach to studying. The data and results are presented in Table 4.22.

TABLE 4.22

**Data and Results of t-test for the Mean Retention Scores of Achievement in Physics Post-Test II between students having Surface Approach to Studying and Strategic Approach to Studying**

| Sample | Mean | Standard deviation | N | t-value | Level of Significance |
|---|---|---|---|---|---|
| Students having Surface Approach to Studying | 15.25 | 4.10 | 32 | 7.32 | 0.01 |
| Students having Strategic Approach to Studying | 28.00 | 8.08 | 26 | | |

As per table 4.22 the t-value obtained for comparison of Mean Retention Scores of Achievement in Physics Post-Test II between students having Surface Approach to studying and Strategic Approach to studying is significant at 0.01 level for appropriate degrees of freedom. The result indicates that the mean Retention Scores of Achievement in Physics Post-

Test II for students having Surface Approach to studying is significantly different from that of students having Strategic Approach to studying.

The result shows that students having Strategic Approach to studying have high mean Retention scores in Achievement in Physics Post-Test II than students having Surface Approach to studying. This indicates that students having Strategic Approach to studying is superior to students having Surface Approach to studying.

### 4.2.2.10. Comparison of Mean Gain Scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test) for students having Deep Approach to Studying and Surface Approach to Studying

Test of significance of difference between means was used to compare the Mean Gain scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test) of students having Deep Approach to studying and Surface Approach to studying. The data and results are presented is Table 4.23.

TABLE 4.23

**Data and Results of t-test for the Mean Gain Scores of Achievement in Physics Post-Test II between students having Deep Approach to studying and Surface Approach to Studying**

| Sample | Mean | Standard deviation | N | t-value | Level of Significance |
|---|---|---|---|---|---|
| Students having Deep Approach to Studying | 21.91 | 8.49 | 22 | 5.07 | 0.01 |
| Students having Surface Approach to Studying | 12.44 | 2.63 | 32 | | |

Table 4.23 reveals that, the t-value obtained for comparison of Mean Gain scores of Achievement in Physics Post-Test II between students having Deep Approach to studying and Surface Approach to studying is significant at 0.01 level for appropriate degrees of freedom. The result indicates that the mean Gain scores of Achievement in Physics Post-Test II for students having Deep Approach to studying and Strategic Approach to studying are significantly different.

High mean Gain score of Achievement in Physics Post-Test II is associated with students having Deep Approach to studying indicating the superiority of this group over students having Surface Approach to studying.

### 4.2.2.11. Comparison of Mean Gain Scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test) for students having Deep approach to studying and Strategic Approach to Studying

Test of significance of difference between Means was used to compare the Mean Gain Scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test) of students having Deep Approach to studying and Strategic Approach to studying. The data and results are presented in Table 4.24.

TABLE 4.24

**Data and Results of t-test for the Mean Gain Scores of Achievement in Physics Post-Test II between students having Deep Approach to studying and Strategic Approach to studying**

| Sample | Mean | Standard deviation | N | t-value | Level of Significance |
|---|---|---|---|---|---|
| Students having Deep Approach to Studying | 21.91 | 8.49 | 22 | 0.20 | NS |
| Students having Strategic Approach to Studying | 21.42 | 7.94 | 26 | | |

As per table 4.24, the t-value obtained for comparison of mean Gain Scores of Achievement in Physics Post-Test II between students having Deep Approach to studying and Strategic Approach to studying is not significant. The result indicates that the students having Deep Approach to studying and Strategic Approach to studying are similar in their mean Gain scores of Achievement in Physics Post-Test II.

**4.2.2.12. Comparison of Mean Gain scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test) for students having Surface Approach to Studying and Strategic Approach to Studying**

The Mean Gain Scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test) of students having Surface Approach to studying and Strategic Approach to studying were compared using Test of significance of difference between means. The data and results are presented in Table 4.25.

TABLE 4.25

**Data and Results of t-test for the Mean Gain Scores of Achievement in Physics Post-Test II between students having Surface Approach to studying and Strategic Approach to Studying**

| Sample | Mean | Standard deviation | N | t-value | Level of Significance |
|---|---|---|---|---|---|
| Students having surface Approach to Studying | 12.44 | 2.63 | 32 | 5.53 | 0.01 |
| Students having Strategic Approach to Studying | 21.42 | 7.94 | 26 | | |

As per Table 4.25, the t-value obtained for comparison of Mean Gain Scores of Achievement in Physics Post-Test II between students having Surface Approach to studying and Strategic Approach to studying is significant at 0.01 level for appropriate degrees of freedom. The result indicates that the mean Gain scores of Achievement in Physics Post-Test II for students having Surface Approach to studying and Strategic Approach to studying are significantly different.

High mean Gain score of Achievement in Physics Post-Test II is associated with students having Strategic Approach indicating the superiority of this group over students having Surface Approach to studying.

**4.2.2.13. Summary and Discussion of Mean Difference Analysis of Achievement in Physics of Students having Deep Approach to studying, Surface Approach to studying and Strategic Approach to studying**

Difference in Mean Achievement in Physics between students having Deep Approach to studying, Surface Approach to studying and Strategic Approach to studying were compared with regard to Post-Test I scores, Retention Scores and Gain Scores in Post-Test I and Post-Test II. The t-values obtained are summarised and presented in Table 4.26.

TABLE 4.26

**Summary of the Results of Mean Difference Analysis of Achievement in Physics of students having Deep Approach to studying, Surface Approach to Studying and Strategic Approach to Studying**

| Dependent Variable | Studying Approaches compared | t-values | Level of significance |
|---|---|---|---|
| Achievement in Physics Post-Test I | Deep Approach Vs Surface Approach | 33.95 | 0.01 |
| | Deep Approach Vs Strategic Approach | 6.63 | 0.01 |
| | Surface Approach Vs Strategic Approach | 8.55 | 0.01 |
| Gain Scores (Post-Test I minus Pre-Test) | Deep Approach Vs Surface Approach | 39.11 | 0.01 |
| | Deep Approach Vs Strategic Approach | 2.56 | 0.05 |
| | Surface Approach Vs Strategic Approach | 6.3 | 0.01 |
| Achievement in Physics Post-Test II | Deep Approach Vs Surface Approach | 27.07 | 0.01 |
| | Deep Approach Vs Strategic Approach | 3.51 | 0.01 |
| | Surface Approach Vs Strategic Approach | 7.32 | 0.01 |
| Gain Scores (Post-Test II minus Pre-Test) | Deep Approach Vs Surface Approach | 5.07 | 0.01 |
| | Deep Approach Vs Strategic Approach | 0.20 | NS |
| | Surface Approach Vs Strategic Approach | 5.53 | 0.01 |

As per Table 4.26, t-values indicate that students having Deep Approach to studying, Surface Approach to studying and Strategic Approach to studying differ significantly in their Achievement in Physics with regard to scores in Post-Test I, Post-Test II and Gain scores in Post-Test I and Post-Test II except for the case of comparison of Gain scores in

Post-Test II of students having Deep Approach to studying and Strategic Approach to studying. The t-values indicate that the difference between students having Deep Approach to studying and Surface Approach to studying is much greater than the difference between student having Deep approach to studying and Strategic Approach to studying. Analysis of Mean scores suggest that students having Deep approach to studying is superior to students having Strategic Approach to studying and Surface Approach to studying in their Achievement in Physics. Students having Strategic Approach to studying is superior to students having Surface Approach to studying but inferior to students having Deep Approach to Studying in their Achievement in physics. Students having Surface Approach to studying is having least mean achievement in physics.

### 4.2.3. INVESTIGATION OF THE MAIN EFFECT AND INTERACTION EFFECT OF METHODS OF TEACHING AND STUDYING APPROACH ON ACHIEVEMENT IN PHYSICS (POST-TEST I AND POST-TEST II) FOR TOTAL SAMPLE, BOYS AND GIRLS

This part of the analysis was taken up with a view to investigate whether variation in Achievement in Physics depend on variation in the select independent variables separately or in combination. The basic assumptions of using the ANOVA such as normality, linearity and homogeneity were ensured using Statistical Package for Social Sciences (SPSS). The analysis of the residuals were used for this purpose. The random pattern of the residuals indicate that the distribution is approximately normal. No missing observations were found in any cell. The analysis of residuals show that the dispersion of dependent variable within cells did not differ significantly which ensure the homogeneity of data. According to Ferguson (1981) one advantage of ANOVA is that reasonable departures from the assumptions of normality and homogeneity may occur without seriously affecting the validity of the inferences drawn from the data. However the examination of the major assumptions revealed that the basic assumptions are met to a satisfactory extend.

In this section, an attempt was made to investigate whether variation in Achievement in Physics (Post-test I and Post-test II) is dependent on variation in the teaching methods namely Concept Attainment Model of Teaching and Objective Based Instruction and the Studying Approaches namely Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying. Two-way analysis of variance was used to study the single effect and cross over effect of Methods of Teaching and Studying Approach on Achievement in physics. ANOVA was done separately for Total sample, Boys and Girls.

The data was analysed using 2x3 factorial ANOVA and the entire computations were carried out using Statistical Package for Social Sciences. Due to unequal number of cases in cells, the programme for unequal numbers was used for processing the data.

The results of two-way ANOVA and the interpretation of the results are discussed in this section. The main effects and interaction effect on Post-Test I for Total sample, Boys and Girls are presented first. The same pattern was used to discuss the results of two-way ANOVA for Achievement in Physics (Post-Test II).

#### 4.2.3.1. Main Effect and Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I for Total sample

To study the main effect and interaction effect of Methods of Teaching by Studying Approach on Achievement in Physics Post-Test I, ANOVA was carried out separately for the Total sample. Data and result of Two-way ANOVA are summarised and presented in Table 4.27.

TABLE 4.27

**Data and Results of Two-way ANOVA of Methods of Teaching by studying Approach (Achievement in Physics Post-Test I) for Total Sample (N=80)**

| Source of Variation | Sum of squares (S.S.) | Degrees of freedom dF | Mean square of variance | F | Level of signifi-cance |
|---|---|---|---|---|---|
| Methods of Teaching | 564.20 | 1 | 564.20 | 25.73 | 0.01 |
| Studying Approach | 8823.73 | 2 | 4411.87 | 201.22 | 0.01 |
| Methods of Teaching x Studying Approach | 347.95 | 2 | 173.98 | 7.94 | 0.01 |
| Explained | 9885.69 | 5 | 1977.14 | 90.18 | 0.01 |
| Residual | 1622.50 | 74 | 21.93 | | |
| Total | 11508.19 | 79 | 145.67 | | |

**Main Effect**

As per Table 4.27 the F-values obtained for the main effect of Teaching Methods and studying Approach on Achievement in Physics Post-Test I are 25.73 and 201.22 respectively. Both these values are found to be significant at 0.01 level for appropriate degrees of freedom. The results suggest that the scores of Achievement in Physics Post-Test I differ significantly with the Teaching Methods and Studying Approaches for the Total sample.

**Interaction Effect**

As per Table 4.27 the F-value obtained for the interaction effect of Teaching Methods and studying Approach on Achievement in physics Post-Test I is 7.94 which is found to be significant at 0.01 level for appropriate degrees of freedom. The result suggests that Achievement in Physics Post-Test I depends on the combined effect of methods of Teaching and Studying Approach for Total sample.

### 4.2.3.2. Main Effect and Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I for the sample of Boys

To study the main effect and interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I, ANOVA was carried out separately for the Boys. Data and results of the two-way ANOVA are summarised and presented in Table 4.28.

TABLE 4.28

**Data and Results of Two-way ANOVA of Achievement in Physics Post-Test I by Methods of Teaching by Studying Approach for the sample of Boys (N=40)**

| Source of Variation | Sum of squares (S.S) | Degrees of freedom dF | Mean square of variance | F | Level of significance |
|---|---|---|---|---|---|
| Methods of Teaching | 366.78 | 1 | 366.78 | 22.98 | 0.01 |
| Studying Approach | 5248.46 | 2 | 2624.23 | 164.43 | 0.01 |
| Methods of Teaching x Studying Approach | 127.22 | 2 | 63.61 | 3.99 | 0.05 |
| Explained | 5667.28 | 5 | 1133.46 | 71.02 | 0.01 |
| Residual | 542.62 | 34 | 15.96 | | |
| Total | 6209.90 | 30 | 159.23 | | |

**Main Effect**

As per Table 4.28, the F-value obtained for the main effect of Teaching Methods on Achievement in Physics Post-Test I is 22.98 which is significant at 0.01 level for appropriate degrees of freedom. The F value obtained for the main effect of Studying Approach on Achievement in Physics Post-Test I is 164.43 which is also significant at 0.01 level for appropriate degrees of freedom. Hence it may be concluded that the Methods of Teaching and Studying Approach have significant main effect on Achievement in Physics Post-Test I for the sample of Boys.

**Interaction Effect**

As per Table 4.28, the F value obtained for the interaction effect of Teaching Methods and Studying Approach on Achievement in Physics Post-Test I is 3.99 which is significant at 0.05 level for appropriate degrees of freedom. The result suggests that Achievement in Physics Post-Test I depends on the combined effect of Methods of Teaching and Studying Approach for the sample of Boys.

### 4.2.3.3. Main Effect and Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I for the sample of Girls

To study the main effect and interaction effect of Methods of teaching and studying Approach on Achievement in Physics Post-Test I, ANOVA was carried out separately for the sample of Girls. Data and results of the two-way ANOVA are summarised and presented in Table 4.29.

TABLE 4.29

**Data and Results of two-way ANOVA of Achievement in Physics Post-Test I by Methods of Teaching by Studying Approach for the sample of Girls (N=40)**

| Source of Variation | Sum of squares (S.S) | Degrees of freedom dF | Mean square of variance | F | Level of significance |
|---|---|---|---|---|---|
| Methods of Teaching | 205.32 | 1 | 205.32 | 8.82 | 0.01 |
| Studying Approach | 3518.75 | 2 | 1759.38 | 75.61 | 0.01 |
| Methods of Teaching x Studying Approach | 310.84 | 2 | 155.421 | 6.68 | 0.01 |
| Explained | 4258.62 | 5 | 851.72 | 36.60 | 0.01 |
| Residual | 791.16 | 34 | 23.27 | | |
| Total | 5049.78 | 39 | 129.48 | | |

**Main Effect**

As per Table 4.29, the F values obtained for the main effect of Teaching Methods and Studying Approach on Achievement in Physics Post-Test I are 8.82 and 75.61 respectively. Both these values are found to be significant at 0.01 level for appropriate degrees of freedom. The results indicate that scores of Achievement in Physics Post-Test I differ significantly with the Teaching Methods and Studying Approaches for the sample of Girls.

**Interaction Effect**

As per Table 4.29, the F-value obtained for the interaction effect of Teaching Methods and Studying Approach on Achievement in Physics Post-Test I is 6.68 which is significant at 0.01 level for appropriate degrees of freedom. The result suggests that Achievement in Physics Post-Test I depends on the combined effect of Methods of teaching and studying Approach for Girls.

### 4.2.3.4. Main Effect and Interaction Effect of Methods of Teaching and studying Approach on Achievement in Physics Post-Test II for Total sample

The sum of squares, variance and F-values were calculated to examine the main effect and interaction effect of Methods of Teaching and studying Approach on Achievement in Physics Post-Test II for Total sample. The data and results of Two-way ANOVA are summarised and presented in Table 4.30.

TABLE 4.30

**Data and Results of Two-way ANOVA of Achievement in Physics Post-Test II by Methods of Teaching by studying Approach for Total sample (N=80)**

| Source of Variation | Sum of squares (S.S) | Degrees of freedom dF | Mean square of variance | F | Level of significance |
|---|---|---|---|---|---|
| Methods of Teaching | 1703.34 | 1 | 1703.34 | 95.90 | 0.01 |
| Studying Approach | 6057.33 | 2 | 3028.66 | 170.52 | 0.01 |
| Methods of Teaching x Studying Approach | 824.66 | 2 | 412.33 | 23.21 | 0.01 |
| Explained | 8822.43 | 5 | 1764.49 | 99.34 | 0.01 |
| Residual | 1314.37 | 74 | 17.76 | | |
| Total | 10136.80 | 79 | 128.31 | | |

**Main Effect**

As per Table 4.30, the F-values obtained for the main effect of Teaching Methods and Studying Approach in Achievement in Physics Post-Test II are 95.90 and 170.52 respectively. Both these values are significant at 0.01 level for appropriate degrees of freedom. The results suggest that the scores of Achievement in Physics Post-Test II differ significantly with the Teaching Methods and Studying Approaches for the Total sample.

**Interaction Effect**

The F-value obtained for the interaction effect of Teaching Methods and Studying Approach on Achievement in Physics Post-Test II is 23.21 which is found to be significant at 0.01 level for appropriate degrees of freedom. The result suggests that Achievement in Physics Post Test II depends on the combined effect of Methods of Teaching and Studying Approach for Total sample.

### 4.2.3.5. Main Effect and Interaction Effect of Methods of teaching and studying Approach on Achievement in Physics Post-Test II for the sample of Boy (N=40)

The sum of squares, variance and F-values were calculated to examine the main effect and interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II for the sample of Boys. The data and results of two-way ANOVA are summarised and presented in Table 4.31.

TABLE 4.31

**Data and Results of Two-way ANOVA of Achievement in Physics Post-Test II by Methods of Teaching by studying Approach for Total sample of Boys (N=40)**

| Source of Variation | Sum of squares (S.S) | Degrees of freedom dF | Mean square of variance | F | Level of significance |
|---|---|---|---|---|---|
| Methods of Teaching | 1023.46 | 1 | 1023.46 | 72.12 | 0.01 |
| Studying Approach | 2995.51 | 2 | 1497.75 | 105.54 | 0.01 |
| Methods of Teaching x Studying Approach | 325.73 | 2 | 162.86 | 11.48 | 0.01 |
| Explained | 4233.26 | 5 | 846.65 | 59.66 | 0.01 |
| Residual | 482.52 | 34 | 14.19 | | |
| Total | 4715.78 | 39 | 120.92 | | |

**Main Effect**

As per Table 4.31, the F-values obtained for the main effect of Teaching Methods and Studying Approach on Achievement in Physics Post-Test II are 72.12 and 105.54 respectively. Both these values are found to be significant at 0.01 level for appropriate degrees of freedom. The results indicate that scores of Achievement in Physics Post-Test II differ significantly with Teaching Methods and Studying Approach for Boys.

**Interaction Effect**

The F-value obtained for the interaction effect of Teaching Methods and Studying Approach on Achievement in Physics Post-Test II is 11.48 which is significant at0.01level for appropriate degrees of freedom. The result suggests that Achievement in Physics Post-Test II depends on the combined effect of Methods of Teaching and Studying Approach for Boys.

**4.2.3.6. Main Effect and Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II for the sample of Girls (N=40)**

The sum of squares, variance and F-values were calculated to examine the main effect and interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II for the sample of Girls. The data and results of Two-way ANOVA are summarised and presented in Table 4.32.

TABLE 4.32

**Data and Results of Two-way ANOVA of Achievement in Physics Post-Test II by Methods of Teaching by Studying Approach for Total sample of Girls (N=40)**

| Source of Variation | Sum of squares (S.S) | Degrees of freedom dF | Mean square of variance | F | Level of significance |
|---|---|---|---|---|---|
| Methods of Teaching | 662.71 | 1 | 662.71 | 54.09 | 0.01 |
| Studying Approach | 2910.75 | 2 | 1455.37 | 118.78 | 0.01 |
| Methods of Teaching x Studying Approach | 649.41 | 2 | 324.71 | 26.50 | 0.01 |
| Explained | 4590.39 | 5 | 918.08 | 74.93 | 0.01 |
| Residual | 416.59 | 34 | 12.25 | | |
| Total | 5006.98 | 39 | 128.38 | | |

**Main Effect**

As per Table 4.32, the F-values obtained for the Main effect of Teaching Methods and Studying Approach on Achievement in Physics Post-Test II are 54.09 and 118.78 respectively. Both these values are significant at 0.01 level for appropriate degrees of freedom. The results indicate that scores of Achievement in Physics Post-Test II differ significantly with Teaching Methods and Studying Approaches for the sample of Girls.

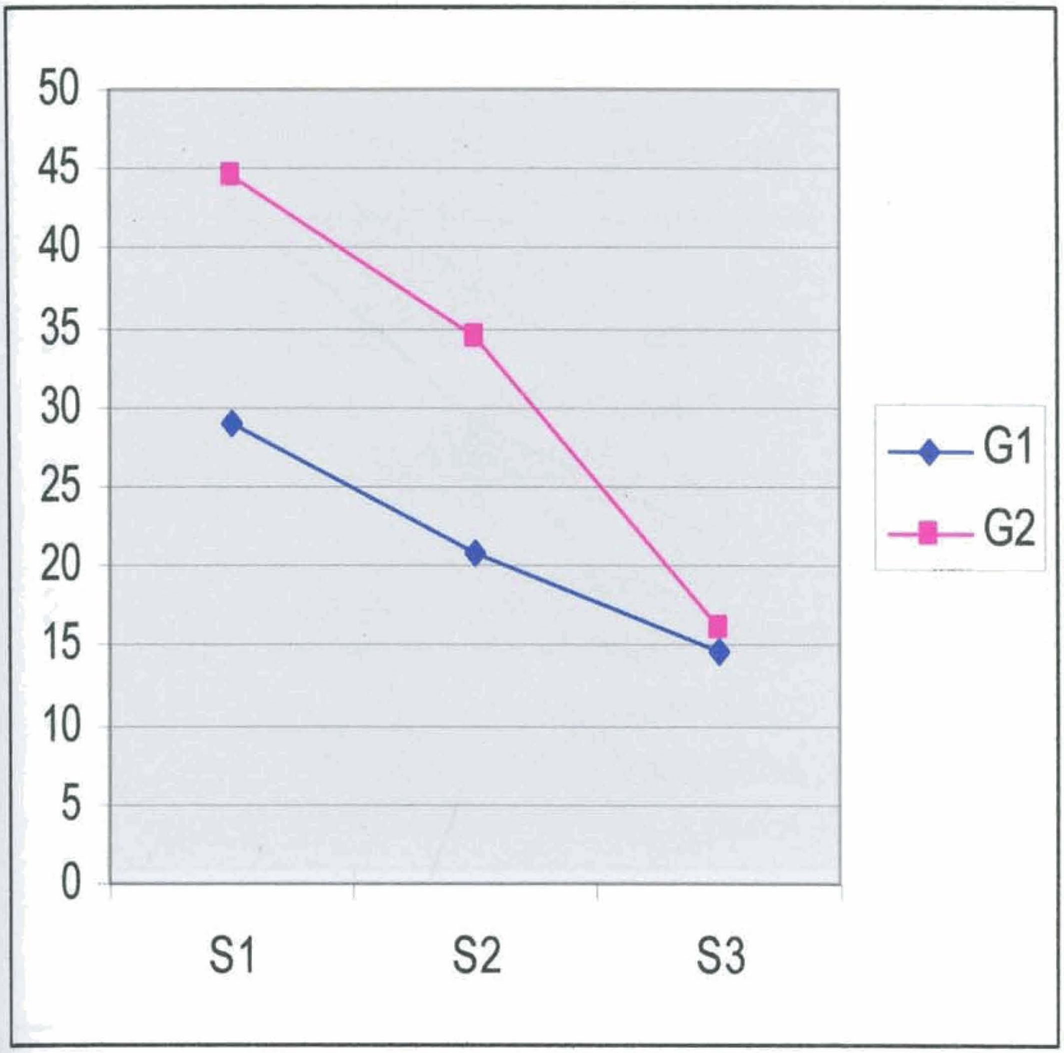
**Interaction Effect**

The F-value obtained for the interaction effect of Teaching Methods and studying Approach on Achievement in Physics Post Test II is 26.50 which is significant at 0.01 level for appropriate degrees of freedom. The result indicates that Achievement in Physics Post Test II depends on the combined effect of Methods of Teaching and Studying Approach for Girls.

**4.2.3.7. Graphical Representation of the Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I for Total sample, Boys and Girls**

Nine F-values computed to examine the main effect and interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I for Total sample, Boys and Girls revealed that all the F-values are significant. Therefore an attempt was made to study the interactions graphically. Three categories of Studying Approach were marked on the X-axis and the mean Achievement in Physics Post-Test I was marked along the Y-axis. The interaction effect was examined separately for Total sample, Boys and Girls.

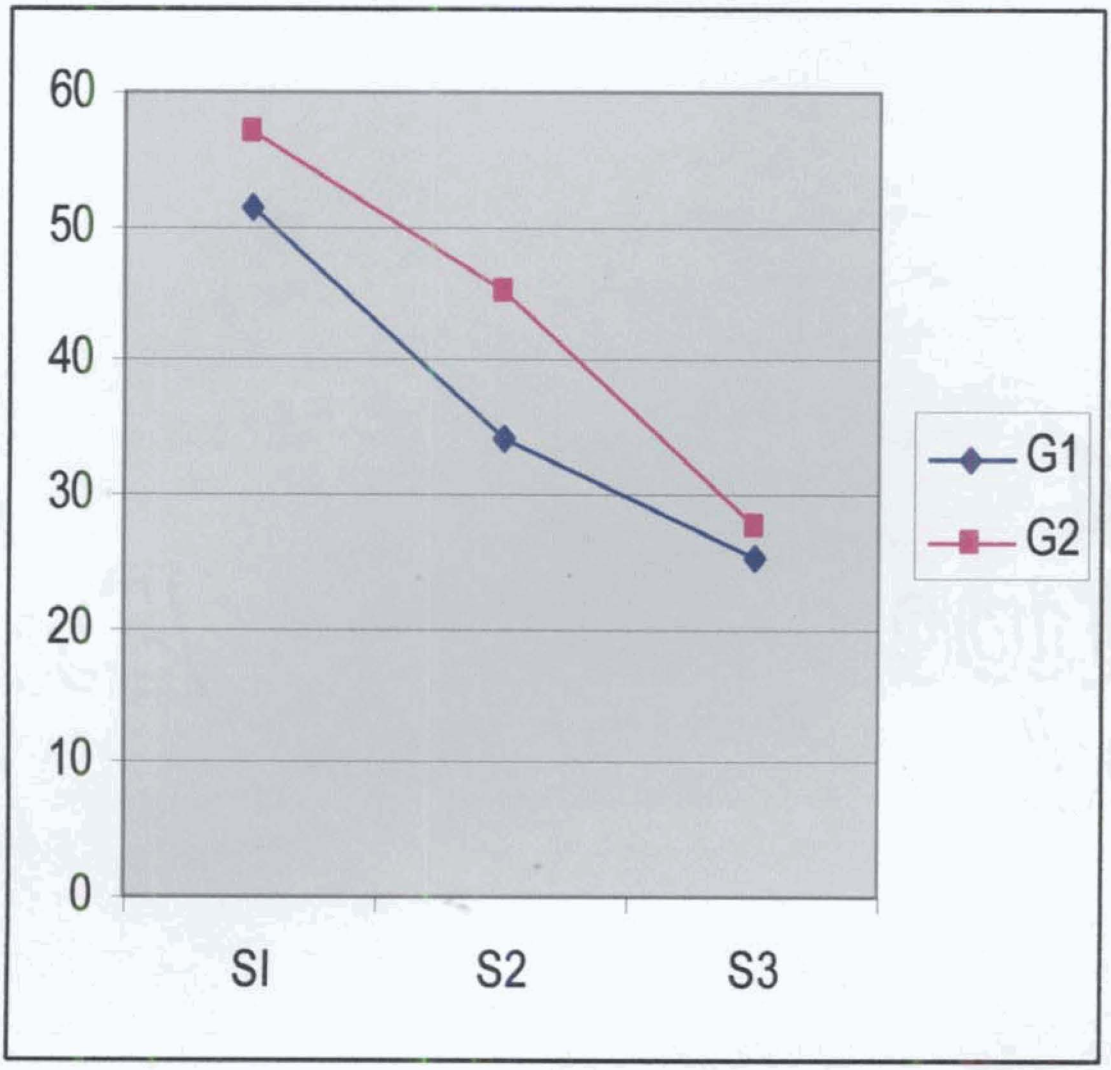
Graphical representation of the relationship between Methods of Teaching and Studying Approach of Total sample, Boys and Girls are presented in Figures 4-1, 4-2 and 4-3 respectively.




G1 – Control Group
G2 – Experimental Group

S1 – Deep Approach
S2 – Strategic Approach
S3 – Surface Approach

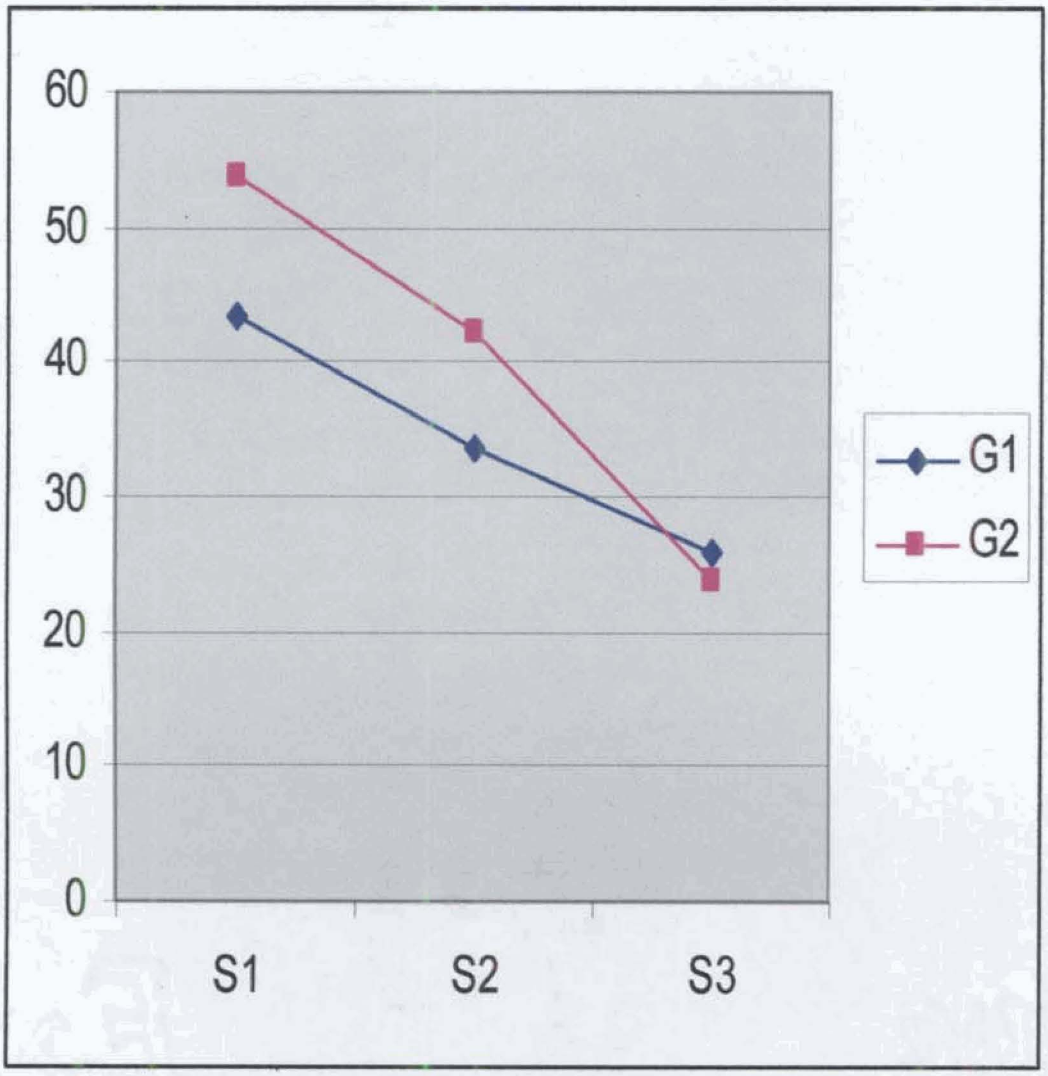
**FIGURE 4-1 Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I for Total Sample**




G1 – Control Group
G2 – Experimental Group

S1 – Deep Approach
S2 – Strategic Approach
S3 – Surface Approach

**FIGURE 4-2 Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I for Boys**




G1 – Control Group
G2 – Experimental Group

S1 – Deep Approach
S2 – Strategic Approach
S3 – Surface Approach

**FIGURE 4-3 Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I for Girls**

An examination of the graphs in Figures 4-1, 4-2 and 4-3 shows that the lines representing the mean scores of Achievement in Physics Post-Test I of the Experimental Group and Control Group at three levels of Studying Approach are not horizontal. This suggests the significant main effects of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I for Total sample, Boys and Girls. The fact that the lines separating the effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I are not parallel further illustrates the significant interaction effect. The slope of the lines in figures 4-1, 4-2 and 4-3 suggest that the interaction is synergistic interaction, that is, the better the Studying Approach the larger the mean scores in Achievement in Physics tend to be. The graphs also indicate that the mean Achievement in Physics is higher for the Experimental Group for students having Deep Approach to Studying, Strategic Approach to Studying and Surface Approach to Studying in the case of Total sample and Boys. In the case of Girls, the Experimental Group is having higher mean Achievement in Physics than the Control Group for students having Deep Approach to Studying and Strategic Approach to Studying. The Control Group and Experimental Groups are having almost similar mean Achievement in Physics for students having Surface Approach to Studying.

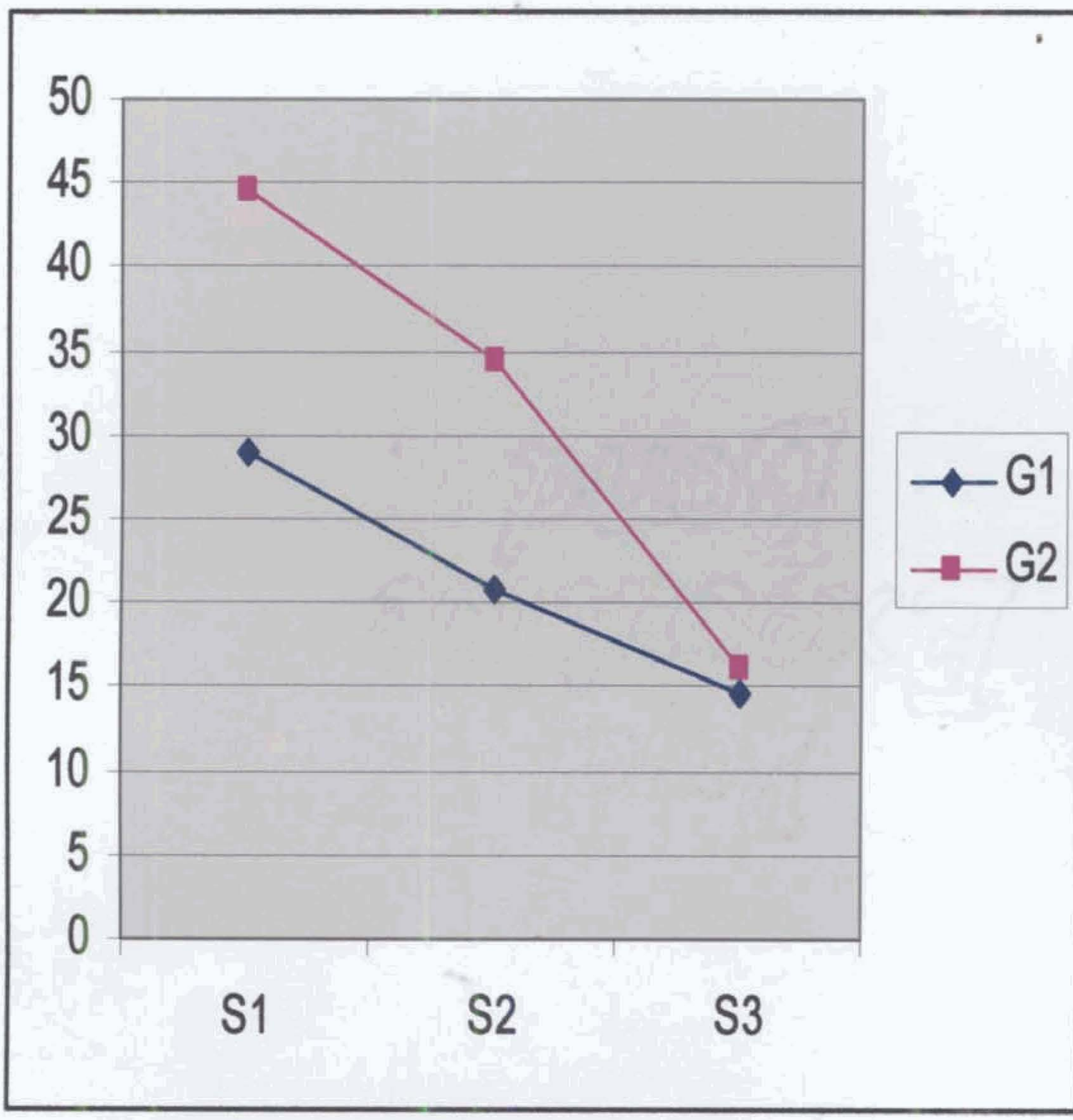
In the case of figure 4-1 and 4-3 it can be noted that difference in mean Achievement in Physics Post-Test I between Experimental Group and Control Group becomes narrower for students having Surface Approach to Studying than students having Strategic Approach to Studying. The difference is widest for students having Deep Approach to Studying. This interaction can be termed as Ceiling effect Interaction (Mc Burney, 2002).

The graphs further indicate that students having Deep Approach to Studying have highest mean scores in Achievement in Physics Post-Test I than students having Strategic Approach to Studying and Surface Approach to Studying in all the cases for both Experimental Group and Control Group. The students having Surface Approach to Studying is having the lowest mean Achievement in Physics in all the cases.

#### 4.2.3.8. Graphical Representation of the Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II for Total sample, Boys and Girls

Nine F-values computed to examine the main effect and interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II for Total sample, Boys and Girls revealed that all the F-ratios are significant. Therefore, the investigator made an attempt to study the nature of the relations of the variables graphically. Three categories of Studying Approach were marked on the X-axis and the mean Achievement in Physics Post-Test II was marked along the Y-axis. The interaction effect was examined separately for Total sample, Boys and Girls.

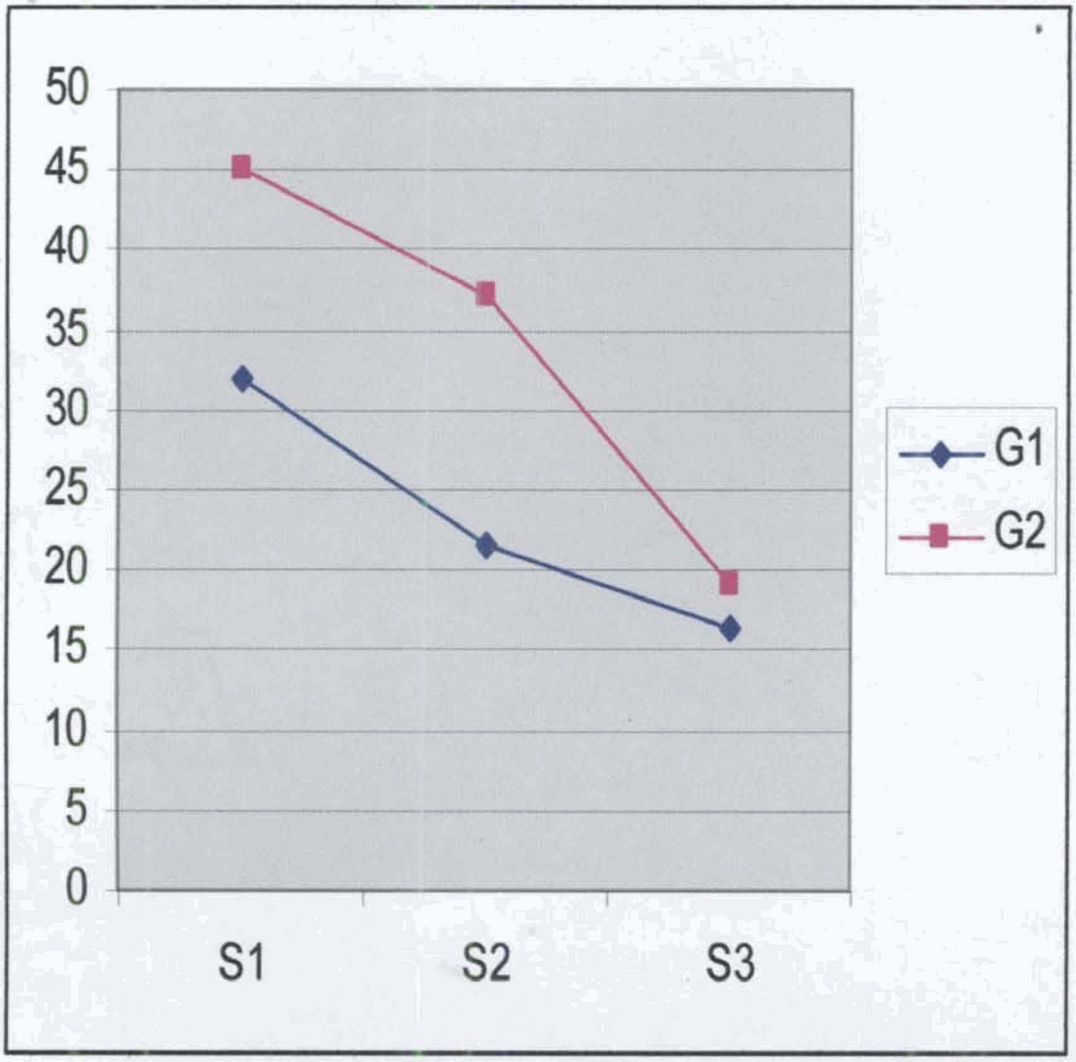
Graphical representation of the relationship between Methods of Teaching and Studying Approach of Total sample, Boys and Girls are presented in Figures 4-4, 4-5 and 4-6 respectively.




G1 – Control Group
G2 – Experimental Group

S1 – Deep Approach
S2 – Strategic Approach
S3 – Surface Approach

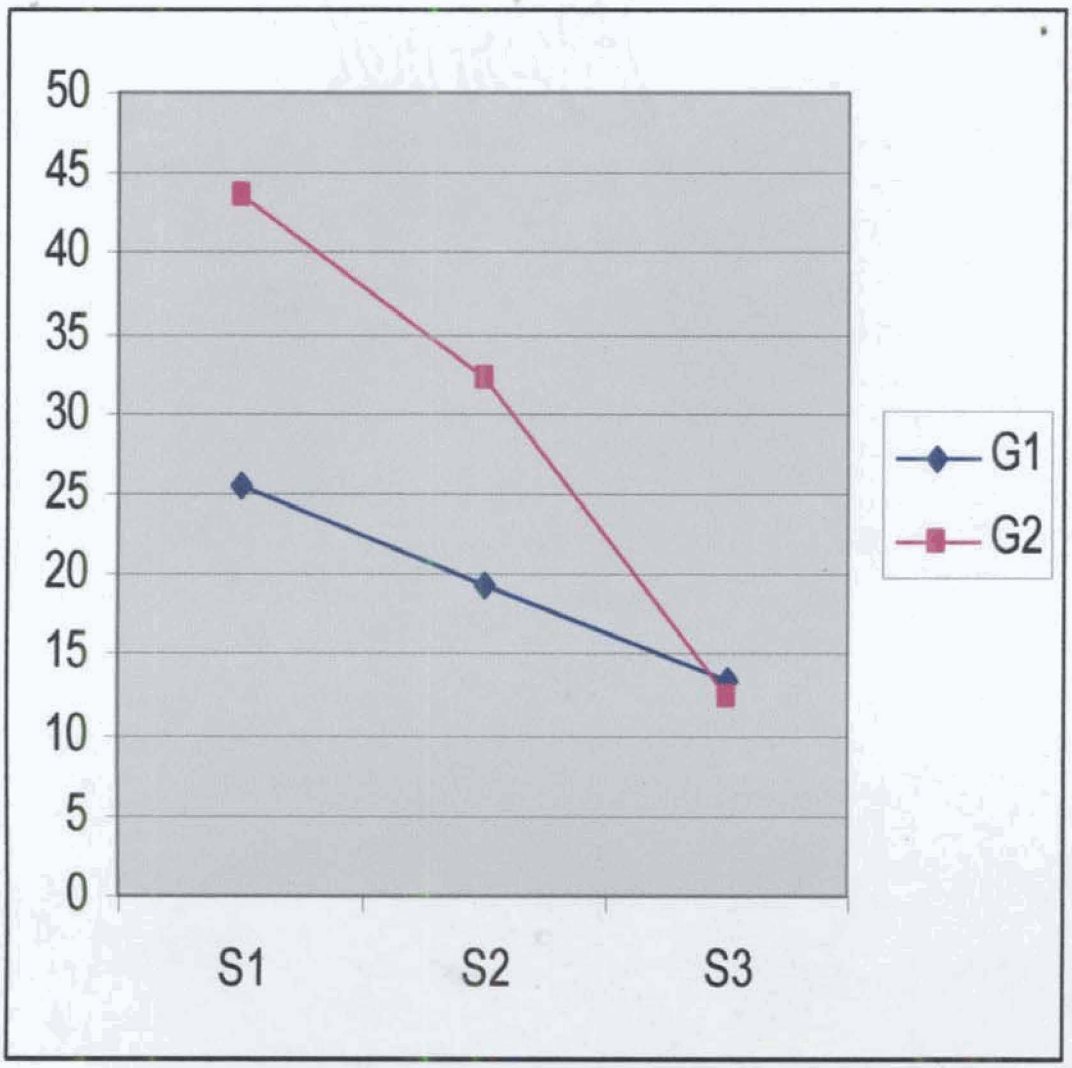
**FIGURE 4-4 Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II for Total sample**




G1 – Control Group
G2 – Experimental Group

S1 – Deep Approach
S2 – Strategic Approach
S3 – Surface Approach

**FIGURE 4-5 Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II for Boys**




G1 – Control Group
G2 – Experimental Group

S1 – Deep Approach
S2 – Strategic Approach
S3 – Surface Approach

**FIGURE 4-6 Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II for Girls**

An examination of the graphs figures 4-4, 4-5 and 4-6 show that the lines representing the mean scores of Achievement in Physics Post-Test II of the Experimental Group and Control Group at three levels of Studying Approach are not horizontal. This suggests the significant main effects of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II for Total sample, Boys and Girls. The fact that the lines separating the effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II are not parallel further illustrates the significant interaction effect. The slope of the lines in figures 4-4, 4-5 and 4-6 suggest that the interaction is synergistic interaction, that is, the better the Studying Approach the larger the mean scores in Retention in Physics tend to be. The graphs also indicate that the mean Retention in Physics is higher for the Experimental Group for students having Deep Approach to Studying, Strategic Approach to Studying and Surface Approach to Studying in the case of Total sample and Boys. In the case of Girls, the Experimental Group is having higher mean Retention in Physics than the Control Group for students having Deep Approach to Studying and Strategic Approach to Studying. The Experimental Group and the Control Group are having almost similar mean retention in Physics for students having Surface Approach to Studying.

In the case of figure 4-6 it can be noted that difference in mean Achievement in Physics Post-Test II (Retention) between Experimental Group and Control group become narrower for students having Surface Approach to Studying than students having Strategic Approach to Studying. The difference is widest for students having Deep Approach to Studying. This interaction can be termed as Ceiling effect Interaction.

The graphs further indicate that students having Deep Approach to Studying highest mean Retention scores in Physics than students having Strategic Approach to Studying and Surface Approach to Studying for both Experimental Group and Control Group in all the cases. The students having Surface Approach to Studying is having the lowest mean Retention in Physics in all the cases.

**4.2.3.9. Summary of Two-way ANOVA in Achievement in Physics**

To study the main effect and interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics eighteen F-values were found out. The significance of F-values obtained for the ANOVA are presented in Table 4.33.

TABLE 4.33

**Summary of the Significance of F-values of the Main Effect and Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics for Total sample, Boys and Girls**

| Dependent Variable | Sample | Source of variation | F-value | Level of significance |
|---|---|---|---|---|
| Achievement in Physics Post-Test I | Total | Methods of Teaching | 25.73 | 0.01 |
| | | Studying Approach | 201.22 | 0.01 |
| | | Methods of Teaching x Studying Approach | 7.94 | 0.01 |
| | Boys | Methods of Teaching | 22.98 | 0.01 |
| | | Studying Approach | 164.43 | 0.01 |
| | | Methods of Teaching x Studying Approach | 3.99 | 0.05 |
| | Girls | Methods of Teaching | 8.82 | 0.01 |
| | | Studying Approach | 75.61 | 0.01 |
| | | Methods of Teaching x Studying Approach | 6.68 | 0.01 |
| Achievement in Physics Post-Test II (Retention) | Total | Methods of Teaching | 95.90 | 0.01 |
| | | Studying Approach | 170.52 | 0.01 |
| | | Methods of Teaching x Studying Approach | 23.21 | 0.01 |
| | Boys | Methods of Teaching | 72.12 | 0.01 |
| | | Studying Approach | 105.54 | 0.01 |
| | | Methods of Teaching x Studying Approach | 11.48 | 0.01 |
| | Girls | Methods of Teaching | 54.09 | 0.01 |
| | | Studying Approach | 118.78 | 0.01 |
| | | Methods of Teaching x Studying Approach | 26.50 | 0.01 |

As per Table 4.33, it is evident that all the eighteen F-values obtained are significant. The scrutiny of the results of ANOVA conducted on Post-Test I and Post-Test II revealed the following:

(i) Method of Teaching has significant Main effect on Achievement in Physics Post-Test I and Post-Test II. Hence Achievement in Physics and Retention in Physics can be considered to be dependent on the Method of Teaching

(ii) Studying Approach has significant main effect on Achievement in Physics Post-Test I and Post-Test II. Hence Achievement in Physics and Retention in Physics can be considered to be dependent on Studying Approach.

(iii) Highly significant F-ratios are noticed for the main effect of Studying Approach on Achievement in Physics Post-Test I and Post-Test II. Hence it may be concluded that Achievement in Physics and Retention in Physics are highly influenced by the Studying Approach of the learner.

(iv) The interaction effect of Methods of Teaching and Studying Approach is significant for Achievement in Physics Post-Test I and Post-Test II. Therefore it may be inferred that variations in Achievement in Physics and Retention in Physics can be attributed to the combined effect of Methods of Teaching and Studying Approach.

### 4.2.4. POSTHOC INVESTIGATION OF GROUP DIFFERENCES

This part of the analysis was undertaken with a view to make analytical comparison of relevant sub groups with regard to the mean score of the dependent variable after the data was analysed using Analysis of Variance. A post-hoc comparison enable to test the null hypothesis that the means of the dependent variable scores (in the present study Achievement in Physics Post-Test I and Achievement in Physics Post-Test II) for each level of the select independent variable will not be significantly different.

Summary of the two-way ANOVA revealed that there exists significant main effect on Achievement in Physics Post-Test I and Post-Test II for the select independent variables Methods of Teaching and Studying Approach. It was also noticed that significant interaction effect exist for the independent variables on Achievement in Physics Post-Test I and Post-Test II. Hence, Post-hoc comparison was attempted to investigate the significance of mean difference of Achievement in Physics for the groups formed on the basis of two categories.

1. Groups formed on the basis of Methods of Teaching.
2. Groups formed on the basis of Studying Approaches.

The post-hoc analysis is presented under the following sections.

4.2.4.1. Comparison of Mean Scores of Achievement in Physics Post-Test I and Post-Test II between Experimental Group and Control Group

4.2.4.2. Comparison of Mean Scores of Achievement in Physics Post-Test I between groups formed on the basis of Studying Approaches.

4.2.4.3. Comparison of Mean Scores of Achievement in Physics Post-Test II between Groups formed on the basis of Studying Approaches.

**4.2.4.1. Comparison of Mean Scores of Achievement in Physics Post-Test I and Post-Test II between Experimental Group and Control Group**

ANOVA of Achievement in Physics Post-Test I and Post-Test II by Methods of Teaching by Studying Approach was computed for Total Sample, Boys and Girls.

The F-values obtained were significant for Methods of Teaching for Total sample, Boys and Girls. Therefore, mean scores of Achievement in Physics Post-Test I and Post-Test II of the two groups categorised on the basis of Methods of Teaching were compared.

Summary of the result of test of significance of difference between means of Achievement in Physics Post-Test I and Post-Test II of Experimental Group and Control Group are presented in Table 4.34.

TABLE 4.34

**Summary of the Test of Significance of Difference between Means of Achievement in Physics Post-Test I and Post-Test II of the Two Groups Based on Methods of Teaching for Total Sample, Boys and Girls**

| Dependent Variable | Sample | t-Value | Level of Significance |
|---|---|---|---|
| Achievement in Physics Post-Test I | Total | 2.27 | 0.05 |
| | Boys | 1.37 | N.S. |
| | Girls | 1.88 | N.S. |
| Achievement in Physics Post-Test II | Total | 4.30 | 0.01 |
| | Boys | 3.02 | 0.01 |
| | Girls | 3.14 | 0.01 |

Table 4.34 reveals that the t-value is significant at 0.05 level for Total sample. But it is not significant for the subsamples Boys and Girls for Achievement in Physics Post-Test I.

In the case of Achievement in Physics Post-Test II, all the t-values are significant at 0.01 level. This shows that the two groups based on Methods of Teaching have significant difference in their Achievement in Physics Post-Test II for Total Sample, Boys and Girls.

In all the cases high mean scores were found associated with Concept Attainment Model of Teaching. This indicates the advantage of Concept Attainment Model over Objective Based Instruction.

**4.2.4.2. Comparison of Mean Scores of Achievement in Physics Post-Test I between Groups formed on the basis of Studying Approaches**

Scheffé test of multiple comparison was used for comparing groups categorised into three levels on the basis of Studying Approaches. Mean scores of Achievement in Physics Post-Test I of three groups namely students having Deep Approach, Surface Approach and Strategic Approach to Studying were compared (taken in pairs) for Total sample, Boys and Girls.

Scheffé's test was used to compare the mean scores of the relevant pairs of group means. The steps followed in applying the method were: (i) Calculating F-ratio between pairs of means using the within-group variance estimate, (ii) consulting a table of F and obtaining the value of F required for significance at the 0.05 and 0.01 level for dF1 = (K-1) and dF2 = (N – k) for 0.01 level for dF1= (K–1) and dF2 = (N–K) for the total sample and the relevant subsamples separately; (iii) Using the formula F' = (K–1)F, calculating the F' required for significance at 0.05 level and 0.01 level and (iv) comparing the value of F with the value of F' to decide the significance of difference between means. For any difference to be significant at the required level, F must be greater than or equal to F'.

Data and Results of the comparison of Mean Achievement in Physics Post-Test I of Total sample, Boys and Girls are presented in Table 4.35.

TABLE 4.35

**Summary of the Group Difference in Mean Achievement in Physics Post-Test I for the three Studying Approaches for Total Sample, Boys and Girls**

| Sl. No. | Sample | Groups compared | F Value | $N_1$ | $N_2$ | Value required for significance at 0.01 level | Level of significance |
|---|---|---|---|---|---|---|---|
| 1 | Total | Deep Approach Vs. Surface Approach | 268.33 | 22 | 32 | 9.36 | 0.01 |
| | | Deep Approach Vs. Strategic Approach | 57.20 | 22 | 26 | 9.36 | 0.01 |
| | | Surface Approach Vs. Strategic Approach | 79.42 | 32 | 26 | 9.36 | 0.01 |
| 2 | Boys | Deep Approach Vs. Surface Approach | 184.54 | 12 | 15 | 9.36 | 0.01 |
| | | Deep Approach Vs. Strategic Approach | 49.71 | 12 | 13 | 9.36 | 0.01 |
| | | Surface Approach Vs. Strategic Approach | 41.43 | 15 | 13 | 9.36 | 0.01 |
| 3 | Girls | Deep Approach Vs. Surface Approach | 99.26 | 10 | 17 | 9.36 | 0.01 |
| | | Deep Approach Vs. Strategic Approach | 14.99 | 10 | 13 | 9.36 | 0.01 |
| | | Surface Approach Vs. Strategic Approach | 40.40 | 17 | 13 | 9.36 | 0.01 |

A perusal of Table 4.35 reveals that the groups having deep approach to studying, surface approach to studying and strategic approach to studying differ significantly in their mean Achievement in Physics Post-Test I for Total sample, Boys and Girls at 0.01 level of significance.

**4.2.4.3. Comparison of Mean Scores of Achievement in Physics Post-Test II between Groups formed on the basis of Studying Approaches**

Mean scores of Achievement in Physics Post-Test II of the three groups namely students having Deep Approach, Surface Approach and Strategic Approach to Studying were compared (taken in pairs) for the Total sample, Boys and Girls. Scheffe's test was used to compare the mean scores of the relevant pairs of group means. Data and Results of the comparison of mean Achievement in Physics Post-Test II of Total sample, Boys and Girls are presented in Table 4.36.

TABLE 4.36

**Summary of the Group Difference in Mean Achievement in Physics Post-Test II for the three Studying Approaches for Total Sample, Boys and Girls**

| Sl. No. | Sample | Groups compared | F Value | $N_1$ | $N_2$ | Value required for significance | Level of significance |
|---|---|---|---|---|---|---|---|
| 1 | Total | Deep Approach Vs. Surface Approach | 120.54 | 22 | 32 | 9.36 | 0.01 |
| | | Deep Approach Vs. Strategic Approach | 18.20 | 22 | 26 | 9.36 | 0.01 |
| | | Surface Approach Vs. Strategic Approach | 46.73 | 32 | 26 | 9.36 | 0.01 |
| 2 | Boys | Deep Approach Vs. Surface Approach | 57.71 | 12 | 15 | 9.36 | 0.01 |
| | | Deep Approach Vs. Strategic Approach | 11.95 | 12 | 13 | 9.36 | 0.01 |
| | | Surface Approach Vs. Strategic Approach | 16.93 | 15 | 13 | 9.36 | 0.01 |
| 3 | Girls | Deep Approach Vs. Surface Approach | 62.88 | 10 | 17 | 9.36 | 0.01 |
| | | Deep Approach Vs. Strategic Approach | 6.57 | 10 | 13 | 6.06 | 0.05 |
| | | Surface Approach Vs. Strategic Approach | 31.93 | 17 | 13 | 9.36 | 0.01 |

As per Table 4.36, F-values obtained for the mean difference in Achievement in Physics Post-Test II for the three groups compared, taken in pairs for the total sample and Boys are found to be significant at 0.01 level for appropriate degrees of freedom. For the sample of Girls, the F values obtained for comparison between (i) Deep Approach to Studying and Surface Approach to Studying and (iii) between Surface Approach to Studying and Strategic Approach to Studying are significant at 0.01 level and the F value for comparison between Deep Approach to Studying and Strategic Approach to Studying is significant at 0.05 level for appropriate degrees of freedom.

The result indicates that the students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying differ significantly in their mean Achievement in Physics Post-Test II (Retention in Physics) for Total sample, Boys and Girls.

**Summary of Post-hoc Comparison of Group Differences**

Wherever F-values were found to be significant, comparison of the mean scores of Achievement in Physics Post-Test I and Post-Test II revealed that four out of six t-values were found to be significant for the groups based on Methods of Teaching. High mean scores are seen associated with groups taught through Concept Attainment Model of Teaching.

Multiple comparison with regard to Mean Achievement scores in Physics Post-Test I and Post-Test II for the three groups based on Studying Approaches for the Total sample, Boys and Girls revealed that all the eighteen group pair comparisons were found to be significantly different for the mean scores.

The scrutiny of the results indicate the following.

(i) The groups taught through Concept Attainment Model of Teaching and Objective Based Instruction differ significantly in their Mean Achievement in Physics Post-Test I for the Total sample.

(ii) The groups taught through Concept Attainment Model of Teaching and Objective Based Instruction significantly differ in their mean Achievement in Physics Post-Test II (Retention in Physics) for the Total sample, Boys and Girls.

(iii) The groups having Deep Approach to Studying and Surface Approach to Studying differ significantly in their mean Achievement in Physics Post-Test I and Post-Test II for the Total sample, Boys and Girls.

(iv) The groups having Deep Approach to Studying and Strategic Approach to Studying differ significantly in their mean

Achievement in Physics Post-Test I and Post-Test II for the Total sample, Boys and Girls.

(v) The groups having Surface Approach to Studying and Strategic Approach to Studying differ significantly in their mean Achievement in Physics Post-Test I and Post-Test II for the Total sample, Boys and Girls.

### 4.2.5. INVESTIGATION OF THE MAIN EFFECT AND INTERACTION EFFECT OF METHODS OF TEACHING AND STUDYING APPROACH ON ACHIEVEMENT IN PHYSICS (POST-TEST I AND POST-TEST II) FOR TOTAL SAMPLE, BOYS AND GIRLS WHEN INITIAL DIFFERENCES IN PREVIOUS KNOWLEDGE OF THE SUBJECT MATTER AND NON-VERBAL INTELLIGENCE ARE CONTROLLED ONE BY ONE AND IN COMBINATION

Analysis of covariance was undertaken to study differences, if any exist, in Achievement in Physics Post-Test I and Post-Test II when initial differences in select variables such as Previous Knowledge of Subject Matter and Non-Verbal Intelligence were controlled. Two-way ANCOVA with 2x3 factorial design was used for the analysis. The analysis is presented under the following sections.

### 4.2.5.1. Analysis of Covariance for Achievement in Physics Post-Test I by Previous Knowledge of Subject Matter for Total sample, Boys and Girls

To examine whether significant changes exist in the mean scores of Achievement in Physics Post-Test I when Previous Knowledge of Subject Matter is taken as covariate, two-way factorial ANCOVA was employed. Data and results of the two-way ANCOVA for Total sample, Boys and Girls are presented in Table 4.37.

TABLE 4.37

**Data and Results of Two-way ANCOVA of Achievement in Physics Post-Test I with Previous Knowledge of Subject Matter as Covariate for Total sample, Boys and Girls**

| Sample | Source of Variation | Sum of squares | DF | Mean Squares | F | Level of signi-ficance |
|---|---|---|---|---|---|---|
| Total (N=80) | Methods of Teaching | 714.01 | 1 | 714.01 | 47.39 | 0.01 |
| | Studying Approach | 8823.73 | 2 | 4411.87 | 292.80 | 0.01 |
| | Previous Knowledge of Subject Matter | 479.38 | 1 | 479.38 | 31.82 | 0.01 |
| | Method of Teaching x Studying Approach | 391.11 | 2 | 195.55 | 12.98 | 0.01 |
| | Explained | 10408.23 | 6 | 1734.71 | 115.13 | 0.01 |
| | Residual | 1099.96 | 73 | 15.07 | | |
| Boys (N=40) | Methods of Teaching | 291.60 | 1 | 291.60 | 23.82 | 0.01 |
| | Studying Approach | 5248.47 | 2 | 2624.23 | 214.38 | 0.01 |
| | Previous Knowledge of Subject Matter | 159.00 | 1 | 159.00 | 12.99 | 0.01 |
| | Method of Teaching x Studying Approach | 106.88 | 2 | 53.44 | 4.37 | 0.05 |
| | Explained | 5805.94 | 6 | 967.66 | 79.05 | 0.01 |
| | Residual | 403.96 | 33 | 12.24 | | |
| Girls (N=40) | Methods of Teaching | 429.03 | 1 | 429.03 | 28.29 | 0.01 |
| | Studying Approach | 3518.75 | 2 | 1759.38 | 116.02 | 0.01 |
| | Previous Knowledge of Subject Matter | 359.38 | 1 | 359.38 | 23.70 | 0.01 |
| | Method of Teaching x Studying Approach | 242.21 | 2 | 121.11 | 7.99 | 0.01 |
| | Explained | 4549.37 | 6 | 758.23 | 50.00 | 0.01 |
| | Residual | 500.41 | 33 | 15.16 | | |

As per table 4.37 all the obtained F-values for the effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I are significant. This indicate that the main effect and interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I is significant for Total sample, Boys and Girls even when the influence of the Co-variate Previous knowledge of the Subject Matter is removed by simple linear regression.

The results suggest that the variation in the mean scores of Achievement in Physics Post-Test I cannot be attributed to the influence of the Covariate Previous Knowledge of Subject Matter. Hence it can be concluded that the differences in the Mean Achievement in Physics Post-Test I may not be due to the effect of Previous Knowledge of Subject Matter but may be due to Methods of Teaching and Studying Approaches.

#### 4.2.5.2. Analysis of Covariance for Achievement in Physics Post-Test I by Non Verbal Intelligence for Total Sample, Boys and Girls

To examine whether significant changes exist in the mean scores of Achievement in Physics Post-Test I when Non Verbal Intelligence is taken as Covariate, two-way factorial ANCOVA was employed. Data and results of the ANCOVA for Total sample, Boys and Girls are presented in Table 4.38.

TABLE 4.38

**Data and Results of Two-way ANCOVA of Achievement in Physics Post-Test I with Non-Verbal Intelligence as Covariate for Total sample, Boys and Girls**

| Sample | Source of Variation | Sum of squares | DF | Mean Squares | F | Level of significance |
|---|---|---|---|---|---|---|
| Total (N=80) | Methods of Teaching | 714.01 | 1 | 714.01 | 62.20 | 0.01 |
| | Studying Approach | 8823.73 | 2 | 4411.87 | 384.36 | 0.01 |
| | Non Verbal Intelligence | 768.56 | 1 | 768.56 | 66.96 | 0.01 |
| | Method of Teaching x Studying Approach | 363.96 | 2 | 181.98 | 15.85 | 0.01 |
| | Explained | 10670.26 | 6 | 1778.38 | 154.93 | 0.01 |
| | Residual | 837.93 | 73 | 11.48 | | |
| Boys (N=40) | Methods of Teaching | 291.60 | 1 | 291.60 | 28.39 | 0.01 |
| | Studying Approach | 5248.46 | 2 | 2624.23 | 255.47 | 0.01 |
| | Non Verbal Intelligence | 197.39 | 1 | 197.39 | 19.22 | 0.01 |
| | Method of Teaching x Studying Approach | 133.47 | 2 | 66.74 | 6.50 | 0.01 |
| | Explained | 5870.92 | 6 | 978.49 | 95.26 | 0.01 |
| | Residual | 338.98 | 33 | 10.27 | | |
| Girls (N=40) | Methods of Teaching | 429.03 | 1 | 429.03 | 60.55 | 0.01 |
| | Studying Approach | 3518.75 | 2 | 1759.38 | 248.30 | 0.01 |
| | Non Verbal Intelligence | 596.98 | 1 | 596.98 | 84.25 | 0.01 |
| | Method of Teaching x Studying Approach | 271.19 | 2 | 135.60 | 19.14 | 0.01 |
| | Explained | 4815.94 | 6 | 802.66 | 113.28 | 0.01 |
| | Residual | 233.83 | 33 | 7.09 | | |

As per Table 4.38, all the obtained F-values for the effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I are significant. This indicate that the main effect and interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I is significant for Total sample, Boys and Girls even when the influence of the covariate Non Verbal Intelligence is removed by simple linear regression.

The results suggest that the variation in the mean scores of Achievement in Physics Post-Test I cannot be attributed to the influence of the Covariate Non Verbal Intelligence. Hence it can be concluded that the differences in the Mean Achievement in Physics Post-Test I may not be due to the effect of Non Verbal Intelligence but may be due to Methods of Teaching and Studying Approaches.

### 4.2.5.3. Analysis of Covariance for Achievement in Physics Post-Test I by Covariates Previous Knowledge of Subject Matter and Non Verbal Intelligence for Total sample, Boys and Girls

To examine whether significant changes exist in the mean scores of Achievement in Physics Post-Test I when Previous Knowledge of the Subject Matter and Non-Verbal Intelligence are taken as covariates two-way factorial ANCOVA was employed. Data and results of the ANCOVA for Total sample, Boys and Girls are presented in Table 4.39.

TABLE 4.39

**Data and Results of Two-way ANCOVA of Achievement in Physics Post -Test I with Previous Knowledge of Subject Matter and Non-Verbal Intelligence as Covariate for Total sample, Boys and Girls**

| Sample | Source of Variation | Sum of squares | DF | Mean Squares | F | Level of significance |
|---|---|---|---|---|---|---|
| Total (N=80) | Method of Teaching | 714.01 | 1 | 714.01 | 63.65 | 0.01 |
| | Studying Approach | 8823.73 | 2 | 4411.87 | 393.31 | 0.01 |
| | Previous Knowledge of Subject Matter | 22.61 | 1 | 22.61 | 2.02 | NS |
| | Non Verbal Intelligence | 768.56 | 1 | 768.56 | 68.52 | 0.01 |
| | Method of Teaching x Studying Approach | 371.64 | 2 | 185.82 | 16.57 | 0.01 |
| | Explained | 10700.54 | 7 | 1528.65 | 136.28 | 0.01 |
| | Residual | 807.65 | 72 | 11.22 | | |
| Boys (N=40) | Method of Teaching | 291.60 | 1 | 291.60 | 27.58 | 0.01 |
| | Studying Approach | 5248.46 | 2 | 2624.23 | 248.17 | 0.01 |
| | Previous Knowledge of Subject Matter | 7.90 | 1 | 7.90 | 0.747 | NS |
| | Non Verbal Intelligence | 197.39 | 1 | 197.39 | 18.67 | 0.01 |
| | Method of Teaching x Studying Approach | 126.17 | 2 | 63.09 | 5.97 | 0.01 |
| | Explained | 5871.53 | 7 | 838.79 | 79.32 | 0.01 |
| | Residual | 338.37 | 32 | 10.57 | | |
| Girls (N=40) | Method of Teaching | 429.03 | 1 | 429.03 | 59.64 | 0.01 |
| | Studying Approach | 3518.75 | 2 | 1759.38 | 244.58 | 0.01 |
| | Previous Knowledge of Subject Matter | 13.35 | 1 | 13.35 | 1.86 | NS |
| | Non Verbal Intelligence | 596.98 | 1 | 596.98 | 82.99 | 0.01 |
| | Method of Teaching x Studying Approach | 261.48 | 2 | 130.74 | 18.18 | 0.01 |
| | Explained | 4819.58 | 7 | 688.51 | 95.71 | 0.01 |
| | Residual | 230.19 | 32 | 7.19 | | |

As per Table 4.39, the obtained F-values for the effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I are significant except for the F values obtained for the covariate Previous Knowledge of Subject Matter. The F-values obtained for the main effects and interaction effect of Methods of Teaching and Studying Approach are found to be significant at 0.01 level. This indicate that the main effect and interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I is significant for Total sample, Boys and Girls even when the influence of the covariates Previous Knowledge of Subject Matter and Non-Verbal Intelligence are jointly removed by statistical methods.

The results suggest that the variation in the mean scores of Achievement in Physics Post-Test I cannot be attributed to the joint influence of the covariates. Hence it can be concluded that the differences in the mean Achievement in Physics Post-Test I may not be due to the joint influence of Previous Knowledge of Subject Matter and Non-Verbal Intelligence but may be due to the effects of Methods of Teaching and Studying Approach.

### 4.2.5.4. Analysis of Covariance for Achievement in Physics Post-Test II by Covariate Previous Knowledge of Subject Matter for Total Sample, Boys and Girls

To examine whether significant changes exist in the mean scores of Achievement in Physics Post-Test II when Previous Knowledge of the Subject Matter is taken as Covariate, two-way factorial ANCOVA was employed. Data and Results of the ANCOVA for Total sample, Boys and Girls are presented in Table 4.40.

TABLE 4.40

**Data and Results of Two-way ANCOVA of Achievement in Physics Post-Test II with Previous Knowledge of Subject Matter as Covariate for Total sample, Boys and Girls**

| Sample | Source of Variation | Sum of squares | DF | Mean Squares | F | Level of significance |
|---|---|---|---|---|---|---|
| Total (N=80) | Method of Teaching | 1650.71 | 1 | 1650.71 | 168.73 | 0.01 |
| | Studying Approach | 1099.15 | 2 | 549.57 | 56.18 | 0.01 |
| | Previous Knowledge of Subject Matter | 5692.85 | 1 | 5962.85 | 581.90 | 0.01 |
| | Method of Teaching x Studying Approach | 891.68 | 2 | 445.84 | 45.57 | 0.01 |
| | Explained | 9422.63 | 6 | 1570.44 | 160.53 | 0.01 |
| | Residual | 714.17 | 73 | 9.78 | | |
| Boys (N=40) | Method of Teaching | 768.64 | 1 | 768.64 | 73.33 | 0.01 |
| | Studying Approach | 148.79 | 2 | 74.39 | 7.10 | 0.01 |
| | Previous Knowledge of Subject Matter | 3204.66 | 1 | 3204.66 | 305.73 | 0.01 |
| | Method of Teaching x Studying Approach | 339.14 | 2 | 169.57 | 16.18 | 0.01 |
| | Explained | 4369.87 | 6 | 728.31 | 69.48 | 0.01 |
| | Residual | 345.90 | 33 | 10.48 | | |
| Girls (N=40) | Method of Teaching | 737.18 | 1 | 737.18 | 88.92 | 0.01 |
| | Studying Approach | 613.51 | 2 | 306.75 | 37.00 | 0.01 |
| | Previous Knowledge of Subject Matter | 2487.20 | 1 | 2487.20 | 300.02 | 0.01 |
| | Method of Teaching x Studying Approach | 567.39 | 2 | 283.70 | 34.22 | 0.01 |
| | Explained | 4733.40 | 6 | 788.90 | 95.16 | 0.01 |
| | Residual | 273.57 | 33 | 8.29 | | |

As per Table 4.40, all the obtained F-values for the effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II are significant. This indicate that the main effect and interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II is significant for Total sample, Boys and Girls even when the influence of the Covariate Previous Knowledge of Subject Matter is statistically removed.

The results suggest that the variation in the mean scores of Achievement in Physics Post-Test II may be due to the effect of Methods of Teaching and Studying Approaches.

#### 4.2.5.5. Analysis of Covariance for Achievement in Physics Post-Test II by Covariate Non-Verbal Intelligence for Total sample, Boys and Girls

To examine whether significant changes exist in the mean scores of Achievement in Physics Post-Test II when Non-Verbal Intelligence is taken as Covariate, two-way factorial ANCOVA was utilized. Summary of the two-way ANCOVA is given in Table 4.41.

TABLE 4.41

**Data and Results of Two-way ANCOVA of Achievement in Physics Post-Test II with Non-Verbal Intelligence as Covariate for Total sample, Boys and Girls**

| Sample | Source of Variation | Sum of squares | DF | Mean Squares | F | Level of signi-ficance |
|---|---|---|---|---|---|---|
| Total (N=80) | Method of Teaching | 1563.29 | 1 | 1563.29 | 166.34 | 0.01 |
| | Studying Approach | 46.98 | 2 | 23.49 | 2.50 | NS |
| | Non-Verbal Intelligence | 7079.55 | 1 | 7079.55 | 753.30 | 0.01 |
| | Method of Teaching x Studying Approach | 773.05 | 2 | 386.52 | 41.13 | 0.01 |
| | Explained | 9450.74 | 6 | 1575.12 | 167.60 | 0.01 |
| | Residual | 686.06 | 73 | 9.40 | | |
| Boys (N=40) | Method of Teaching | 735.67 | 1 | 735.67 | 73.33 | 0.01 |
| | Studying Approach | 55.24 | 2 | 27.62 | 2.75 | NS |
| | Non-Verbal Intelligence | 3354.91 | 1 | 3354.91 | 334.41 | 0.01 |
| | Method of Teaching x Studying Approach | 291.69 | 2 | 145.85 | 14.54 | 0.01 |
| | Explained | 4384.70 | 6 | 730.78 | 72.84 | 0.01 |
| | Residual | 331.07 | 33 | 10.03 | | |
| Girls (N=40) | Methods of Teaching | 780.04 | 1 | 780.04 | 134.83 | 0.01 |
| | Studying Approach | 15.05 | 2 | 7.52 | 1.30 | NS |
| | Non-Verbal Intelligence | 3339.52 | 1 | 3339.52 | 577.23 | 0.01 |
| | Method of Teaching x Studying Approach | 589.96 | 2 | 294.98 | 50.99 | 0.01 |
| | Explained | 4816.06 | 6 | 802.68 | 138.74 | 0.01 |
| | Residual | 190.92 | 33 | 5.79 | | |

A perusal of Table 4.41 reveals that all the obtained F-values are significant except for the F-values of the main effect of Studying Approach on Achievement in Physics Post-Test II. This indicate that the main effect of Studying Approach on Achievement in Physics Post-Test II is not significant for Total sample, Boys and Girls, when the influence of the covariate Non Verbal Intelligence is statistically removed. The results also reveal that the main effect of Methods of Teaching on Achievement in Physics Post-Test II and the interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II are significant for the Total sample, Boys and Girls, even when the influence of the covariate Non-Verbal Intelligence is statistically removed.

The results indicate that the variation in the mean scores of Achievement in Physics Post-Test II may be due to the effect of Methods of Teaching and Studying Approaches. In the case of main effect of Studying Approach on Achievement in Physics Post-Test II, the variation in the mean scores may be partially due to the influence of Studying Approach and partially due to the influence of Non-Verbal Intelligence.

### 4.2.5.6. Analysis of Covariance for Achievement in Physics Post-Test II by Covariates Previous Knowledge of Subject Matter and Non-Verbal Intelligence for Total sample, Boys and Girls

To examine whether significant changes exist in the mean scores of Achievement in Physics Post-Test II when Previous Knowledge of Subject Matter and Non-Verbal Intelligence are taken as covariates, two-way factorial ANCOVA was utilized. Summary of the Two-way ANCOVA is given in Table 4.42.

TABLE 4.42

**Data and Results of Two-way ANCOVA of Achievement in Physics Post -Test II with Previous Knowledge of Subject Matter and Non-Verbal Intelligence as Covariates for Total sample, Boys and Girls**

| Sample | Source of Variation | Sum of squares | DF | Mean Squares | F | Level of significance |
|---|---|---|---|---|---|---|
| Total (N=80) | Method of Teaching | 1574.80 | 1 | 1574.80 | 196.01 | 0.01 |
| | Studying Approach | 75.01 | 2 | 37.50 | 4.67 | 0.05 |
| | Previous Knowledge of Subject Matter | 18.59 | 1 | 18.59 | 2.31 | NS |
| | Non-Verbal Intelligence | 1405.29 | 1 | 1405.29 | 174.91 | 0.01 |
| | Method of Teaching x Studying Approach | 819.79 | 2 | 409.89 | 51.02 | 0.01 |
| | Explained | 9558.32 | 7 | 1365.48 | 169.95 | 0.01 |
| | Residual | 578.48 | 72 | 8.03 | | |
| Boys (N=40) | Method of Teaching | 722.41 | 1 | 722.41 | 70.93 | 0.01 |
| | Studying Approach | 45.61 | 2 | 22.80 | 2.24 | NS |
| | Previous Knowledge of Subject Matter | 14.88 | 1 | 14.88 | 1.46 | NS |
| | Non-Verbal Intelligence | 165.13 | 1 | 165.13 | 16.21 | 0.01 |
| | Method of Teaching x Studying Approach | 295.93 | 2 | 147.96 | 14.53 | 0.01 |
| | Explained | 4389.87 | 7 | 627.12 | 61.58 | 0.01 |
| | Residual | 325.91 | 32 | 10.19 | | |
| Girls (N=40) | Method of Teaching | 782.13 | 1 | 782.13 | 136.27 | 0.01 |
| | Studying Approach | 37.09 | 2 | 18.55 | 3.23 | NS |
| | Previous Knowledge of Subject Matter | 1.30 | 1 | 1.30 | 0.227 | NS |
| | Non-Verbal Intelligence | 853.63 | 1 | 853.63 | 148.72 | 0.01 |
| | Method of Teaching x Studying Approach | 571.54 | 2 | 285.77 | 49.79 | 0.01 |
| | Explained | 4823.31 | 7 | 689.04 | 120.45 | 0.01 |
| | Residual | 183.67 | 32 | 5.74 | | |

As per Table 4.42, the obtained F-values for the effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II are significant except for the F-values obtained for the covariate Previous Knowledge of Subject Matter and for the F-values obtained for main effect of Studying Approach on Achievement in Physics Post-Test II for Boys and Girls. This indicate that the main effect of Methods of Teaching on Achievement in Physics Post-Test II is found to be significant at 0.01 level for the Total sample, Boys and Girls. The main effect of Studying Approach is found to be significant at 0.05 level for the Total sample, but found to be not significant even at 0.05 level for Boys and Girls. The interaction effect of Methods of Teaching and Studying Approach is found to be significant at 0.01 level for the Total sample, Boys and Girls.

The results suggest that the main effect of Methods of Teaching on Achievement in Physics Post-Test II and the Interaction effect of Methods of Teaching and Studying Approach, on Achievement in Physics Post-Test II are significant for Total sample, Boys and Girls even when the influence of the covariates Previous Knowledge of Subject Matter and Non-Verbal Intelligence are jointly removed by statistical methods.

The main effect of Studying Approach on Achievement in Physics Post-Test II is significant for Total sample even when the influence of the covariates Previous Knowledge of Subject Matter and Non-Verbal Intelligence are jointly removed by statistical methods.

The results suggest that the variation in the mean scores of Achievement in Physics Post-Test II cannot be attributed to the joint influence of the covariates. Hence it can be concluded that the differences in the mean Achievement in Physics Post-Test II may not be due to the joint influence of Previous Knowledge of Subject Matter and Non-Verbal Intelligence but may be due to the effects of Methods of Teaching and Studying Approach.

### 4.2.5.7. Summary and Discussion of Two-way Factorial ANCOVA

To examine the main effect and interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I and Achievement in Physics Post-Test II (Retention), if any exist, when initial differences in Previous Knowledge of Subject Matter and Non-Verbal Intelligence were controlled one by one and in combination, eighteen ANCOVA were undertaken. The analysis was done for Total sample, Boys and Girls.

The result of F-values obtained in ANCOVA for Post-Test I and Post-Test II are summarised and presented in Table 4.43.

TABLE 4.43

**Summary of 2x3 Factorial ANCOVA for Post-Test I and Post-Test II for Total Sample, Boys and Girls**

| Dependent Variable | Sample | Co-variates | F Values | | |
|---|---|---|---|---|---|
| | | | Methods of Teaching | Studying Approach | Methods of Teaching x Studying Approach |
| Achievement in Physics Post-Test I | Total | Previous knowledge | 47.39* | 292.80* | 12.98* |
| | | Non-Verbal Intelligence | 62.20* | 384.36* | 15.85* |
| | | Previous knowledge and Non-Verbal Intelligence in combination | 63.65* | 393.31* | 16.57* |
| | Boys | Previous knowledge | 23.82* | 214.38* | 4.37** |
| | | Non-Verbal Intelligence | 28.38* | 255.47* | 6.50* |
| | | Previous knowledge and Non-Verbal Intelligence in combination | 27.58* | 248.17* | 5.97* |
| | Girls | Previous knowledge | 28.29* | 116.02* | 7.99* |
| | | Non-Verbal Intelligence | 60.55* | 248.30* | 19.14* |
| | | Previous knowledge and Non-Verbal Intelligence in combination | 59.64* | 244.58* | 18.18* |
| Achievement in Physics Post-Test II | Total | Previous knowledge | 168.73* | 56.18* | 45.57* |
| | | Non-Verbal Intelligence | 166.34* | 2.50 | 41.13* |
| | | Previous knowledge and Non-Verbal Intelligence in combination | 196.01* | 4.67** | 51.02* |
| | Boys | Previous knowledge | 73.33* | 7.09* | 16.18* |
| | | Non-Verbal Intelligence | 73.33* | 2.75 | 14.54* |
| | | Previous knowledge and Non-Verbal Intelligence in combination | 70.93* | 2.24 | 14.53* |
| | Girls | Previous knowledge | 88.92* | 37.00* | 34.22* |
| | | Non-Verbal Intelligence | 134.83* | 1.30 | 50.99* |
| | | Previous knowledge and Non-Verbal Intelligence in combination | 136.27* | 3.23 | 49.79* |

* indicates significance at 0.01 level.
**indicates significance at 0.05 level.

An examination of the results of Table 4.42 reveal the following:

(i) Main effect and interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I is significant for Total sample, Boys and Girls even when the influence of the Co-variate Previous Knowledge of Subject Matter is removed by statistical methods.

(ii) Main effect and interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I is significant for Total sample, Boys and Girls even when the influence of the Co-variate Non-Verbal Intelligence is statistically removed.

(iii) Main effect and interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I is significant for Total sample, Boys and Girls even when the influence of the Co-variates Previous Knowledge of Subject Matter and Non-Verbal Intelligence are jointly removed by statistical methods.

(iv) Main effect and interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II (Retention in Physics) is significant for Total sample, Boys and

Girls even when the influence of the Co-variate Previous Knowledge of Subject Matter is statistically removed.

(v) Main effect of Methods of Teaching on Achievement in Physics Post-Test II and the interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II are significant for the Total sample, Boys and Girls, even when the influence of the Co-variate Non-Verbal Intelligence is statistically removed.

(vi) Main effect of Studying Approach on Achievement in Physics Post-Test II is not significant for Total sample, Boys and Girls, when the influence of the Co-variate Non-Verbal Intelligence is statistically removed.

(vii) Main effect of Methods of Teaching on Achievement in Physics Post-Test II and interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II are significant for Total sample, Boys and Girls even when the influence of the Co-variates Previous Knowledge of Subject Matter and Non-Verbal Intelligence are jointly removed by statistical methods.

(viii) Main effect of Studying Approach on Achievement in Physics Post-Test II is significant for the Total sample even when the influence of the Co-variates Previous Knowledge of Subject Matter and Non-Verbal Intelligence are jointly removed by statistical methods.

(ix) Main effect of Studying Approach on Achievement in Physics Post-Test II is not significant for Boys and Girls when the influence of the co-variates Previous Knowledge of Subject Matter and Non-Verbal Intelligence are jointly removed by statistical methods.

## 4.3. CONCLUSIONS AND INTERPRETATIONS

The results have been grouped under relevant heads and discussed so as to arrive at a conclusion. The discussion of the results and interpretations are presented below.

Summary of the results of mean difference analysis of Achievement in Physics Post-Test I Gain I (Post-Test I minus Pre-test), Post-Test II (Retention in Physics) and Gain II (Post-Test II minus Pre-Test) for the Experimental group and Control group revealed that nine out of twelve t-values are significant. In all the cases high mean scores are associated with experimental group taught through Concept Attainment Model of Teaching. The results suggest that students taught through Concept Attainment Model have higher Mean Achievement in Physics than students taught through Objective Based Instruction especially for Total sample and the sample of Girls. It is to be noted that students taught through Concept Attainment Model have high mean Retention in Physics than students taught through Objective Based Instruction for the Total sample and samples of Boys and Girls. The above findings are in consistency with findings of Gangrade (1987), Sood (1990) and Shah (2002).

Summary of the results of mean difference analysis of Achievement in Physics of students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying reveal that eleven out of the twelve t-values are significant. The results indicate that students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying differ significantly in their Mean Achievement in Physics Post-Test I, Gain I (Post-Test I minus Pre-Test), Mean Retention in Physics Post-Test II and Gain II (Post-Test II minus Pre-Test). It is to be noted that students having Deep Approach to Studying have high mean scores in all the cases when compared to students having Surface Approach to Studying and Strategic Approach to Studying. Students having Strategic Approach to Studying have high mean scores than students having Surface Approach to Studying but low mean scores when compared to students having Deep Approach to

Studying in all the cases. The t-values indicate that the difference between students having Deep Approach to Studying and Surface Approach to Studying is much greater than the difference between students having Deep Approach to Studying and Strategic Approach to Studying. From the results it can be concluded that students having Deep Approach to Studying is superior to students having Strategic Approach to Studying and Surface Approach to Studying in their mean Achievement and Retention in Physics. The students having Surface Approach to Studying is the most inferior group in terms of Achievement in Retention in Physics. The above findings are in consistency with studies of Harper and Kember (1989), Ramsden *et al.* (1989) and Elias (2005) but against the result of the study of Minbashian *et al.* (2004).

The summary of the results of two-way ANOVA reveal that Methods of Teaching and Studying Approach have significant main effects and interaction effect on Achievement in Physics and Retention in Physics for Total sample, Boys and Girls. The results suggest that variation in Achievement in Physics and Retention in Physics can be attributed to the variation in the Methods of Teaching and Studying Approaches. The high F-values noticed for the main effect of Studying Approach on Achievement in Physics and Retention in Physics indicate that Achievement and Retention in Physics are highly influenced by the Studying Approach of the learner.

Wherever significant F-values were obtained, test of significance of difference in mean Achievement in Physics between Experimental Group and Control Group were employed. Results show that four out of six t-values are found to be significant for the groups based on Methods of Teaching. High mean scores are associated with groups taught through Concept Attainment Model of Teaching.

Multiple comparison with regard to mean Achievement Scores in Physics Post-Test I and Post-Test II for the three groups based on Studying Approaches for Total sample, Boys and Girls reveal that all the eighteen group pair comparisons are found to be significantly different for the mean scores. Students having Deep Approach to Studying have high mean Achievement and Retention in Physics in all the cases. Students having Surface Approach to Studying have the lowest mean scores in Achievement in Physics and Retention in Physics in all the cases. The graphical representation for the interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics and Retention in Physics reveal a synergistic interaction. High mean achievement in all the cases were in favour of Experimental Group taught through Concept Attainment Model of Teaching.

When the effects of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I and Retention in Physics Post-Test II were found out with the effect of Previous Knowledge of Subject Matter and Non-Verbal Intelligence statistically removed one by one and in combination, thirteen out of the eighteen F-values were found to be significant. Main effect and interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I is significant for Total sample, Boys and Girls even when the influence of Previous Knowledge of Subject Matter and Non-Verbal Intelligence are statistically removed one by one and in combination. The result suggest that the variation in the mean scores of Achievement in Physics cannot be attributed to the effects of Previous Knowledge of Subject Matter and Non-Verbal Intelligence but may be due to the effects of Methods of Teaching and Studying Approaches.

In the case of Retention in Physics Post-Test II, it is found that Methods of Teaching and Studying Approach have significant main effects and interaction effect for Total sample, Boys and Girls, even when the effect of Previous Knowledge of Subject Matter is statistically removed. When the effect of Non-Verbal Intelligence is statistically removed, there is significant main effect of Methods of Teaching on Retention in Physics and significant interaction effect of Methods of

Teaching and Studying Approach on Retention in Physics for the Total sample, Boys and Girls. But the main effect of Studying Approach on Retention in Physics is not significant. This suggest that variations in the mean Retention scores in Physics may be partially due to the influence of Non-Verbal Intelligence and partially due to the influence of Studying Approach.

When the effects of Previous Knowledge of Subject Matter and Non-Verbal Intelligence are jointly removed by statistical methods, significant main effect and interaction effect are found for Methods of Teaching and Studying Approach on Retention in Physics for Total sample. For the sample of Boys and Girls main effect of Methods of Teaching and Interaction effect of Methods of Teaching and Studying Approach on Retention in Physics are significant but the main effect of Studying Approach is not significant. The result suggest that the variation in Retention scores in Physics may be partially due to the influence of Studying Approach and partially due to the combined influence of Previous Knowledge of Subject Matter and Non Verbal Intelligence for the subsamples of Boys and Girls.

From the above findings it can be concluded that Methods of Teaching and Studying Approaches have significant main effects and Interaction effect on Achievement in Physics and Retention in Physics.

A study of the F-values of ANCOVA suggest that among the Independent variables, the Studying Approach have higher influence on Achievement in Physics than the Methods of Teaching. This may be due to the fact that the individual academic performance of the learner immediately after the treatment is affected more by his/her Studying Approach than the methods of teaching he is exposed to. Whatever may be the method of teaching, the final effort should come from the part of the individual learner.

A study of F-values of ANCOVA for Retention in Physics suggest that Methods of Teaching have far higher influence on Retention in Physics than the Studying Approaches. This shows the prime importance of Methods of Teaching in retention of the learned material. If Method of Teaching is not effective, even the learner with best Studying Approach may not be able to retain the learned material for a long time. These factors have to be further explored by well designed studies.

The findings of the present study reveal that Concept Attainment Model is more effective than Objective Based Instruction for teaching basic concepts in the secondary school Physics curriculum. It is to be specifically noted that Concept Attainment Model of Teaching is suitable for the organisational set up of the secondary schools of Kerala.

# INTERACTION EFFECT OF CONCEPT ATTAINMENT MODEL OF TEACHING AND STUDYING APPROACH ON ACHIEVEMENT IN PHYSICS OF SECONDARY SCHOOL STUDENTS

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CHAPTER 5

# SUMMARY FINDINGS AND SUGGESTIONS

- *Study in retrospect*
- *Variables of the Study*
- *Objectives*
- *Methodology*
- *Major Findings*
- *Tenability of Hypotheses*
- *Suggestions for Improving Educational Practice*
- *Suggestions for Further Research*

# SUMMARY, FINDINGS AND SUGGESTIONS

This chapter deals with the summary of the various phases in the process of the present investigation, major findings of the study, tenability of hypotheses, suggestions for improving educational practice and suggestions for further research.

## 5.1. STUDY IN RETROSPECT

The present study was intended to examine whether Methods of Teaching and Studying Approaches have differential influence on Achievement in Physics of secondary school students. It was an attempt to examine whether Achievement in Physics vary when Concept Attainment Model of Teaching is adopted in a regular classroom without much disturbing the organisational set up of the school. Hence the present study was executed in the context of a conventional classroom where select topics in Physics were taught through Concept Attainment Model and compared with a class taught through Objective Based Instruction.

The study was hence stated as INTERACTION EFFECT OF CONCEPT ATTAINMENT MODEL OF TEACHING AND

STUDYING APPROACH ON ACHIEVEMENT IN PHYSICS OF SECONDARY SCHOOL STUDENTS.

## 5.2. VARIABLES OF THE STUDY

Variables selected for the present study are the following:

### 5.2.1. Independent Variables

The following are the Independent Variables selected for the study.

5.2.1.1. Concept Attainment Model of teaching

5.2.1.2. Objective Based Instruction

5.2.1.3. Studying Approach

The three Studying Approaches selected are:

(i) Deep approach

(ii) Surface approach

(iii) Strategic approach

### 5.2.2. Dependent Variable

Achievement in Physics and its retention were considered as the dependent variables.

### 5.2.3. Control Variables

The control variables in the experimentation were the following:

5.2.3.1. Previous Knowledge of Subject Matter

5.2.3.2. Non-Verbal Intelligence

## 5.3. OBJECTIVES OF THE STUDY

The present study was designed with the following objectives:

5.3.1. To compare the mean scores of Achievement in Physics Post-Test I (tested immediately after the treatment) of the Control group and the Experimental group.

5.3.2. To compare the mean Gain scores of Achievement in Physics (Post-Test I minus Pre-Test) of the Control group and the Experimental group.

5.3.3. To compare the mean Retention scores of Achievement in Physics Post-Test II (tested two months after experimentation) of the Control group and Experimental group.

5.3.4. To compare the mean Gain scores of Achievement in Physics (Post-Test II minus Pre-Test) of the Control group and Experimental group.

5.3.5. To compare the mean scores of Achievement in Physics Post-Test I of the groups formed on the basis of Studying Approach.

5.3.6. To compare the mean Gain Scores of Achievement in Physics Post-Test I (Post-Test I minus Pre-Test) of the groups formed on the basis of Studying Approach.

5.3.7. To compare the mean Retention scores of Achievement in Physics Post-Test II of the groups formed on the basis of Studying Approach.

5.3.8. To compare the mean Gain Scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test) of the groups formed on the basis of Studying Approach.

5.3.9. To study the main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test I for Total sample, Boys and Girls.

5.3.10. To study the main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test II for Total sample, Boys and Girls.

5.3.11. To study the main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test I for Total sample, Boys and Girls when initial differences in select variables namely Previous Knowledge of Subject Matter and Non-Verbal Intelligence are controlled one by one and in combination.

5.3.12. To study the main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test II for Total sample, Boys and Girls when initial differences in select variables namely Previous Knowledge of Subject Matter and Non-Verbal Intelligence are controlled one by one and in combination.

## 5.4. METHODOLOGY

The methodology of the present investigation is described below:

### 5.4.1. Design of the study

The experimental design used in this study was Pre-Test – Post-Test Equivalent Groups Design. The design is illustrated as follows:

$G_1\ O_1\ X\ O_2$

$G_2\ O_3\ C\ O_4$

$O_1, O_3$ - Pre-Test

$O_2, O_4$ - Post-Test

$$\left.\begin{array}{l} O_2 - O_1 \\ O_4 - O_3 \end{array}\right\} \text{Gain Score}$$

$G_1$ – Experimental Group

$G_2$ – Control Group

X – Application of the Experimental Treatment

C – Application of the Control Treatment

### 5.4.2. Sample for the study

Intact groups of students from standard IX were selected as sample for the study. The groups were matched on the basis of Previous Knowledge of Subject Matter and Non-Verbal Intelligence. The experimental group was taught through Concept Attainment Model of teaching and the control group was taught through Objective Based Instruction. Each group consisted of 40 students.

### 5.4.3. Selection of Topics for Treatment

The topics which were amenable for treatment using Concept Attainment Model of Teaching and Objective Based Instruction were selected. From the analysis of the syllabus of Physics at secondary classes the investigator selected thirty topics for the treatment.

**5.4.4. Instructional Materials and Tools used for the Study**

5.4.4.1. Lesson transcripts based on Concept Attainment Model

5.4.4.2. Lesson transcripts based on Objective Based Instruction

5.4.4.3. Studying Approach Inventory (Usha and Ampili, 2002)

5.4.4.4. Standard Progressive Matrices Test (Raven, 1958)

5.4.4.5. Achievement Test in Physics (Usha and Ampili, 2002)

**5.4.5. Procedure Adopted for Data Collection**

The procedure adopted for collecting necessary data were as follows:

5.4.5.1. Administration of Pre-Test

Pre-Test was administered to the Experimental Group and Control Group before the treatment was given.

5.4.5.2. Administration of Other Tools

Prior to the introduction of treatment in the selected school, data on Non-Verbal Intelligence, and Studying Approaches of the subjects were collected. For this purpose Ravens Progressive Matrices Test and Studying Approach Inventory were administered. The procedure suggested in the manual for the administration was followed especially for Ravens Progressive Matrices Test.

5.4.5.3. Treatment

After selection of the topics for treatment instructional materials and tools were prepared. Experimental Group was taught through Concept Attainment Model of Teaching and Control Group was taught through Objective Based Instruction.

5.4.5.4. Administration of Post-Test I

Post-Test I was administered to each group immediately after the treatment.

5.4.5.5. Administration of Post-Test II

Post-Test II was administered to each group two months after the treatment.

### 5.4.6. Statistical Techniques Used

The statistical processing of the data was done using computer facilities as Statistical Package for Social Sciences. The techniques used for analysing the data were the following:

(i) Test of Significance of difference between means.

(ii) Two-way ANOVA with 2x3 Factorial design.

(iii) Scheffe's Test of Multiple Comparison

(iv) Two way ANCOVA with 2x3 factorial design.

## 5.5. MAJOR FINDINGS OF THE STUDY

The major findings of the investigation are presented in the following sections.

### 5.5.1. RESULTS OF MEAN DIFFERENCE ANALYSIS OF ACHIEVEMENT IN PHYSICS OF EXPERIMENTAL AND CONTROL GROUP

Results of mean difference analysis of Achievement in Physics in Post-Test I and Post-Test II between Experimental Group and Control Group are given below:

#### 5.5.1.1. Difference in the Mean Scores of Achievement in Physics Post-Test I of Experimental Group and Control Group

Significant difference was found in the mean scores of Achievement in Physics Post-Test I for the Total sample at 0.05 level (t = 2.27). But in the case of Boys (t = 1.37) and Girls (t = 1.88) no significant difference was found in the mean scores of Achievement in Physics Post-Test I.

**5.5.1.2. Difference in the Mean Gain Scores of Achievement in Physics (Post-Test I minus Pre-Test) of Experimental Group and Control Group**

Significant difference was found in the mean Gain scores of Achievement in Physics Post-Test I between Experimental Group and Control Group at 0.01 level for Total sample ($t = 3.37$) and Girls ($t = 2.81$). But in the case of Boys ($t = 1.96$), no significant difference was found in the mean Gain scores of Achievement in Physics Post-Test I.

**5.5.1.3. Difference in the Mean Scores of Achievement in Physics Post-Test II of Experimental Group and Control Group**

Significant difference was found in the mean scores of Achievement in Physics Post-Test II between Experimental Group and Control Group at 0.01 level for Total sample ($t = 4.30$), Boys ($t = 3.02$) and Girls ($t = 3.14$).

**5.5.1.4. Difference in the Mean Gain Scores of Achievement in Physics (Post-Test II minus Pre-Test) of Experimental Group and Control Group**

Significant difference was found in the mean Gain scores of Achievement in Physics Post-Test II between Experimental Group and Control Group at 0.01 level for Total sample ($t = 6.68$), Boys ($t = 4.92$) and Girls ($t = 4.59$).

## 5.5.2. RESULTS OF MEAN DIFFERENCE ANALYSIS OF ACHIEVEMENT IN PHYSICS OF STUDENTS HAVING DIFFERENT STUDYING APPROACHES NAMELY DEEP APPROACH, SURFACE APPROACH AND STRATEGIC APPROACH

### 5.5.2.1. Difference in the Mean Scores of Achievement in Physics Post Test I of Students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying

Significant difference was found in the mean scores of Achievement in Physics Post-Test I at 0.01 level between students having Deep Approach to Studying and Surface Approach to Studying (t = 33.95), between students having Deep Approach to Studying and Strategic Approach to Studying (t = 6.63) and between students having Surface Approach to Studying and Strategic Approach to Studying (t = 8.55).

### 5.5.2.2. Difference in the mean Gain scores of Achievement in Physics (Post-Test I minus Pre-Test) of Students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying

Significant difference was found in the mean gain scores of Achievement in Physics Post-Test I at 0.01 level between students having Deep Approach to Studying and Surface Approach to Studying (t = 39.11) and between students having Surface Approach to Studying and Strategic Approach to Studying (t = 6.30). In the case of students having

Deep Approach to Studying and Strategic Approach to Studying, significant difference was found at 0.05 level in the mean gain scores of Achievement in Physics Post-Test I (t = 2.56).

**5.5.2.3. Difference in the mean scores of Achievement in Physics Post-Test II of Students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying**

Significant difference was found in the mean scores of Achievement in Physics Post Test II at 0.01 level between students having Deep Approach to Studying and Surface Approach to Studying (t = 27.07), between students having Deep Approach to Studying and Strategic Approach to Studying (t = 3.51) and between students having Surface Approach to Studying and Strategic Approach to Studying (t = 7.32).

**5.5.2.4. Difference in the mean Gain scores of Achievement in Physics (Post-Test II minus Pre-Test) of students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying**

Significant difference was found in the mean gain scores of Achievement in Physics Post-Test II at 0.01level between students having Deep Approach to Studying and Surface Approach to Studying (t = 5.07) and between students having Surface Approach to Studying and Strategic Approach to Studying (t = 5.53). No significant difference was found in the mean gain scores of Achievement in Physics Post-Test II between students having Deep Approach to Studying and Strategic Approach to Studying.

### 5.5.3. MAIN EFFECT AND INTERACTION EFFECT OF METHODS OF TEACHING AND STUDYING APPROACH ON ACHIEVEMENT IN PHYSICS

#### 5.5.3.1. Main Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I

Significant main effect of Methods of Teaching on Achievement in Physics Post-Test I was found to exist for Total Sample (F = 25.73), Boys (F = 22.98) and Girls (F = 8.82) at 0.01 level of significance. The main effect of Studying Approach on Achievement in Physics Post-Test I was also found to be significant for Total Sample (F = 201.22), Boys (F = 164.43) and Girls (F = 75.61) well beyond 0.01 level of significance.

#### 5.5.3.2. Main Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II

The main effect of Methods of Teaching on Achievement in Physics Post-Test II was found to be significant for Total Sample (F = 95.90), Boys (F = 72.12) and Girls (F = 54.09) at 0.01 level of significance. Significant main effect of Studying Approach on Achievement in Physics Post Test II was found to exist for Total Sample

(F = 170.52), Boys (F = 105.54) and Girls (F = 118.78) well beyond 0.01 level of significance.

**5.5.3.3. Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I**

Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I was found to be significant at 0.01 level for Total sample (F = 7.94) and for Girls (F = 6.68). But for Boys (F = 3.99) at 0.05 level.

**5.5.3.4. Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II**

Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II was found to be significant at 0.01 level for Total sample (F = 23.21), Boys (F = 11.48) and Girls (F = 26.50).

5.5.4. POST-HOC COMPARISON OF GROUP DIFFERENCES

**5.5.4.1. Difference in Mean Scores of Achievement in Physics Post-Test I and Post-Test II between Experimental Group and Control Group**

Significant difference was found in the mean scores of Achievement in Physics Post-Test I for the Total sample at 0.05 level (t = 2.27) but no significant difference was found in the mean scores of Achievement in Physics Post-Test I for Boys (t = 1.37) and Girls (t = 1.88) even at 0.05

level. Significant difference was found in the mean scores of Achievement in Physics Post-Test II between Experimental Group and Control Group at 0.01 level for Total sample (t = 4.30), Boys (t = 3.02) and Girls (t = 3.14).

### 5.5.4.2. Difference in Mean Scores of Achievement in Physics Post-Test I among Groups formed on the basis of Studying Approaches

Results of Multiple comparison using Scheffe test of the three groups formed on the basis of Studying Approaches (Deep Approach, Surface Approach and Strategic Approach) with respect to mean Achievement in Physics Post-Test I reveal the following:

| Sl. No. | Sample | Groups compared | F-value | Level of significance |
|---|---|---|---|---|
| 1 | Total | Deep Approach Vs. Surface Approach | 268.33 | 0.01 |
| | | Deep Approach Vs. Strategic Approach | 57.20 | 0.01 |
| | | Surface Approach Vs. Strategic Approach | 79.42 | 0.01 |
| 2 | Boys | Deep Approach Vs. Surface Approach | 184.54 | 0.01 |
| | | Deep Approach Vs. Strategic Approach | 49.71 | 0.01 |
| | | Surface Approach Vs. Strategic Approach | 41.43 | 0.01 |
| 3 | Girls | Deep Approach Vs. Surface Approach | 99.26 | 0.01 |
| | | Deep Approach Vs. Strategic Approach | 14.99 | 0.01 |
| | | Surface Approach Vs. Strategic Approach | 40.40 | 0.01 |

It is revealed from the summary of the result that significant mean difference exist at 0.01 level in all the nine comparisons. Hence it can be concluded that significant difference in Achievement in Physics Post-Test I exist among groups formed on the basis of Studying Approaches.

### 5.5.4.3. Difference in Mean Scores of Achievement in Physics Post-Test II among Groups formed on the basis of Studying Approaches

Results of multiple comparison using Scheffé test for the three groups formed on the basis of Studying Approaches (Deep Approach, Surface Approach and Strategic Approach) with respect to mean Achievement in Physics Post-Test II reveal the following.

| Sl. No. | Sample | Groups compared | F-value | Level of signi-ficance |
|---|---|---|---|---|
| 1 | Total | Deep Approach Vs. Surface Approach | 120.54 | 0.01 |
| | | Deep Approach Vs. Strategic Approach | 18.20 | 0.01 |
| | | Surface Approach Vs. Strategic Approach | 46.73 | 0.01 |
| 2 | Boys | Deep Approach Vs. Surface Approach | 57.71 | 0.01 |
| | | Deep Approach Vs. Strategic Approach | 11.95 | 0.01 |
| | | Surface Approach Vs. Strategic Approach | 16.93 | 0.01 |
| 3 | Girls | Deep Approach Vs. Surface Approach | 62.88 | 0.01 |
| | | Deep Approach Vs. Strategic Approach | 6.57 | 0.05 |
| | | Surface Approach Vs. Strategic Approach | 31.93 | 0.01 |

It is revealed from the summary of the results that significant mean difference exist at 0.01 level in eight out of nine comparisons and at 0.05 level in one comparison i.e., between Deep Approach and Strategic Approach for the sample of Girls. Hence it can be concluded that significant difference in Achievement in Physics Post-Test II exist among groups formed on the basis of Studying Approaches.

### 5.5.5. RESULTS OF ANALYSIS OF COVARIANCE

Altogether fifty four Analysis of Covariance effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I/Post-Test II were estimated by controlling Previous Knowledge of Subject Matter and Non-Verbal Intelligence one by one and in combination. The results are summarised in the following sections.

#### 5.5.5.1. Main Effect of Methods of Teaching on Achievement in Physics Post-Test I and Post-Test II with Previous Knowledge of Subject Matter as Covariate

When Previous Knowledge of Subject Matter was taken as Covariate, the analysis for Post-Test I revealed that all the F-values are significant beyond 0.01 level. The F-values obtained are 47.39, 23.82 and 28.89 for Total sample, Boys and Girls respectively.

With Previous Knowledge of Subject Matter as Covariate, the analysis for Post-Test II revealed that all the F-values are significant at

0.01 level. The F-values obtained are 168.73 for Total sample, 73.33 for Boys and 88.92 for Girls.

**5.5.5.2. Main Effect of Methods of Teaching on Achievement in Physics Post-Test I/Post-Test II with Non-Verbal Intelligence as Covariate**

When Non-Verbal Intelligence was taken as covariate, the analysis for Post-Test I revealed that all the F-values are significant at 0.01 level. The F-values obtained are 62.20 for Total sample, 28.38 for Boys and 60.55 for Girls.

When Non-Verbal Intelligence was taken as Co-variate, the analysis for Post-Test II revealed that all the F-values are significant at 0.01 level. The F-values obtained are 166.34 for Total sample, 73.33 for Boys and 134.83 for Girls.

**5.5.5.3. Main Effect of Methods of Teaching on Achievement in Physics Post-Test I/Post-Test II with Previous Knowledge of Subject Matter and Non-Verbal Intelligence as Covariates**

When Previous Knowledge of Subject Matter and Non-Verbal Intelligence in combination were taken as Covariates, the anlaysis of Post-Test I revealed that all the F-values are significant at 0.01 level. The F-values are 63.65 for Total sample, 27.58 for Boys and 59.64 for Girls.

When Previous Knowledge of Subject Matter and Non-Verbal Intelligence in combination were taken as Covariates, the analysis of Post-Test II revealed that all the F-values are significant at 0.01 level. The F-values are 196.01 for Total sample, 70.93 for Boys and 136.27 for Girls.

**5.5.5.4. Main Effect of Studying Approach on Achievement in Physics Post-Test I / Post-Test II with Previous Knowledge of Subject Matter as Covariate**

When Previous Knowledge of the Subject Matter was taken as co-variate, the analysis of Post-Test I revealed that all the F-values are significant at 0.01 level. The F-values are 292.80 for Total sample, 214.38 for Boys and 116.02 for Girls.

When Previous Knowledge of Subject Matter was taken as Covariate, the analysis of Post-Test II revealed that all the F-values are significant at 0.01 level. The F-values are 56.18 for Total sample, 7.09 for Boys and 37.00 for Girls.

**5.5.5.5. Main Effect of Studying Approach on Achievement in Physics Post-Test I/Post-Test II with Non Verbal Intelligence as Co-variate**

When Non-Verbal Intelligence was taken as Co-variate, the analysis of Post-Test I revealed that all the F-values are significant well beyond 0.01 level. The F-values are 384.36 for Total sample, 255.47 for Boys and 248.30 for Girls.

When Non-Verbal Intelligence was taken as co-variate, the analysis of Post-Test II revealed that the F-values are not significant even at 0.05 level. The F-values are 2.50 for Total sample, 2.75 for Boys and 1.30 for Girls.

**5.5.5.6. Main Effect of Studying Approach on Achievement in Physics Post-Test I / Post-Test II with Previous Knowledge of Subject Matter and Non-Verbal Intelligence**

When Previous Knowledge of Subject Matter and Non-Verbal Intelligence in combination were taken as co-variates, the analysis of Post-Test I revealed that all the F-values are significant well beyond 0.01 level. The F-values are 393.31 for Total sample, 248.17 for Boys and 244.58 for Girls.

When Previous Knowledge of Subject Matter and Non-Verbal Intelligence in combination were taken as covariates, the analysis of Post-Test II revealed that two out of three F-values are not significant even at 0.05 level (F-values for Boys (2.24) and Girls (3.23)). The F-value for Total sample (4.67) was found to be significant at 0.05 level.

### 5.5.5.7. Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I/Post-Test II with Previous Knowledge of Subject Matter as Co-variate

When Previous Knowledge of Subject Matter was taken as co-variate, the analysis of Post-Test I revealed that two out of three F-values are significant at 0.01 level. The F-values are 12.98 for Total sample, and 7.99 for Girls. In the case of Girls, the F-value (4.37) was found to be significant at 0.05 level.

When Previous Knowledge of Subject Matter was taken as Co-variate analysis of Post-Test II revealed that all the F-values are significant at 0.01 level. The F-values are 45.57 for Total sample, 16.18 for Boys and 34.22 for Girls.

### 5.5.5.8. Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post Test I/Post Test II with Non-Verbal Intelligence as Covariate

When Non-Verbal Intelligence was taken as co-variate, analysis of Post-Test I revealed that all the F-values are significant beyond 0.01 level. The F-values are 15.85 for Total sample, 6.50 for Boys and 19.14 for Girls.

When Non-Verbal Intelligence was taken as Co-variate, analysis of Post-Test II revealed that all the F-values are significant beyond 0.01 level.

The F-values are 41.13 for Total sample, 14.54 for Boys and 50.99 for Girls.

**5.5.5.9. Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I/Post-Test II with Previous Knowledge of Subject Matter and Non-Verbal Intelligence as Co-variates**

When Previous Knowledge of Subject Matter and Non-Verbal Intelligence in combination were taken as co-variates, the analysis of Post-Test I revealed that all the F-values are significant beyond 0.01 level. The F-values are 16.57 for Total sample, 5.97 for Boys and 18.18 for Girls.

When Previous Knowledge of Subject Matter and Non-Verbal Intelligence in combination were taken as co-variates, the analysis of Post-Test II revealed that all the F-values are significant beyond 0.01 level. The F-values are 51.02 for Total sample, 14.53 for Boys and 49.79 for Girls.

## 5.6. TENABILITY OF HYPOTHESES

The tenability of the hypotheses of the present study was examined on the basis of the findings. The study showed that most of the hypotheses set for the study are substantiated.

**5.6.1. First hypothesis states that "There will be significant difference in the Mean Scores of Achievement in Physics Post-Test I (tested immediately after the treatment) between Control Group and Experimental Group"**

Comparisons of mean Achievement in Physics on Post-Test I were done for Total sample, Boys and Girls. The t-value for the Total sample was found to be significant. But the t-values for Boys and Girls were not found to be significant. Hence first hypothesis is partially substantiated.

**5.6.2. The second hypothesis states that "There will be significant difference in the mean Gain Scores of Achievement in Physics (Post-Test I minus Pre-Test) between Control Group and Experimental Group"**

The mean Gain Scores (Post-Test I score minus Pre-Test score) on Achievement in Physics was computed and compared between Experimental Group and Control Group for Total sample, Boys and Girls. Two out of three t-values were found to be significant. The second hypothesis is therefore, substantiated to a greater extent.

**5.6.3. The third hypothesis states that "There will be significant difference in the mean Retention scores of Achievement in Physics Post-Test II (tested two months after the treatment) between Control Group and Experimental Group"**

Three comparisons of mean retention in Physics Post-Test II between Experimental Group and Control Group were done. All the t-values were found to be significant. Hence the third hypothesis is fully substantiated.

**5.6.4. The fourth hypothesis states that "There will be significant difference in the mean Gain Scores of Achievement in Physics (Post-Test II minus Pre-Test) between Control Group and Experimental Group**

Significant difference beyond 0.01 level in the mean gain scores on Achievement in Physics (Post-Test II minus Pre-Test) between Experimental Group and Control Group was noticed for Total sample, Boys and Girls. Hence fourth hypothesis is fully substantiated.

**5.6.5. The fifth hypothesis states that "Students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying will have significant difference in their mean scores of Achievement in Physics in Post-Test I"**

Three comparisons of mean Achievement in Physics Post-Test I were done between Groups formed on the basis of Studying Approaches. All the t-values were found to be significant. Hence fifth hypothesis is fully substantiated.

**5.6.6. The sixth hypothesis states that "Students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying will have significant difference in their mean Gain Scores of Achievement in Physics Post-Test I (Post-Test I minus Pre-Test)**

Significant difference in the mean gain scores of Achievement in Physics (Post-Test I minus Pre-Test) was noticed between Groups formed on the basis of Studying Approaches. Hence this hypothesis is fully substantiated.

**5.6.7. The seventh hypothesis stats that "Students having Deep Approach to Studying, Surface Approach to Studying will have significant difference in their mean Retention Scores of Achievement in Physics Post-Test II**

Three comparisons of mean Retention in Physics Post-Test II between Groups formed on the basis of Studying Approaches were done. All the t-values were found to be significant beyond 0.01 level. Hence this hypothesis is fully substantiated.

**5.6.8. The eighth hypothesis states that "Students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying will have significant difference in their mean Gain scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test)"**

Two out of three t-values were found to be significant for the comparison of mean Gain Scores of Achievement in Physics Post-Test II for Groups formed on the basis of Studying Approaches. Hence this hypothesis is substantiated to a greater extent.

**5.6.9. The ninth hypothesis states that :There will be significant main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test I for Total sample, Boys and Girls"**

Significant main effect of Methods of Teaching on Post-Test I was found to exist since all the F-values were significant for Total sample, Boys and Girls.

Main effect of Studying Approach on Achievement in Physics Post-Test I was found to be significant for Total sample, Boys and Girls.

The interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I was found to be significant for Total sample, Boys and Girls.

Hence the hypothesis is fully substantiated.

**5.6.10. The tenth hypothesis states that "There will be significant main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test II for Total sample, Boys and Girls"**

Main effect of Methods of Teaching on Achievement in Physics Post-Test II was found to be significant at 0.01 level for Total sample, Boys and Girls.

Main effect of Studying Approach on Achievement in Physics Post-Test II was found to be significant at 0.01 level for Total sample, Boys and Girls.

Interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II was found to be significant in all the cases.

Hence the hypothesis is fully substantiated.

**5.6.11. The eleventh hypothesis states that "There will be significant main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test I for Total sample, Boys and Girls when initial difference in select variables namely Previous Knowledge of Subject Matter and Non-Verbal Intelligence are controlled one by one and in combination"**

To test this hypothesis, twenty-seven ANCOVA were attempted. In all the cases the F-values were found to be significant.

Therefore the eleventh hypothesis is fully substantiated.

**5.6.12. The twelfth hypothesis states that "There will be significant main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test II for Total sample, Boys and Girls when initial differences in select variables namely Previous Knowledge of Subject Matter and Non-Verbal Intelligence are controlled one by one and in combination"**

Twenty seven ANCOVA were done to test this hypothesis. Out of these twenty two F-values were found to be significant and five F-values were found not significant.

Hence this hypothesis can be substantiated to a greater extent.

## 5.7. SUGGESTIONS FOR IMPROVING EDUCATIONAL PRACTICE

Based on the findings of the present investigation, the following suggestions are put forth for improving the existing educational practice in schools.

1. From the present study, it is noticed that Concept Attainment Model is effective in the teaching of the select topics in Physics for Achievement in Physics of standard IX students. It is to be specially noted that Concept Attainment Model which focuses on concept and thinking processes and not merely on rote learning of content is feasible in a normal secondary school class with a rigid organisational set up. This Method of Teaching ensures more active participation of students in learning process and better content mastery of the essential concepts which especially have a carry over value.

2. During the experiment, using Concept Attainment Model it was observed that students enjoy the lessons well since the class starts in the form of a game. For students who were weak and shy in the beginning, the use of appropriate prompts by the teacher helped for better learning of concepts.

3. In Concept Attainment Model of Teaching students are forming hypotheses. This enhance their thinking ability and scientific attitude. The analysis of thinking strategies help the students to become scientific and systematic in their studies. This has a carry over effect in day-to-day life. Therefore teachers should follow this method of teaching since it will improve the outlook and personality of students.

4. In Concept Attainment Model of Teaching all the students are actively participating and forming their own hypotheses about the labelled examples. Hence Concept Attainment Model has an inbuilt mechanism for attending to individual differences of the learners.

5. Teachers in Concept Attainment Model especially in the Reception Oriented Strategy have the full responsibility of leading the classroom instruction, monitoring the thinking process of students and providing feedback to students concerning their errors. The preparation of lesson transcripts, carefully selecting and ordering labelled examples, and organizing the sequencing of the lesson very carefully consume a considerable amount of time of the teacher in preparing for teaching. This may require special training for teachers not only for preparation of lesson transcripts, but also for

effective classroom transaction. But once a lesson transcript is prepared, this can be used in successive years, with modification whenever it is found necessary. Different Physics teachers can pool their expertise and extra time for preparing lesson transcripts in CAM format and can successfully implement these in Physics syllabus.

6. From the present study it is noticed that students having different Studying Approaches will differ significantly in their achievement. Students who have Deep Approach to Studying and Strategic Approach to Studying are found to be superior to students having Surface Approach to Studying in their Achievement and Retention in Physics. Hence teachers should make the students aware of the importance of their Studying Approach and should give them guidance in adopting proper studying approaches.

7. The study of Wilding *et al.* (2006) revealed that there is consistent relation between general life goals and studying approaches of the individual. In the present system of educational practice prevalent in Kerala students do not know the goals of education. The purpose of the study is just to get good grade in examination. The acquired knowledge remain isolated and not integrated with life activities. There should be deliberate attempt on the part of educators and

teachers to make the students aware of learning as a life long process. A shift should be made in the goals of science education to make it future oriented. In order to develop a better studying approach students should be made aware of the importance of the subject matter they learn, its relation to life and the reasons for practising it during studies.

8. The present study indicates that deep approach to studying is associated with seeking meaning, organising ideas and using logic. The surface approach is associated with rote memorisation, fragmented knowledge, lack of purpose and syllabus boundedness. The present system of examination and evaluation practised in secondary schools of Kerala is syllabus bounded. This will create more students with surface approach to studying. Therefore the evaluation system should be reformed and more stress should be given to formative evaluation in the secondary school curriculum.

9. Studies of many researchers like Tait and Entwistle (1993, 1995), Karaquannopoulou *et al.* (2005), Richardson (2005), Struyven (2006) and Mimirinis and Bhattacharya (2007) indicate that studying approach is positively related with perception of the students about the learning environment. The studying approach depends on the institutional set up and requirements. Therefore

educational administrators and teachers should make an effort to create the right perception in students about the course of study and institutional environment. Classrooms should be equipped with modern facilities in tune with the technological advancement of the world. Education should be made more vivid, enriched and experience based. Teachers and the school authorities can provide extra reading materials and other facilities to encourage students to have an in depth study of the different subjects.

10. The present study stresses the importance of appropriate studying approach for better academic outcome. The studies of Abouserie (1995), Andreou *et al.* (2006) and Wilding *et al.* (2006) indicate that studying approach depends on many individual characteristics of the learner. Therefore the learning environment should cater to individual differences. Multiple learning opportunities, diversified curriculum and courses rich in learning experience should be provided to develop better studying approach and in turn better academic outcome. Students should be made aware of the importance of studying approach for better academic performance. Separate and deliberate instructional training should be given to students for learning how to study. Teachers should try to improve the studying approach of low achievers by modifying the learning

environment and achieving a balance between teaching strategy and studying methods.

11. In order to create more students with deep approach to studying science classes should provide chances for observation and experimentation. Students should seek evidences and clarifications and learning should be made syllabus free and enjoyable. In order to create interest and motivation in students learning should be life oriented. Thinking ability and creativity should be enhanced and students should be made self reliant and independent. Projects and assignments should not be examination bound but should cater to individual differences. To achieve this, innovative teaching strategies like Concept Attainment Model should be provided in secondary school science curriculum.

## 5.8. SUGGESTIONS FOR FURTHER RESEARCH

The findings of the present study can further be extended by future researchers on the lines suggested below.

1. The replication of the study can be attempted on other concepts in Physics from secondary school curriculum.

2. Interaction effect of Concept Attainment Model of Teaching and Studying Approach on Achievement in Physics of Upper Primary Students and Higher Secondary Students can be studied.

3. The study can be replicated for Chemistry and other Science subjects.

4. Interaction effect of Concept Attainment Model and Studying Approach on Achievement in Physics by considering Examination Anxiety, Self-Concept, Creativity as Control variables can be studied.

5. The study can be attempted for the subsamples based on English/ Malayalam medium, rural/urban, private/government population.

6. The study can be replicated on students with learning disabilities, special needs, social disadvantage and of different classroom learning environment.

7. A study on the interaction effect of Methods of Teaching and Studying Approach on Academic Achievement can be conducted for the population of teacher trainees.

8. The interaction effect of other information processing Models of Teaching and Studying Approach on Achievement in Physics can be experimented.

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# APPENDICES

## APPENDIX IA

## DEPARTMENT OF EDUCATION
## UNIVERSITY OF CALICUT
## LESSON TRANSCRIPT FOR CONCEPT ATTAINMENT MODEL –No. IV
## (Standard IX)

**Dr. P. Usha** **Ampili Aravind**

*Time: 45 minutes*

1. Name of the concept : Force
2. Essential Attributes :
   1. Force can change the state of rest of a body (changes position)
   2. It can change the speed of the body.
   3. It can change the direction of motion.
   4. Force tends to change the state of rest of a body.
   5. Force tends to change the state of motion of a body in a straight line.
   6. Force is necessary to stop motion.
3. Non Essential Attributes :

   The state, size, weight, shape, colour etc. of the body.
4. Positive Exemplars :
   1. Lifting up of a ball
   2. Kicking a football
   3. Pulling a cart
   4. Pushing a car
   5. Kicking a rolling ball in another direction
   6. Kicking a rolling ball in the same direction

7. Stopping a moving ball.

5. Negative exemplars

1. a ball placed still on the floor
2. a cart in the state of rest
3. a car in the state of rest
4. movement of a ball on a surface without friction.

Rule: Force is that which changes or tends to change the state of rest or of uniform motion of a body in a straight line.

| | | |
|---|---|---|
| * Type of model | : | Reception oriented CAM |
| * Type of concept | : | Conjunctive |
| * Mode of presentation | : | Verbal example, simple experiments and explanation |
| * Thinking strategy | : | Wholistic strategy |

**Syntax**

**Phase I**

**Presentation of data and Identification of the Concept**

| | | |
|---|---|---|
| Teacher : | Today we are going to play a game. I will give you some examples of a particular concept that I have in mind. If the example contains the concept I have in mind, I will say 'Yes' and otherwise I will say 'No'. You will have to identify the particular concept I have in mind. You will have to cite more examples, test the characteristics of the concept and give a definition of that concept according to its characteristics | Orientation to Programme |

| | | | |
|---|---|---|---|
| | | Let us see an example which is an 'Yes'.<br>Lifting up of a ball.<br>Can you say what my concept is? | Teacher presents first labelled example |
| Students | : | No | |
| Teacher | : | See the next example. It is a 'No'. A ball placed still on the floor. Can you guess what my concept is? | Teacher presents second labelled example |
| Students | : | Something related with rest and motion | Students form first hypothesis |
| Teacher | : | That is not a clear answer. Here is another example which is a 'Yes'.<br>Kicking a football.<br>Now can you say what my concept is? | Teacher presents third labelled example |
| Students | : | In your 'yes' examples the position of the object is changed while in the 'No' example there is no change of position. | Students form second hypothesis |
| Teacher | : | You are correct. Let me give you another 'Yes' example.<br>Pulling a cart | Teacher presents fourth labelled example. |
| Students | : | Work has to be done to pull a cart | Students form third hypothesis |
| Students | : | The cart is moving because of the work done | |
| Teacher | : | Good. But the concept is not clear enough. Look at this example. A cart in the state of rest. It is a 'No' example. | Teacher presents fifth labelled example. |

| | | | |
|---|---|---|---|
| Students | : | The cart is not moving because nobody is pulling it. | Students form fourth hypothesis. |
| Teacher | : | Very good. Can you name the concept now? | |
| Students | : | Something related to doing work. | |
| Teacher | : | 'Yes'. It is a 'Force'. Now look at another 'Yes' example.<br>Pushing a car.<br>What is happening here? | Teacher names the concept |
| Student | : | Force is applied on car. But it is not moving. | Students form hypotheses |
| Student | : | Car is not actually moving because force is not enough. | |
| Teacher | : | Correct. Now let me give you another 'No' example.<br>Movement of a ball in a surface without friction.<br>What can you say about it? | Teacher gives seventh labelled example |
| Student | : | The ball continues to roll because there is no friction. | Students form hypotheses |
| Student | : | The ball will stop if the ground exerts force on it. | |
| Teacher | : | Very good. . Now let me give you another 'Yes' example.<br>Kicking a rolling ball in another direction.<br>What is happening here? | Teacher gives eighth labelled example |
| Student | : | The direction of motion of the ball changes due to application of force | Students form hypotheses |
| Teacher | : | Correct. Now can you give the characteristics or essential attributes of force? | |

| | | | |
|---|---|---|---|
| Student | : | Force can change the state of rest of a body. | |
| Student | : | Force can change the direction of motion of a body. | |
| Student | : | Force can change the speed of a body. | |
| Student | : | Force tends to change the state of rest of a body | |
| Student | : | Force is necessary to stop motion | |
| Teacher | : | Very good. | |
| | | Force is that which changes or tends to change the state of rest or of uniform motion of a body in a straight line. | Teacher states the concept rule |
| | | Now can you name the non-essential attributes? | |
| Students | : | No | |
| Teacher | : | The weight of the object. It does not determine the force applied on it. Anything more? | |
| Students | : | The size of the object, the shape of the object, the state of the object etc. | Students test the non-essential attributes. |
| Teacher | : | Very correct. | |

## Phase II

## Testing the Attainment of the Concept

| | | | |
|---|---|---|---|
| Teacher | : | Now I am going to test whether you have understood the concept of force. I shall give you some examples. You have to say whether it is a 'Yes' example or a 'No' example. | Students label the unlabelled examples |
| | | Lifting up of a book. | |
| Students | : | 'Yes' | |
| Teacher | : | A car in the state of rest. | |

| | | |
|---|---|---|
| Students : | 'No' | |
| Teacher : | Kicking a rolling ball in the same direction. | |
| Students : | 'Yes' | |
| Teacher : | A book placed still on the table. | |
| Students : | 'No'. | |
| Teacher : | Stopping a moving ball. | |
| Students : | 'Yes' | |
| Teacher : | You are correct. Then can you define force. | |
| Students : | Force is that which changes or tends to change the state of rest or of uniform motion of a body in a straight line. | Student states the concept rule. |
| Teacher : | Good. Give some more examples of force. | |
| Student : | Pushing a table | |
| Student : | Pushing a wall | |
| Student : | Lifting a stone | |
| Student : | Stopping a rolling wheel | |
| Student : | Changing direction of motion of a rolling wheel | |
| Teacher : | Very good. | |

**Phase III**

**Analysis of Thinking Strategies**

| | | |
|---|---|---|
| Teacher : | Can you explain how you came to the conclusion of our concept. | |
| Student : | The first 'yes' example was lifting up of a ball and the first 'No' example was a ball placed still on the floor. Then I thought that it is something related with rest and motion. Then you gave the second and third 'Yes' examples. I thought that it is something related with doing work. | Students describes thoughts |

Teacher : What about other examples?

Student : When you gave the sixth labelled example I thought that application of force always do not change position. But it can produce a tendency to change state.

Teacher : Then how did you arrive at the conclusions about the essential attributes of force?

Student : When you gave the seventh labelled example I thought that force is necessary to stop motion. From the 8th 'Yes' example I found that force can change the direction of motion of a body along a straight line. Then once more I went through all the 'Yes' and 'No' examples and analysed the essential attributes of force. Thus I arrived at the concept of force.

**APPENDIX IB**

**DEPARTMENT OF EDUCATION**
**UNIVERSITY OF CALICUT**

**LESSON TRANSCRIPT FOR CONCEPT ATTAINMENT MODEL-No.VI**
**(Standard IX)**

**Dr. P. Usha** **Ampili Aravind**

*Time: 45 minutes*

1. Name of the concept : Inertia of rest and Inertia of motion
2. Essential Attributes :

(1) an object at rest cannot move by itself.

(2) an object at rest continues to be in its state of rest.

(3) application of an external force is necessary for the change of state of rest

[for Inertia of rest]

(1) An object in linear motion cannot come to rest by itself.

(2) It continues to be in its state of motion in a straight line.

(3) Application of an external force is necessary for the change of state of motion.

[for Inertia of motion]

3. Non-essential attributes :

The size, weight, shape etc. of the object.

4. Positive examplars:

(1) Falling forward of a standing passenger, when a fast moving bus is suddenly stopped.

(2) Athletes running some distance before making a long jump.

(3) Rabbits running in a zig-zag manner if chased by dog.

(4) Running of a man in a zig-zag manner if chased by an elephant.

[for Inertia of Motion]

(1) The falling backward of a standing passenger when a bus stands moving suddenly.

(2) Beating of a carpet with a stick to clean it.

(3) Shaking of the branches of a mango tree to pluck mangoes.

(4) Remaining intact of a pile of coins placed one over another, even if we strike the lowest coin.

[for Inertia of rest]

5. Negative exemplars

(1) The falling backward of a standing passenger when a bus starts moving suddenly.

(2) Beating of a carpet with a stick to clean it.

(3) Shaking of the branches of a mango tree to pluck mangoes.

(4) Remaining intact of a pile of coins placed one over another, even if we strike the lowest coin.

[for Inertia of Motion]

(1) Falling forward of a standing passenger, when a fast moving bus is suddenly stopped.

(2) Athletes running some distance before making a long jump.

(3) Rabbits running in a zig-zag manner if chased by dog.

(4) Running of a man in a zig-zag manner if chased by an elephant.

[for Inertia of Rest]

Rule: 'Inertia of rest' is the incapability of a body to change by itself its state of rest.

'Inertia of Motion' is the incapability of a body to change by itself its state of uniform motion along a straight line.

| | | | |
|---|---|---|---|
| * | Type of model | : | Reception Oriented CAM |
| * | Type of concept | : | Conjunctive |
| * | Mode of presentation | : | Verbal example, simple experiments and explanation. |
| * | Thinking strategy | : | Wholistic strategy |

**Syntax**

**Phase I**

**Presentation of data and Identification of the Concept**

| | | | |
|---|---|---|---|
| Teacher | : | Today we are going to play a game. I will give you some examples of a particular concept that I have in mind. If the example contains the concept that I have in mind, I will say 'Yes' or otherwise I will say 'No'. You will have to identify the particular concept I have in mind. You will have to cite more examples, test the characteristics of the concept and give a definition of the concept according to its characteristics. | Orientation to programme |
| Teacher | : | Let us see an example which is an 'Yes'.<br>When a fast moving bus is suddenly stopped, a standing passenger tends to fall forward.<br>Can you say what I have in mind? | Teacher presents first labelled example |
| Students | : | Moving passenger cannot stop easily. | Students forms first hypothesis |
| Teacher | : | Your idea is correct. But the concept is not clear. See the next example. It is a 'No'. | Teacher presents the second |

| | | |
|---|---|---|
| | When a bus starts moving suddenly, a standing passenger tends to fall backwards.<br>Can you guess what my concept is? | labelled example |
| Students : | No | |
| Teacher : | Look at this example now.<br>Athletes run some distance before making a long jump.<br>It is an 'yes' example. | Teacher presents the third labelled example |
| Students : | To increase the speed of jumping | Student forms second hypothesis |
| Teacher : | That is not a clear answer. Here is another example which is a 'No'.<br>Beating of a carpet with a stick to make it clean. | Teacher presents fourth labelled example. |
| Students : | Give some more examples | |
| Teacher : | Here is another 'yes' example. Running of rabbits in zig-zag manner if chased by dog. | Teacher presents fifth labelled example. |
| Students : | It may be because dog cannot easily run in a zig-zag manner. | Student forms third hypothesis |
| Teacher : | See this 'yes' example. A man chased by an elephant runs in a zig-zag manner. | Teacher presents sixth labelled example. |
| Students : | In your 'yes' examples a moving object cannot stop easily. | Student forms fourth hypothesis. |
| Teacher : | Good. Anything more? | |
| Students : | In your 'yes' example a moving object cannot change its direction easily. | Fifth hypothesis. |

| | | | |
|---|---|---|---|
| Teacher | : | Very good. Can you name the concept? | |
| Students | : | No | |
| Teacher | : | It is 'inertia of motion'. Now, can you give the characteristics or essential attributes of Inertia of motion | Teacher names the concept |
| Students | : | An object in motion cannot come to rest by itself. | |
| Students | : | An object in motion has a tendency to continue in its state of motion. | |
| Students | : | An object moving in straight line cannot change its direction of motion easily. | |
| Students | : | Application of an external force is necessary for the change of state of motion. | |
| Teacher | : | Very good.<br>Inertia of motion is the incapability of a body to change its state of uniform motion along a straight line. | Teacher states the concept rule. |
| Teacher | : | Now look at the 'No' examples. Is there any concept in it? | |
| Students | : | In your 'No' example an object in a state of rest cannot move by itself | Sixth hypothesis |
| Teacher | : | Correct. Anything more? | |
| Students | : | In your 'No' example an object at rest has a tendency to continue in its state of rest. | Seventh hypothesis. |
| Teacher | : | Can you give any other characteristics? | |
| Students | : | An external force is needed to change state of rest | Eighth hypothesis |
| Teacher | : | Very good. Can you name this concept? | |
| Students | : | Yes. It is 'Inertia of rest'. | Student names the concept |
| Teacher | : | Very good. Now let us put all the essential attributes together. | |

| | | | |
|---|---|---|---|
| Students | : | An object at rest cannot move by itself. | Student tests all the essential attributes |
| Students | : | It continues to be in its state of rest. | |
| Students | : | Application of an external force is necessary for the change of state of rest | |
| Teacher | : | Good. Now can you define 'inertia of rest'? | |
| Students | : | 'Inertia of rest' is the incapability of a body to change by itself, its state of rest. | Student states the concept rule |
| Teacher | : | Can you name the non-essential attributes of these concepts? | |
| Students | : | No | |
| Teacher | : | Consider the weight of the object. It does not determine 'inertia of rest' or 'inertia of motion'. Anything more? | Student tests the non-essential attributes |
| Students | : | The size of the object, the shape of the object etc. | |
| Teacher | : | Very correct. | |

**Phase II**

**Testing the Attainment of the Concept**

| | | | |
|---|---|---|---|
| Teacher | : | Now I am going to test whether you have understood the concepts 'inertia of rest' and 'inertia of motion'. I shall give you some examples. If it is 'inertia of motion' you have to say 'yes' and if it is 'inertia of rest' you has to say 'No'. | |
| Teacher | : | When a fast moving train is suddenly stopped, a standing passenger falls forward. | |
| Students | : | 'Yes' | Student labels the unlabelled examples |
| Teacher | : | To pluck mangoes we sometimes shake the branches of the tree. | |
| Students | : | 'No' | |
| Teacher | : | I will show you an experiment now. | |

| | | |
|---|---|---|
| | Teacher places a number of coins one over another and forms a pile. Then she strikes the lowest coin. The students observe that the pile of coins remain intact. | |
| Teacher : | If we strike the lowest coin of a number of coins placed one over another, the pile of coins remain intact. If this a 'Yes' or 'No' example? | |
| Students : | 'No'. | |
| Teacher : | Right. Then can you define 'inertia of motion'. | |
| Students : | Inertia of motion is the incapability of a body to change by itself its state of uniform motion along a straight line. | Student states the concept rule. |
| Teacher : | Then what is 'inertia of rest'. | |
| Students : | Inertia of rest is the incapability of a body to change by itself its state of rest. | Student states the concept rule. |
| Teacher : | Give some more examples of 'inertia of motion'. | Student generates identical examples |
| Students : | Sportsman running some distance before throwing a javelin. | |
| Students : | Deer running in zig-zag manner when chased by Lion. | |
| Teacher : | Good. Give some more examples of 'inertia of rest'. | |
| Students : | When a train starts moving suddenly a standing passenger tends to fall backwards | Student generates examples. |
| Students : | If we strike the lowest card of a pile of cards placed one over other, the pile of cards remain intact. | |
| Teacher : | Very good. | |

**Phase III**

**Analysis of Thinking Strategies**

| | | | |
|---|---|---|---|
| Teacher | : | Can you explain how you came to the conclusion of our concepts. | |
| Students | : | The first 'yes' example was falling forward of a standing passenger, when a fast moving bus is suddenly stopped. I thought that moving objects cannot stop easily. Then you gave the example of Athletes running some distance before making a long jump. Then I thought that a moving body continues to move for sometime. | Students describes thoughts. |
| Teacher | : | What about other examples? | |
| Students | : | When you gave the first two 'No' examples I thought it was something concerned with remaining in whatever state the object was. Then you gave the other 'yes' examples. This helped me in formulating our initial hypotheses. | |
| Teacher | : | Then how did you arrive at the conclusion? | |
| Students | : | Once more I went through both the 'Yes' and 'No' examples and found that in the 'Yes' examples objects in state of motion were having a tendency to continue in their motion along the same direction and in the 'No' examples the objects in the state of rest were having a tendency to remain in their state of rest. Thus I arrived at the concepts of 'inertia of motion' and 'inertia of rest'. | Student describes thought process. |

## APPENDIX IC

## OBSERVATION PROFORMA FOR CONCEPT ATTAINMENT MODEL OF TEACHING

Name of the teacher : Name of the Institution:
Designation : Experience in teaching:

For each of the 18 statements in the proforma, circle the term that best describes the teacher's behaviour.

| Sl. No. | Statements | Level of Effectiveness | | | |
|---|---|---|---|---|---|
| | | T (Thoroughly) | P (Partially) | M (Missing) | NN (Not Needed) |
| 1. | Did the teacher state the purpose of the game? | | | | |
| 2. | Did the teacher explain the procedure of the game? (How the 'Yeses' and 'Nos' function?) | | | | |
| 3. | Did the initial 'Yes' clearly contain the essential attributes? | | | | |
| 4. | If teaching a conjunctive concept, did the teacher begin with a 'Yes' exemplar? | | | | |
| 5. | Did the teacher ask questions that focused students thinking on the essential attributes? | | | | |
| 6. | Did the teacher ask the students to compare the 'Yes' exemplars ? | | | | |
| 7. | Did the teacher ask the students to contrast the attributes of the 'Yes' exemplars with those of the 'No' exemplars? | | | | |
| 8. | Did the teacher present labelled exemplars? | | | | |
| 9. | Did the teacher ask the students to generate and test hypothesis about the identity of the concept? | | | | |
| 10. | Did the teacher ask the students to name the concept? | | | | |
| 11. | Did the teacher ask the student to state the essential attributes of the concept? | | | | |

| Sl. No. | Statements | Level of Effectiveness | | | |
|---|---|---|---|---|---|
| | | T (Thoroughly) | P (Partially) | M (Missing) | NN (Not Needed) |
| 12. | After the concept was agreed upon, did the teacher present additional exemplars and ask whether they contained the concept? | | | | |
| 13. | Did the teacher ask the students to justify their answers? | | | | |
| 14. | Were the students able to supply their own exemplars to fit the concept? | | | | |
| 15. | Did the teacher ask the students to justify their exemplars by identifying the essential attributes? | | | | |
| 16. | Did the teacher ask the students to describe the thinking process they used in attaining the concept? | | | | |
| 17. | Did the teacher ask the students to reflect on the role of attributes and concepts in their teaching strategies? | | | | |
| 18. | Did the teacher ask the students to evaluate the effectiveness of their strategies? | | | | |

19. Explain your overall judgement of the teacher's effectiveness:

_______________________________________________

_______________________________________________

20. Suggestions for Improvement:

_______________________________________________

_______________________________________________

## APPENDIX II A

## DEPARTMENT OF EDUCATION
## UNIVERSITY OF CALICUT

## LESSON TRANSCRIPT FOR OBJECTIVE BASED INSTRUCTION-IV

| | | | | | |
|---|---|---|---|---|---|
| Name of the teacher | : | Ampili Aravind | | | |
| Name of the School | : | NSSKPTHSS Ottapalam | Standard and division | : | IX $A_1$ |
| Subject | : | Physics | Strength | : | 40 |
| Unit | : | Force | Period | : | IV |
| Topic | : | Force | Date | : | 19.07.2005 |

| | | |
|---|---|---|
| Content overview | : | Force |
| Content Analysis | | |
| Scientific terms | : | Force, State of rest, State of motion, External force. |
| Scientific facts | : | 1. A moving object will continue to move if not stopped.<br>2. A book in a state of rest continues to be in that state, if an external force is not applied. |
| Scientific Concepts | : | Force is that which moves or tends to move an object. |
| Instructional Objectives | : | 1. The pupil acquires knowledge about the above terms, facts and concept.<br>2. The pupil develops comprehension of the concept force.<br>3. The pupil applies knowledge in daily life situations.<br>4. The pupil analyses the different types of forces.<br>5. The pupil synthesises the properties of force.<br>6. The pupil evaluates the effects of force. |
| Previous knowledge | : | The pupil knows that when an object is pushed or pulled, it moves. |
| Teaching aids | : | Chart. |

42. Water is taken in a vessel and heated. The temperature is measured using a thermometer. It is observed that temperature increased gradually as water is heated. But when water begins to boil there is no rise in temperature even though it is heated continuously.

This is because:

A. No heat is absorbed when water boils.

B. Thermometer becomes insensitive to temperature.

C. Temperature of water vapour cannot be noted using a thermometer.

D. Heat is absorbed by water to change into water vapour.

43. The property by which a liquid produces a force in order to reduce te relative motion between its different layers is called:

A. Viscosity

B. Surface tension

C. Friction

D. Capillarity.

44. You are to conduct an experiment to find out whether the electrical conductivity of a substance depends on the number of free electrons in the substance

If the electrical conductivity depends on the number of free electrons, what should be done to find this out accurately?

A. Find the electrical conductivity of an insulator and check if it is proportional to the number of free electrons.

B. Find the electrical conductivity of a good conductor and check if it is proportional to the number of free electrons.

C. Find the electrical conductivity of a semi-conductor and check if it is proportional to the number of free electrons.

D. Find the electrical conductivity of different insulators, conductors and semi conductors and check accurately the relationship between conductivity and the number of free electrons.

45. Which of the following is an example of a viscous liquid?

A. Water

B. Coltar

C. Petrol

D. Kerosine

46. In an experiment a 100 g weight is placed on a dial balance and the reading is noted. Now the weight is placed 30 cm above the balance and dropped. The reading is noted again. Then a 200g weight is dropped on the balance from the same height and reading is noted. The reading is different in each case.

Which of the following statements are implicit in the experiment?

A. The balance show different reading because different weights are dropped.

B. The weights strike the dial with different velocity.

| CONTENT | SPECIFICATION | LEARNING EXPERIENCE | EVALUATION |
|---|---|---|---|
| INTRODUCTION | | | |
| When an object is pushed it moves. | recalls | The teacher asks the pupils what will happen if we push an object. The pupil answers. | |
| PRESENTATION | | | |
| An object moves if we push it because we apply force on it. | recognises | Through discussion pupil comes to the conclusion that an object moves when we push it because we are applying force on it.<br>Force (B.B) | Why does an object move when we push it? |
| Force is that which moves or tends to move an object | observes the experiment.<br>notes minute details.<br>defines. | The teacher asks a pupil to push a toy car. When the pupil applies a little force it tends to move. When he pushes it harder, the car moves forward. Through observation and discussion pupils comprehend the meaning of force. | What is force? |
| An object cannot move if an external force is not applied on it. | Performs experiment<br>finds out reason | Pupil places a ball on the floor. The pupils observe that if no force is applied the ball will remain still. When it is kicked it moves. Through this experiment pupil understands that an object cannot move if an external force is not applied on it. | What happens to object if an external force is not applied on it? |
| If a rolling object is kicked again it moves faster. | realises | Through experiment pupil realises that a rolling object will move faster if it is kicked again. | If we kick a rolling ball again what will happen? |

| | | | |
|---|---|---|---|
| If a rolling ball is kicked in another direction its direction of motion changes. | recognises. gives explanation. | Through experiment pupil recognises that when a rolling ball is kicked in another direction its direction of motion changes. | What happens to a moving ball if it is kicked in another direction? |
| Force is need to stop motion. | draws inferences. | Through experiments and discussion pupil infers that force is required to stop a moving object. | Why does a rolling ball stop after sometime? |
| Force is that which changes or tends to change the state of rest or that of uniform motion of an object in a straight line. | defines. | Pupil explains that force can change state of rest, state of motion, speed of motion and direction of motion. With the help of the teacher the pupil defines force. | Define force? |

CONTENT REVIEW

1. Why does an object move when we push it?
2. What happens to an object if a force is not applied on it?
3. If we kick a rolling ball in the same direction what will happen?
4. If we kick a rolling ball in another direction what will happen?
5. What all changes can be done on a body applying force?
6. Define force.

HOME ASSIGNMENT

1. Define force.
2. Observe the different instances of force in your day to day life and note them down.

# APPENDIX II B

## DEPARTMENT OF EDUCATION
## UNIVERSITY OF CALICUT

## LESSON TRANSCRIPT FOR OBJECTIVE BASED INSTRUCTION-VI

Name of the teacher : Ampili Aravind
Name of the school : NSSKPTHHSS Ottapalam
Subject : Physics
Unit : Force
Topic : Inertia of Rest and Inertia of Motion

Standard and Division: IXA
Strength : 40
Period : III
Date : 21-07-2005

| | |
|---|---|
| Content Overview : | Inertial of Rest and Inertia of Motion |
| Content Analysis | |
| Scientific terms : | Force, State of rest, state of motion, Inertia, Inertia of rest, Inertia of motion |
| Scientific Facts : | 1. A body cannot change the state of rest by itself<br>2. A body moving in a strait line cannot change the direction or speed of motion by itself |
| Scientific Concepts : | 1. Inertia of rest is the tendency of a body to continue in its state of rest<br>2. Inertia of motion is the tendency of a body to continue in its state of uniform motion along a straight line. |
| Instructional Objectives: | 1. The pupil acquires knowledge about the above terms, facts and concepts<br>2. The pupil develops comprehension of the concepts Inertia of rest and inertia of motion.<br>3. The pupil applies knowledge in daily life situations.<br>4. The pupil analyses the different instances of inertia of rest and inertia of motion in daily life.<br>5. The pupil synthesises the properties of inertia of rest and inertia of motion.<br>6. The pupil evaluates the effects of inertia of rest and inertia of motion. |
| Previous knowledge : | The pupil knows that an object continues in its state of rest or uniform motion along a straight line, unless a force is applied on it. |
| Teaching aids : | Charts, Carrom coins, |

| CONTENT | SPECIFICATION | LEARNING EXPERIENCE | EVALUATION |
|---|---|---|---|
| INTRODUCTION<br>When force is applied on a moving ball it will stop. When force is applied on a ball at rest it will move | recalls | The teacher kicks a ball on ground. The pupil observes that the ball moves. The teacher applies force on the moving ball. It stops. The pupil recalls that force is needed to start motion and stop motion | |
| PRESENTATION<br>An object continues in its state of rest if no force is acting on it. | recognises | Through discussion pupils come to the conclusion that an object continues in its state of rest if no force is acting on it.<br>(State of rest (B.B.) | What happens to an object in a state of rest when no force is applied on it? |
| An object continues in its state of uniform motion along a straight line if no external force acts on it. | observes the experiment<br>notes minute details<br>finds out reason<br>infers | The teacher asks a pupil to observe a moving ball on ground. Through observation and discussion pupils comprehend that the ball slows down and comes to rest after some time because of the force exerted on it by the ground. Through discussion pupils realise that the ball will move on infinitely in the same direction with the same speed on a friction less surface. Pupils infer that if an external force is not applied, an object continues in its state of uniform motion along a straight line<br>State of uniform motion (B.B.) | What happens to an object in a state of uniform motion along a straight line when no external force is applied on it? |
| Inertia of rest is the tendency of a body to continue in its state of rest | defines | With the help of the teacher the pupil defines inertia of rest<br>(Inertia of rest (B.B.) | Define Inertia of rest? |
| Examples of Inertia of rest<br>1. We can strike off the lowest coin form a pile of carrom coins without disturbing other coins | observes the experiment<br>illustrates<br>finds out reason<br>draws inferences | The teacher arranges a pile of carrom coins on the table. The teacher asks a pupil to strike off the lowest coin from the pile of coins without disturbing other coins. Pupils observe that other coins remain undisturbed. Pupil infers that this is due to inertia of | Cite examples for inertial of rest. |

| CONTENT | SPECIFICATION | LEARNING EXPERIENCE | EVALUATION |
|---|---|---|---|
| | draws inferences | rest of the coins. Through discussion pupil finds that mangoes fall down when we shake the branch of a mango tree due to inertia of rest. | |
| 2. Mangoes detach from the stalk when we violently shake the branch of a mango tree. | | | |
| Inertia of motion is the tendency of a body to continue in its uniform motion along a straight line | compares and contrasts defines | Pupils defines inertia of motion Inertia of motion (B-B) With the help of the teacher pupil realises that a body moving in a straight line also has inertia | Define inertia of motion? |
| Examples of Inertial of motion | | | |
| 1. A person stepping out of a moving bus has to run forward a few steps 2. The fan continues to rotate for sometime even after it is switched off. | identifies life situations performs experiment observes draws inference | The teacher explains the instance of a person stepping out a moving bus. The pupil realises that the person has to run forward a few steps. The teacher asks a pupil to stop the fan in the classroom. Pupils observe that fan continues to rotate for sometime even after it is switched off. Pupil identifies these instances as daily life examples of Inertia of motion? | Compare inertia of rest and inertia of motion with the help of daily example. |
| A standing person tends to fall backward when a bus at rest is moved forward quickly due to inertia of rested A standing person tends to fall forward when a moving bus comes to rest quickly | realises cites examples explains compares | Teacher describes the instance of a standing person when a bus at rest is moved forward quickly. Pupil comprehends this is an example of Inertia of rest Pupils explains that a standing person tends to fall forward when sudden break is applied on a moving | Cite daily life examples for inertia of motion? |

| CONTENT | SPECIFICATION | LEARNING EXPERIENCE | EVALUATION |
|---|---|---|---|
| due to inertia of motion | | bus due to inertia of motion<br>Pupil compares Inertia of rest and Inertia of motion. | |

| | |
|---|---|
| CONTENT REVIEW | 1. What happens to an object in a state of rest when no external force is applied on it?<br>2. What happens to an object in a state of uniform motion along a straight line when no external force is applied on it?<br>3. Define Inertia of rest.<br>4. Define Inertia of motion<br>5. Cite examples for inertia of rest and inertia of motion |
| Home Assignment | 1. Define Inertia of rest and Inertia of motion<br>2. Find out different instances of inertia of rest and Inertia of motion from daily life situations and note them down. |

## APPENDIX- IIIA

## DEPARTMENT OF EDUCATION
## UNIVERSITY OF CALICUT

# STUDYING APPROACH INVENTORY
**(Draft Version)**


**Dr. P. USHA**
Reader
Department of Education
University of Calicut

**AMPILI ARAVIND**
Research Scholar


## INSTRUCTIONS

For each of the following statements three alternative responses- 'Agree', 'disagree' and 'not sure'- are given. Read the statements carefully and select the most appropriate response. Put a 'X' in the relevant circle provided in the response sheet against each statement number. Do not write anything in the question booklet. Kindly answer all the questions.

For Example, Item No.3 is:

3. I wonder whether the activities connected with the course are relevant. If your response is 'Agree' put a 'X' in the response sheet as shown here.

| Agree | Disagree | Not sure |
|---|---|---|
| ⊗ | O | O |

1. While studying, I try to find out for myself the meaning of the prescribed lessons.
2. I analyze the content critically, while reading a book.
3. I wonder whether the activities provided in the school are relevant.
4. I like to analyze the reason behind things.
5. I come across really gripping ideas while studying.
6. I am in the habit of reading without thinking much about the content.
7. During night I lie awake worrying about assignments I have to submit.

8. It is difficult for me to prepare study notes on my own.

9. I somehow find suitable learning environment to get on with my studies.

10. I abide by instructions given by my teachers.

11. I accept, what is being told to me, only after elaborate thinking and analysis.

12. Much of my learning involves rote memorization.

13. I really enjoy studying the academic topics.

14. I think about how to get the appreciation of the teacher while doing projects and assignments.

15. I think about what I want to get out of my studies to keep my studying well oriented.

16. I prepare models and charts as a part of class project works and not because I am interested.

17. While studying, I can easily remember bits and pieces but cannot present it as a whole concept.

18. Though uninterested in studying, I have to study because of many other reasons.

19. I write everything I hear in classes as it is difficult for me to grasp the important points.

20. I am in the habit of going over my work again and again to find out whether there are any mistakes.

21. I put a lot of effort to make sure that I have all the important study material with me.

22. I find myself attached to certain subjects and would like to study those subjects more.

23. I like teachers to give guidelines while assigning the projects or duties.

24. To memorize the study materials, I have to write or repeat it quite a number of times.

25. I follow a timetable while revising for examinations.

26. I think about how to present an assignment or answer a question in an impressive manner before starting work on it.

27. My mind questions the facts presented in lectures or in books.

28. While writing an assignment, I try to incorporate the view points of the teacher who is going to value it.

29. While reading a text book I think a lot about ideas presented in them.

30. My life experiences influence the way I absorb new ideas.

31. When I am learning from text books, I try to get an insight of curricular objectives.

32. I generally utilize my day time effectively.

33. I learn by heart because I don't understand much of what is taught.

34. I study really hard because I am determined to do well.

35. While revising for examinations, I concentrate on portions highlighted as important by the teachers.

36. My mind follows the idea from classroom teaching even while doing other things.

37. I wonder what prompted me to go to school.

38. I analyse the details to know about the author's ideas while reading a book or an article.

39. I keep in mind teacher's comments on my previous work to get higher marks next time.

40. While studying, I concentrate fully on what I am doing.

41. I plan my study time to make use of it effectively.

42. I am in the habit of planning my work in advance.

43. It is important for me to try my level best to be successful in my studies.

44. While studying, I take short breaks to review and recollect the material already learned.

45. I go through the fundamentals before solving a problem or taking up an assignment.

46. While studying a new topic, I try to get an overview of the ideas presented.

47. While studying, I examine the portion carefully to reach my own conclusions.

48. I use to analyse new ideas by linking it with my previous knowledge.

49. I like to play around with ideas of my own, even though they are not connected with my studies.

50. I try to relate the learning materials with other topics studied.

51. It is difficult for me to understand the meaning of the topics as they are presented in a manner beyond my comprehension.

52. I am anxious whether I will be able to attain the expected standard while doing the assigned work.

53. I have definite purpose behind my studies and know how to achieve it.

54. It is very easy for me to motivate myself.

55. I worry a lot about whether I will be able to complete my studies successfully.

56. I can get down to work whenever I need to.

57. I am always uptodate in my studies and work.

58. I find nothing in the syllabus quite interesting.

**APPENDIX III B**

# DEPARTMENT OF EDUCATION
# UNIVERSITY OF CALICUT

## STUDYING APPROACH INVENTORY
### RESPONSE SHEET

Name :                                                  Boy/Girl :
Name of school :                                        Rural/Urban :
Standard :                    Division:

| Sl. No. | Agree | Disagree | Not sure | Sl. No. | Agree | Disagree | Not sure |
|---|---|---|---|---|---|---|---|
| 1 | O | O | O | 30 | O | O | O |
| 2 | O | O | O | 31 | O | O | O |
| 3 | O | O | O | 32 | O | O | O |
| 4 | O | O | O | 33 | O | O | O |
| 5 | O | O | O | 34 | O | O | O |
| 6 | O | O | O | 35 | O | O | O |
| 7 | O | O | O | 36 | O | O | O |
| 8 | O | O | O | 37 | O | O | O |
| 9 | O | O | O | 38 | O | O | O |
| 10 | O | O | O | 39 | O | O | O |
| 11 | O | O | O | 40 | O | O | O |
| 12 | O | O | O | 41 | O | O | O |
| 13 | O | O | O | 42 | O | O | O |
| 14 | O | O | O | 43 | O | O | O |
| 15 | O | O | O | 44 | O | O | O |
| 16 | O | O | O | 45 | O | O | O |
| 17 | O | O | O | 46 | O | O | O |
| 18 | O | O | O | 47 | O | O | O |
| 19 | O | O | O | 48 | O | O | O |
| 20 | O | O | O | 49 | O | O | O |
| 21 | O | O | O | 50 | O | O | O |
| 22 | O | O | O | 51 | O | O | O |
| 23 | O | O | O | 52 | O | O | O |
| 24 | O | O | O | 53 | O | O | O |
| 25 | O | O | O | 54 | O | O | O |
| 26 | O | O | O | 55 | O | O | O |
| 27 | O | O | O | 56 | O | O | O |
| 28 | O | O | O | 57 | O | O | O |
| 29 | O | O | O | 58 | O | O | O |

## APPENDIX III C

## DEPARTMENT OF EDUCATION
## UNIVERSITY OF CALICUT

## DETAILS OF ITEM ANALYSIS OF STUDYING APPROACH INVENTORY

| Item No. | t value | Item selected/ omitted | Item No. | t value | Item selected/ omitted |
|---|---|---|---|---|---|
| 1 | 3.79 | S | 30 | 4.95 | S |
| 2 | 6.89 | S | 31 | 5.83 | S |
| 3 | 2.50 | O | 32 | 7.71 | S |
| 4 | 7.32 | S | 33 | 3.14 | S |
| 5 | 7.19 | S | 34 | 7.87 | S |
| 6 | 2.96 | S | 35 | 4.46 | S |
| 7 | 1.87 | O | 36 | 8.19 | S |
| 8 | 2.49 | O | 37 | 3.75 | S |
| 9 | 5.57 | S | 38 | 7.86 | S |
| 10 | 3.63 | S | 39 | 4.46 | S |
| 11 | 8.34 | S | 40 | 6.85 | S |
| 12 | 2.60 | S | 41 | 9.87 | S |
| 13 | 7.84 | S | 42 | 7.20 | S |
| 14 | 3.81 | S | 43 | 6.78 | S |
| 15 | 6.59 | S | 44 | 8.25 | S |
| 16 | 1.88 | O | 45 | 8.61 | S |
| 17 | 2.78 | S | 46 | 5.44 | S |
| 18 | 1.20 | O | 47 | 8.83 | S |
| 19 | 3.36 | S | 48 | 7.02 | S |
| 20 | 7.57 | S | 49 | 6.99 | S |
| 21 | 9.58 | S | 50 | 7.93 | S |
| 22 | 6.38 | S | 51 | 1.83 | O |
| 23 | 3.85 | S | 52 | 4.58 | S |
| 24 | 4.56 | S | 53 | 6.25 | S |
| 25 | 6.26 | S | 54 | 8.55 | S |
| 26 | 7.98 | S | 55 | 6.44 | S |
| 27 | 9.06 | S | 56 | 6.17 | S |
| 28 | 5.42 | S | 57 | 7.02 | S |
| 29 | 9.52 | S | 58 | 5.15 | S |

## APPENDIX III D

## DEPARTMENT OF EDUCATION
## UNIVERSITY OF CALICUT

## STUDYING APPROACH INVENTORY
**(Final Version)**

**Dr. P. USHA**
Reader
Department of Education
University of Calicut

**AMPILI ARAVIND**
Research Scholar

### INSTRUCTIONS

For each of the following statements three alternative responses- 'Agree', 'disagree' and 'not sure'- are given. Read the statements carefully and select the most appropriate response. Put a 'X' in the relevant circle provided in the response sheet against each statement number. Do not write anything in the question booklet. Kindly answer all the questions.

For Example, Item No.3 is:

3. I wonder whether the activities connected with the course are relevant. If your response is 'Agree' put a 'X' in the response sheet as shown here.

| Agree | Disagree | Not sure |
|---|---|---|
| ⊗ | O | O |

1. While studying, I try to find out for myself the meaning of the prescribed lessons.
2. I analyze the content critically, while reading a book.
3. I like to analyze the reason behind things.
4. I come across really gripping ideas while studying.
5. I am in the habit of reading without thinking much about the content.
6. I somehow find suitable learning environment to get on with my studies.

7. I abide by instructions given by my teachers.
8. I accept, what is being told to me, only after elaborate thinking and analysis.
9. Much of my learning involves rote memorization.
10. I really enjoy studying the academic topics.
11. I think about how to get the appreciation of the teacher while doing projects and assignments.
12. I think about what I want to get out of my studies to keep my studying well oriented.
13. While studying, I can easily remember bits and pieces but cannot present it as a whole concept.
14. I write everything I hear in classes as it is difficult for me to grasp the important points.
15. I am in the habit of going over my work again and again to find out whether there are any mistakes.
16. I put a lot of effort to make sure that I have all the important study material with me.
17. I find myself attached to certain subjects and would like to study those subjects more.
18. I like teachers to give guidelines while assigning the projects or duties.
19. To memorize the study materials, I have to write or repeat it quite a number of times.
20. I follow a timetable while revising for examinations.
21. I think about how to present an assignment or answer a question in an impressive manner before starting work on it.
22. My mind questions the facts presented in lectures or in books.
23. While writing an assignment, I try to incorporate the view points of the teacher who is going to value it.
24. While reading a text book I think a lot about ideas presented in them.
25. My life experiences influence the way I absorb new ideas.

26. When I am learning from text books, I try to get an insight of curricular objectives.

27. I generally utilize my day time effectively.

28. I learn by heart because I don't understand much of what is taught.

29. I study really hard because I am determined to do well.

30. While revising for examinations, I concentrate on portions highlighted as important by the teachers.

31. My mind follows the idea from classroom teaching even while doing other things.

32. I wonder what prompted me to go to school.

33. I analyse the details to know about the author's ideas while reading a book or an article.

34. I keep in mind teacher's comments on my previous work to get higher marks next time.

35. While studying, I concentrate fully on what I am doing.

36. I plan my study time to make use of it effectively.

37. I am in the habit of planning my work in advance.

38. It is important for me to try my level best to be successful in my studies.

39. While studying, I take short breaks to review and recollect the material already learned.

40. I go through the fundamentals before solving a problem or taking up an assignment.

41. While studying a new topic, I try to get an overview of the ideas presented.

42. While studying, I examine the portion carefully to reach my own conclusions.

43. I use to analyse new ideas by linking it with my previous knowledge.

44. I like to play around with ideas of my own, even though they are not connected with my studies.

45. I try to relate the learning materials with other topics studied.

46. I am anxious whether I will be able to attain the expected standard while doing the assigned work.

47. I have definite purpose behind my studies and know how to achieve it.

48. It is very easy for me to motivate myself.

49. I worry a lot about whether I will be able to complete my studies successfully.

50. I can get down to work whenever I need to.

51. I am always uptodate in my studies and work.

52. I find nothing in the syllabus quite interesting.

## APPENDIX IV

# DEPARTMENT OF EDUCATION
# UNIVERSITY OF CALICUT

## STANDARD PROGESSIVE MATRICES SETS A, B, C, D & E

### RESPONSE SHEET

Name :

Place :

Age :

Test begun :

Ref. No :

Date :

Birthday :

Test Ended :

| A | | | B | | | C | | | C | | | E | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | 1 | | | 1 | | | 1 | | | 1 | | |
| 2 | | | 2 | | | 2 | | | 2 | | | 2 | | |
| 3 | | | 3 | | | 3 | | | 3 | | | 3 | | |
| 4 | | | 4 | | | 4 | | | 4 | | | 4 | | |
| 5 | | | 5 | | | 5 | | | 5 | | | 5 | | |
| 6 | | | 6 | | | 6 | | | 6 | | | 6 | | |
| 7 | | | 7 | | | 7 | | | 7 | | | 7 | | |
| 8 | | | 8 | | | 8 | | | 8 | | | 8 | | |
| 9 | | | 9 | | | 9 | | | 9 | | | 9 | | |
| 10 | | | 10 | | | 10 | | | 10 | | | 10 | | |
| 11 | | | 11 | | | 11 | | | 11 | | | 11 | | |
| 12 | | | 12 | | | 12 | | | 12 | | | 12 | | |

| Time | Total | Grade |
|---|---|---|
| | | |

Tested by ______________________________

## APPENDIX V A

## UNIVERSITY OF CALICUT
## DEPARTMENT OF EDUCATION

# ACHIEVEMENT TEST IN PHYSICS
**(Standard IX)**
**(Draft Version)**

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**Dr. P. Usha**
**Reader**
**Department of Education**
**University of Calicut**

**Ampili Aravind**
**Research Scholar**

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*Instructions*:

This is a Physics test paper. Do not write anything on the question paper. You are given separate sheets to write answers. For each question four answers are given marked by A, B, C and D. Mark the correct answer by putting an 'X' mark on the letter denoting the correct answer. Each question carries one mark.

1. Which of the following is the product of mass and velocity of a body?
   A. Force
   B. Momentum
   C. Weight
   D. Energy
2. The property of a body by which it continues in its state of rest is:
   A. Momentum
   B. Inertia of rest
   C. Inertia of motion
   D. Weight
3. The splitting up of composite light into its component colours is known as:
   A. Reflection
   B. Refraction
   C. Dispersion
   D. Scattering
4. The ability to do work is known as:
   A. Force
   B. Inertia

C. Energy

D. Power

5. Which of the following statement is true about circular motion?

A. Work done by centripetal force is always zero.

B. Work done by centripetal force is sometimes zero.

C. Work done by centripetal force is never zero.

D. Work done by centripetal force is always one.

6. Which of the following colour deviates more when composite light is split up into its component colours

A. Violet.

B. Red

C. Green

D. Blue

7. Total effect produced by a force on a body is known as:

A. Impulse

B. Impulsive force

C. Momentum

D. Inertia

8. What happens to the force of attraction between two objects when the distance between them is increased?

A. Increases

B. Decreases

C. Remains the same

D. None of the above.

9. Which of the following colour has minimum deviation when composite light is split up into its component colours.

A. Violet

B. Red

C. Green

D. Blue

10. Statement 1. A stone is being dropped from a height.

Statement 2. A stone is being released from a catapult.

Which of the following is true regarding the above statements?

A. In both cases work is done by Potential Energy.

B. In both cases work is done by Kinetic Energy.

C. Work is done by P.E. in the first case and K.E. in the second case.

D. Work is done by K.E. in the first case and P.E. in the second case

11. The highest limit of friction just before and object starts moving is:
    A. rolling friction
    B. sliding friction.
    C. Pulling friction
    D. limiting friction
12. A man was firing a bullet from a rifle supporting it with his shoulder. When the bullet was fired from the rifle he felt pain on his shoulder. This is because:
    A. The rifle moved backwards due to the force of reaction exerted by the bullet.
    B. The rifle moved backwards due to the force of action exerted by the bullet
    C. The rifle moved forward due to the force of action it was exerting on the bullet.
    D. The rifle moved forward due to the force of reaction it was exerting on the bullet.
13. What happens when break is applied to a fast moving bicyle?
    A. It comes to rest immediate
    B. It moves forward for sometime and gradually comes to rest.
    C. It goes on moving
    D. It moves forward faster.
14. A parachute can slowly land on ground because of:
    A. friction of atmospheric air.
    B. density of atmospheric air.
    C. pressure of atmospheric air
    D. gravitational attraction of earth.
15. The phenomenon of capillarity is caused by:
    A. Cohesion
    B. Adhesion
    C. Surface tension
    D. Viscosity
16. Irregular and partial reflection of light during its passage through a medium is known as:
    A. refraction
    B. defraction
    C. dispersion
    D. scattering
17. In an experiment a rope is inserted through a glasstube and a stone is tiled on the tope end of the rope. A weight hanger with a few weights on it is tied to the lower

end of the rope. When the glass tube is rotated, the stone begins to rotate in a circular path.

If the radius of the circular path of the stone is directly proportional to the speed of rotation, which of the following would you expect to observe as the speed of rotation is increased.

A. The stone moves away from the tube and the weight hanger moves up.

B. The stone comes closer to the tube and the weight hanger moves down.

C. The stone remains rotating through the same circular path.

D. The stone breaks away from the thread and flies off.

18. Liquids having low viscosity are known as:

A. Viscous

B. Mobile liquids

C. Dense liquids.

D. Oily liquids.

19. Property of certain materials by virtue of which light of longer wavelength is emitted by absorbing light of shorter wavelength:

A. Fluroscence

B. Conductivity

D. Phosphorescence

C. Colour sensitivity

20. We know that sky is blue. But often the sky in the urban area is grey in colour. This may be because:

A. Red light is scattered ten times more intensely than blue light.

B. Blue light is scattered ten times more intensely than red.

C. Scattering is same for all colours.

D. Scattering is not happening in urban sky.

21. What happens to viscosity when temperature is increased?

A. Increases

B. Decreases

C. Remains the same

D. None of the above

22. The name given to the force of attraction between the same kind of molecules is:

A. Cohesion

B. Adhesion

C. Fricton

D. Viscous force

23. A brush is being immersed in water. Then which of the following statements is correct?
    - A. Its bristles will remain in the same position.
    - B. Its bristles will come close together because of surface tension of water.
    - C. Its bristles will come close together because of viscosity of water.
    - D. Its bristles will spread out.
24. The sky appears blue because:
    - A. Red light is scattered more
    - B. Blue light is scattered more
    - C. Scattering is same for all colours
    - D. Scattering is not happening.
25. Acceleration of a body in a state of uniform circular motion is known as:
    - A. Centrifugal acceleration.
    - B. Liner acceleration.
    - C. Diametric acceleration.
    - D. Radial acceleration.
26. The rising and setting sun appears red because during sunrise and sunset:
    - A. The sunlight is not scattered.
    - B. All the colours are equally scattered.
    - C. Sunlight has to traverse great distance through the earth's atmosphere so blue colour is lost due to scattering.
    - D. Sunlight has to traverse great distance through the earth's atmosphere and red colour is lost due to scattering.
27. When a boy observed the sky in a rainy evening, he saw a rainbow in the sky. But when he did the same observation on a sunny evening be could not see the rainbow

    Which of the following conclusions do you think, can be justified?
    - A. During summer season sunlight is dispersed by water drops in the atmosphere.
    - B. During rainy reason sunlight is dispersed by water drops in the atmosphere.
    - C. During summer season sunlight is not dispersed in the atmosphere.
    - D. During rainy season sunlight is not dispersed in the atmosphere..
28. (i) a blotting paper absorbs ink.

    (ii) a burning lamp absorbs oil

    The above statements are daily life examples of:.
    - A. Capillarity
    - B. Gravity
    - C. Surface tension
    - D. Viscosity

29. In an experiment, a boy pulled a table along a rough surface. He found it hard to pull it. He repeated the experiment by pulling it along a smooth surface. Less force was necessary for this. He repeated the experiment pulling the table along surfaces having different smoothness and concluded that as the smoothness of the surface increases, less force is needed to pull the table

    Which of the following statements is true with respect to the above experiment?

    A. Friction is caused by the smoothness of the surfaces in contact.

    B. Friction is caused by the roughness of the surfaces in contact.

    C. Friction is caused by the similarity of the surfaces in contact.

    D. Friction is caused by the difference of the substances in contact.

30. Plants can absorb water from soil because:

    A. Capillary force is doing work against gravity.

    B. Surface tension is doing work against gravity.

    C. Frictional force is doing work against gravity.

    D. Viscosity is doing work against gravity.

31. The force of attraction between a proton and an electron is:

    A. gravitational force..

    B. nuclear force

    C. electrostatic force

    D. magnetic force

32. Consider an experiment where an object of mass 2kg is hung from the hook of a spring balance. The reading of the spring balance is 2 kg. Now the balance is allowed to fall such that the object and balance falls simultaneously. The balance shows zero reading.

    Which of the conclusions do you think, is justified?

    A. The balance shows zero reading because the object is detached from it.

    B. The balance shows zero reading because work is done against gravitational attraction.

    C. The balance shows zero reading because the object and balance is falling towards the earth.

    D. The balance shows zero reading because freely falling bodies experience weightlessness. .

33. In an experiment a loop of wire is immersed in soap solution in a beaker. When it is taken out a layer of soap solution is formed on it. A piece of wet thread with both ends tied together is placed on it. The thread is shapeless. But when the soap layer inside the thread is pricked with a needle, the thread become circular in shape. This is because:

    A. The thread exerts equal force on cell sides of the soap layer.

    B. The thread exerts unequal force on all sides of the soap layer.

    C. The soap layer exerts equal force on all sides of the thread.

D. The soap layer exerts unequal force on all sides of the thread.

34. The root cause of surface tension is:

A. Cohesion

B. Adhesion

C. Friction

D. Viscosity

35. A book is placed on a table. It was observed that the book rotates when the table is rotated. In this experiment centripetal force for rotation of the book is given by frictional force between the book and the table. The book was found to be thrown away when the speed of rotation of the table was increased.

Which of the conclusions can be justified based on the above experiment?

A. The book rotates slowly when the table is rotated faster.

B. The book rotates faster when the table is rotated slowly.

C. The book was thrown away because the centripetal force was balanced by friction.

D. The book was thrown away because beyond a speed limit centripetal force cannot be balanced by friction.

36. The ability of liquids to rise through small holes against gravity is known as:

A. Viscosity

B. Capillarity

C. Surface tension

D. Super fluidity

37. Consider the case of a ball rolling on an imaginary road. The road considered here is supposed to be frictionless. Which of the following statements is correct?

A. It comes to rest after sometime..

B. It goes on moving infinitely with the same speed..

C. It slows down but goes on moving.

D. It speeds up and goes on moving.

38. What happens to surface tension when temperature of a liquid increases?

A. Increases

B. Decreases

C. Remains the same

D. None of the above

39. Why does a person riding a bicycle tilt it while moving on a curved road?

A. to obtain speed

B. to obtain energy

C. to obtain centripetal force

D to obtain centrifugal force

40. An electric bell is placed inside a bell jar. We can hear the sound of the bell when current is passed through the circuit. However, when air is gradually removed from the bell jar, sound decreases even though we can see the gong vibrating at the same speed

A statement is given below concerning the above experiment.

'Air is required for the sound waves to travel'.

Which of the following should be done to verify this statement?

A. Place the jar at a distance and find out if sound can be heard.

B. Bring the jar closer and find out if sound can be heard more clearly.

C. Evacuate the jar completely and find out if sound can be heard.

D. Fill the jar again with air and find out if sound can be heard.

41. A big explosion is taking place in the moon. Then which of the following statement is correct?

A. We can hear the sound

B. We cannot hear the sound

C. We can hear the sound partially.

D. We can hear the sound only when we are looking at the moon.

42. The lowest value of relative density is:

A. Zero

B. One

C. Less than one

D. Greater than one.

43. You are to conduct an experiment to determine whether an iron nail kept in contact with any pole of a magnet will acquire magnetism.

If the iron nail gets magnetised when touched by a bar magnet, you would expect to observe that:

A. The iron nail attracts iron filings if touched.

B. The iron nail repels iron filings if touched.

C. The iron nail attracts iron filings kept at a distance.

D. The iron nail repels iron filings kept at a distance.

44. When a man is riding a bicycle, the back wheel of the bicycle is rotated and the bicycle moves forward. But if the back wheel is rotated with the bicycle placed on its stand, it will not move forward. Again, the moment the wheel touches the ground, the bicycle moves forward.

This is because:

A. When the wheel rotates in contact with the ground, gravitational force acts in the opposite direction of motion.

B. When the wheel rotates in contact with the ground the gravitational force acts in the same direction of motion.

C. When the wheel rotates in contact with the ground the frictional force of the ground acts in the opposite direction of motion.

D. When the wheel rotates in contact with the ground the frictional force acts in the same direction of motion.

45. Capillary fall occurs when:

A. Cohesion is greater than adhesion.

B. Adhesion is greater than cohesion.

C. Both cohesion and adhesion are the same.

D. Cohesion is different from adhesion.

46. A liquid drop is always spherical because:

A. A spherical drop will have more freedom of movement.

B. A spherical drop will have minimum surface area.

C. A sphericaldrop will have maximum surface area.

D. A spherical drop will have less freedom of movement.

47. In an experiment, a scientist placed an object at the equator and found its weight. Then he placed it at the poles and found its weight. From the data be found the weight of the object when it is placed at the centre of the earth. He concluded that the object had different weights in the three instances.

Which of the following assumptions is implicit in this experiment?

A. The weight of the object is negligible at the centre of the earth.

B. Acceleration due to gravity is the same at all places on the earth's surface.

C. Acceleration due to gravity is different at different places.

D. Weight is not determined by acceleration due to gravity.

48. Which of the following is the phenomenon occuring when the natural frequency of the body undergoing forced vibration is equal to the natural frequency of the forcing body.

A. Natural vibration

B. Forced vibration

C. Resonance

D. Echo

49. In a wave motion (i) crest and trough are produced (ii) the particles of the medium move perpendicular to the direction of wave motion (iii) there is no pressure difference in the medium. Then the wave is a:

A. Transverse wave

B. Longitudinal wave

C. Electro magnetic wave

D. Radio wave

50. While travelling on top of a bus, a man accidently touched a live electric wire passing over him and got severe shock. Another man purposefully touched a live electric cable from his television but got no shock at all. This may be because:

A. The current through household appliances are at very low voltage.

B. The household cable had a plastic covering over it.

C. The second man was resistant to electric shock.

D. A man will not get electric shock inside his house.

51. A cotton cloth was dipped in water and allowed to dry in summer season. The time taken by the cloth to dry completely was noted. This experiment was repeated in rainy season. It was observed that the clothe took less time to get dried.

Which of the following conclusions do you think, can be justified?

A. In summer season atmospheric air is saturated with water vapour.

B. In rainy season atmospheric air is saturated with water vapour.

C. In summer season atmospheric temperature is low.

D. In rainy season atmospheric temperature is high.

52. You are to conduct an experiment to determine whether the rate of evaporation of a liquid is affected by an increase in the amount of heat given. You have the relevant apparatus to conduct the experiment.

If the increase in the amount of heat has an observable effect on the rate of evaporation in liquids, almost immediately after increasing the amount of heat you would expect to observe a notable change in the:

A. Temperature of liquid molecules.

B. Motion of liquid molecules

C. Amount of liquid vapour over the liquid surface.

D. Pressure of the liquid.

53. Water is taken in a vessel and heated. The temperature is measured using a thermometer. It is observed that temperature increased gradually as water is heated. But when water begins to boil there is no rise in temperature even though it is heated continuously.

This is because:

A. No heat is absorbed when water boils.

B. Thermometer becomes insensitive to temperature.

C. Temperature of water vapour cannot be noted using a thermometer.

D. Heat is absorbed by water to change into water vapour.

54. The property by which a liquid produces a force in order to reduce te relative motion between its different layers is called:

A. Viscosity

B. Surface tension

C. Friction

D. Capillarity.

55. You are to conduct an experiment to find out whether the electrical conductivity of a substance depends on the number of free electrons in the substance

If the electrical conductivity depends on the number of free electrons, what should be done to find this out accurately?

A. Find the electrical conductivity of an insulator and check if it is proportional to the number of free electrons.

B. Find the electrical conductivity of a good conductor and check if it is proportional to the number of free electrons.

C. Find the electrical conductivity of a semi-conductor and check if it is proportional to the number of free electrons.

D. Find the electrical conductivity of different insulators, conductors and semi conductors and check accurately the relationship between conductivity and the number of free electrons.

56. Which of the following is an example of a viscous liquid?

A. Water

B. Coltar

C. Petrol

D. Kerosine

57. In an experiment a 100 g weight is placed on a dial balance and the reading is noted. Now the weight is placed 30 cm above the balance and dropped. The reading is noted again. Then a 200g weight is dropped on the balance from the same height and reading is noted. The reading is different in each case.

Which of the following statements are implicit in the experiment?

A. The balance show different reading because different weights are dropped.

B. The weights strike the dial with different velocity.

C. Force of a moving body depends on mass and velocity

D. All the above assumptions are implicit in the experiment.

58. When a person get electric shock, his heart tends to stop. This is because:

A. He is having tension

B. Viscosity of blood decreases

C. Viscosity of blood increases

D. Pressure of blood decreases.

59. The constant temperature at which a liquid boils is called its:

A. boiling point

B. melting point

C. freezing point

D. temperature of inversion

60. Water is taken in a glass tumbler and level of water is observed. It is seen that water level is slightly high where water touches glass. If the water is placed in a flat vessel the rise of water is less than if it is placed in a narrow vessel. If water is taken in a thin capillary tube the rise will be maximum.

Which of the following inference can be considered true with respect to the above experiment.

A. The rise of water depends on 'g'.

B. The rise of water depends on the surface area of water.

C. The rise of water depends on the viscosity of water.

D. The rise of water depends on the density of water.

61. The process by which liquid molecules escape from the liquid surface when heated is known as:

A. Boiling

B. Sublimation

C. Evaporation

D. Melting

62. Three statements regarding the properties of liquid molecules are given below:

(i) Liquid molecules have freedom of movement.

(ii) Liquid molecules cannot escape the liquid surface due to force of cohesion.

(iii) When heated, they get kinetic energy to overcome the force of cohesion.

Consider the above statements and find out which of the following are correct:

A. All the above statements are true.

B. All the above statements are false.

C. Statements (i) and (ii) are true.

D. Statements (ii) and (iii) are true.

63. The ratio of the density of a substance to the density of water is known as:

A. Humidity

B. Density

C. Relative humidity

D. Relative density.

64. "Soldiers do not march over hanging bridges"

Consider the above statement and find out which of the following is correct?

A. The statement is true because the bridge will collapse due to forced vibrations.

B. The statement is false because the bridge will not collapse due to forced vibrations.

C. The statement is true because the bridge may collapse due to resonance.

D. The statement is false because nothing will happen to the bridge.

65. Violin is called a source of sound because:

  A. It is a musical instrument.

  B. It produces sound due to mechanical vibrations.

  C. It produces melodious sound than a drum.

  D. None of the above.

66. A bat can travel safely at night without striking obstacles because:

  A. bat can see in darkness.

  B. bat can produce sound waves which pass through obstacles.

  C. bat's skin is sensitive to obstacles.

  D. bat can produce sound waves which reflect from the obstacles and reach back to the bat.

67. To clean a carpet we beat it with a stick. The principle involved here is:

  A. Principle of inertia of rest.

  B. Principle of momentum.

  C. Principle of inertia of motion.

  D. Principle of friction.

68. When we strike a steel tumbler half filled with water with a rod, sound is produced. Here sound is produced due to:

  A. The vibration of steel tumbler

  B. The vibration of water

  C. The vibration of both steel tumbler and water.

  D. The vibration of the rod.

69. 'Action and reaction are equal and opposite'.

  Considering the above statement which of the following are correct?

  A. They cancel each other because they are equal and opposite.

  B. They do not cancel each other because they are equal and opposite.

  C. They cancel each other because they are acting on the same object.

  D. They do not cancel each other because they are acting on different objects.

70. In a wave motion ,

  (i) Compressions and rare fractions are produced.

  (ii) The particles of the medium travel in the same direction of wave motion.

  (iii) The pressure and density of the medium is different at different points.

  That wave is a:

  A. Transverse wave

  B. Longitudinal wave

  C. Electro magnetic wave

  D. Radio wave.

71. When a person is jumping ashore from a boat, the boat moves backward. This is because of:
    A. The force of reaction applied by the boat
    B. The force of reaction applied by the person
    C. The force of action applied by the boat
    D. The force of action applied by the person.

72. The phenomenon of magnetization of a magnetic substance under the influence of a magnet is called:
    A. Magnetic flux
    B. Magnetic Induction
    C. Magnetic deflection
    D. Electro magnetic relay.

73. Work is said to be done when:
    A. Force is applied on a body but body is not displaced.
    B. Force is applied on a body and body is displaced in the direction of the force.
    C. Force is applied on a body and body is displaced in the opposite direction of force
    D. None of the above.

74. The energy possessed by a body due to its state of strain:
    A. Kinetic energy
    B. Potential energy
    C. Electrical energy
    D. Chemical energy.

75. The relative density of water:
    A. Zero
    B. Less than one
    C. One
    D. Greater than one.

**APPENDIX V B**

# DEPARTMENT OF EDUCATION
# UNIVERSITY OF CALICUT

# ACHIEVEMENT TEST IN PHYSICS

## SCORING KEY

| Q. No. | Correct Answer | Q. No. | Correct Answer | Q. No. | Correct Answer |
|---|---|---|---|---|---|
| 1 | B | 26 | C | 51 | B |
| 2 | B | 27 | B | 52 | C |
| 3 | C | 28 | A | 53 | D |
| 4 | C | 29 | B | 54 | A |
| 5 | A | 30 | A | 55 | D |
| 6 | A | 31 | C | 56 | B |
| 7 | A | 32 | D | 57 | D |
| 8 | B | 33 | C | 58 | C |
| 9 | B | 34 | A | 59 | A |
| 10 | A | 35 | D | 60 | B |
| 11 | D | 36 | B | 61 | C |
| 12 | A | 37 | B | 62 | A |
| 13 | B | 38 | B | 63 | D |
| 14 | A | 39 | C | 64 | C |
| 15 | C | 40 | C | 65 | B |
| 16 | D | 41 | B | 66 | D |
| 17 | A | 42 | B | 67 | C |
| 18 | B | 43 | A | 68 | C |
| 19 | A | 44 | C | 69 | D |
| 20 | C | 45 | A | 70 | B |
| 21 | B | 46 | A | 71 | B |
| 22 | A | 47 | C | 72 | B |
| 23 | B | 48 | C | 73 | B |
| 24 | B | 49 | A | 74 | B |
| 25 | D | 50 | B | 75 | C |

## APPENDIX V C

# DEPARTMENT OF EDUCATION
# UNIVERSITY OF CALICUT

## ACHIEVEMENT TEST IN PHYSICS

### RESPONSE SHEET

Time : 2 hours

Std. : IX
Max. Mark:75

Name of the student :.............................................................

Name of the school :.............................................................

Male / Female :.............................................................

| Qn. No. | Correct Answer | | | | Qn. No. | Correct Answer | | | | Qn. No. | Correct Answer | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | A | B | C | D | 26 | A | B | C | D | 51 | A | B | C | D |
| 2 | A | B | C | D | 27 | A | B | C | D | 52 | A | B | C | D |
| 3 | A | B | C | D | 28 | A | B | C | D | 53 | A | B | C | D |
| 4 | A | B | C | D | 29 | A | B | C | D | 54 | A | B | C | D |
| 5 | A | B | C | D | 30 | A | B | C | D | 55 | A | B | C | D |
| 6 | A | B | C | D | 31 | A | B | C | D | 56 | A | B | C | D |
| 7 | A | B | C | D | 32 | A | B | C | D | 57 | A | B | C | D |
| 8 | A | B | C | D | 33 | A | B | C | D | 58 | A | B | C | D |
| 9 | A | B | C | D | 34 | A | B | C | D | 59 | A | B | C | D |
| 10 | A | B | C | D | 35 | A | B | C | D | 60 | A | B | C | D |
| 11 | A | B | C | D | 36 | A | B | C | D | 61 | A | B | C | D |
| 12 | A | B | C | D | 37 | A | B | C | D | 62 | A | B | C | D |
| 13 | A | B | C | D | 38 | A | B | C | D | 63 | A | B | C | D |
| 14 | A | B | C | D | 39 | A | B | C | D | 64 | A | B | C | D |
| 15 | A | B | C | D | 40 | A | B | C | D | 65 | A | B | C | D |
| 16 | A | B | C | D | 41 | A | B | C | D | 66 | A | B | C | D |
| 17 | A | B | C | D | 42 | A | B | C | D | 67 | A | B | C | D |
| 18 | A | B | C | D | 43 | A | B | C | D | 68 | A | B | C | D |
| 19 | A | B | C | D | 44 | A | B | C | D | 69 | A | B | C | D |
| 20 | A | B | C | D | 45 | A | B | C | D | 70 | A | B | C | D |
| 21 | A | B | C | D | 46 | A | B | C | D | 71 | A | B | C | D |
| 22 | A | B | C | D | 47 | A | B | C | D | 72 | A | B | C | D |
| 23 | A | B | C | D | 48 | A | B | C | D | 73 | A | B | C | D |
| 24 | A | B | C | D | 49 | A | B | C | D | 74 | A | B | C | D |
| 25 | A | B | C | D | 50 | A | B | C | D | 75 | A | B | C | D |

APPENDIX V D

**DEPARTMENT OF EDUCATION**
**UNIVERSITY OF CALICUT**

## DETAILS OF ITEM ANALYSIS OF ACHIEVEMENT TEST IN PHYSICS

| Item No. | U | L | $D_i = \frac{U+L}{2N}$ | $D_p = \frac{U-L}{N}$ | Item Omitted/ Selected |
|---|---|---|---|---|---|
| 1 | 100 | 52 | 0.76 | 0.48 | S |
| 2 | 96 | 44 | 0.70 | 0.52 | S |
| 3 | 100 | 100 | 1 | 0 | 0 |
| 4 | 88 | 40 | 0.64 | 0.48 | S |
| 5 | 64 | 28 | 0.46 | 0.36 | S |
| 6 | 60 | 24 | 0.42 | 0.36 | S |
| 7 | 80 | 16 | 0.48 | 0.64 | S |
| 8 | 56 | 20 | 0.38 | 0.36 | S |
| 9 | 76 | 44 | 0.60 | 0.32 | S |
| 10 | 88 | 36 | 0.72 | 0.32 | S |
| 11 | 84 | 64 | 0.74 | 0.20 | O |
| 12 | 76 | 16 | 0.46 | 0.60 | S |
| 13 | 76 | 36 | 0.56 | 0.40 | S |
| 14 | 60 | 20 | 0.40 | 0.40 | S |
| 15 | 48 | 24 | 0.36 | 0.24 | O |
| 16 | 48 | 20 | 0.14 | 0.28 | O |
| 17 | 56 | 24 | 0.40 | 0.32 | S |
| 18 | 40 | 28 | 0.34 | 0.12 | O |
| 19 | 80 | 16 | 0.48 | 0.64 | S |
| 20 | 56 | 20 | 0.38 | 0.36 | S |
| 21 | 84 | 36 | 0.60 | 0.48 | S |
| 22 | 48 | 36 | 0.42 | 0.12 | O |
| 23 | 72 | 24 | 0.48 | 0.48 | S |
| 24 | 96 | 56 | 0.76 | 0.40 | S |
| 25 | 34 | 32 | 0.33 | 0.02 | O |

| Item No. | U | L | $D_i = \frac{U+L}{2N}$ | $D_p = \frac{U-L}{N}$ | Item Omitted/ Selected |
|---|---|---|---|---|---|
| 26 | 84 | 52 | 0.68 | 0.32 | S |
| 27 | 68 | 32 | 0.50 | 0.36 | S |
| 28 | 60 | 24 | 0.42 | 0.36 | S |
| 29 | 52 | 20 | 0.56 | 0.32 | S |
| 30 | 76 | 32 | 0.54 | 0.44 | S |
| 31 | 68 | 36 | 0.52 | 0.32 | S |
| 32 | 52 | 20 | 0.36 | 0.32 | S |
| 33 | 76 | 40 | 0.58 | 0.36 | S |
| 34 | 60 | 32 | 0.46 | 0.28 | O |
| 35 | 56 | 24 | 0.40 | 0.32 | S |
| 36 | 100 | 100 | 1 | 0 | 0 |
| 37 | 76 | 40 | 0.58 | 0.36 | S |
| 38 | 68 | 24 | 0.46 | 0.44 | S |
| 39 | 88 | 32 | 0.60 | 0.58 | S |
| 40 | 84 | 28 | 0.56 | 0.56 | S |
| 41 | 8 | 12 | 0.10 | -0.02 | O |
| 42 | 88 | 40 | 0.60 | 0.40 | S |
| 43 | 88 | 44 | 0.66 | 0.44 | S |
| 44 | 76 | 44 | 0.60 | 0.30 | S |
| 45 | 92 | 48 | 0.70 | 0.40 | S |
| 46 | 84 | 28 | 0.56 | 0.56 | S |
| 47 | 88 | 40 | 0.60 | 0.40 | S |
| 48 | 76 | 32 | 0.54 | 0.44 | S |
| 49 | 76 | 12 | 0.44 | 0.64 | S |
| 50 | 76 | 28 | 0.68 | 0.48 | S |
| 51 | 28 | 16 | 0.22 | 0.12 | O |
| 52 | 84 | 28 | 0.74 | 0.49 | S |
| 53 | 100 | 52 | 0.76 | 0.48 | S |
| 54 | 68 | 24 | 0.46 | 0.44 | S |
| 55 | 100 | 52 | 0.76 | 0.48 | S |
| 56 | 76 | 40 | 0.58 | 0.36 | S |

| Item No. | U | L | $D_i = \frac{U+L}{2N}$ | $D_p = \frac{U-L}{N}$ | Item Omitted/ Selected |
|---|---|---|---|---|---|
| 57 | 100 | 64 | 0.82 | 0.36 | S |
| 58 | 76 | 40 | 0.58 | 0.36 | S |
| 59 | 52 | 44 | 0.48 | 0.08 | O |
| 60 | 88 | 44 | 0.66 | 0.44 | S |
| 61 | 48 | 36 | 0.42 | 0.12 | O |
| 62 | 72 | 24 | 0.48 | 0.48 | S |
| 63 | 100 | 98 | 0.98 | 0.04 | O |
| 64 | 92 | 56 | 0.74 | 0.36 | S |
| 65 | 48 | 12 | 0.30 | 0.36 | S |
| 66 | 68 | 8 | 0.38 | 0.60 | S |
| 67 | 64 | 20 | 0.42 | 0.44 | S |
| 68 | 92 | 24 | 0.58 | 0.68 | S |
| 69 | 88 | 40 | 0.64 | 0.48 | S |
| 70 | 96 | 56 | 0.76 | 0.40 | S |
| 71 | 72 | 24 | 0.48 | 0.48 | S |
| 72 | 60 | 29 | 0.45 | 0.31 | S |
| 73 | 92 | 37 | 0.65 | 0.55 | S |
| 74 | 88 | 72 | 0.80 | 0.16 | O |
| 75 | 85 | 36 | 0.61 | 0.55 | S |

# APPENDIX V E

## UNIVERSITY OF CALICUT
## DEPARTMENT OF EDUCATION

## ACHIEVEMENT TEST IN PHYSICS
**(Standard IX)**
**(Final Version)**

**Dr. P. Usha**
**Reader**
**Department of Education**
**University of Calicut**

**Ampili Aravind**
**Research Scholar**

*Instructions*:

This is a Physics test paper. Do not write anything on the question paper. You are given separate sheets to write answers. For each question four answers are given marked by A, B, C and D. Mark the correct answer by putting an 'X' mark on the letter denoting the correct answer. Each question carries one mark.

1. Which of the following is the product of mass and velocity of a body?
   A. Force
   B. Momentum
   C. Weight
   D. Energy
2. The property of a body by which it continues in its state of rest is:
   A. Momentum
   B. Inertia of rest
   C. Inertia of motion
   D. Weight
3. The ability to do work is known as:
   A. Force
   B. Inertia
   C. Energy
   D. Power
4. Which of the following statement is true about circular motion?
   A. Work done by centripetal force is always zero.
   B. Work done by centripetal force is sometimes zero.

C. Work done by centripetal force is never zero.

D. Work done by centripetal force is always one.

5. Which of the following colour deviates more when composite light is split up into its component colours

A. Violet.

B. Red

C. Green

D. Blue

6. Total effect produced by a force on a body is known as:

A. Impulse

B. Impulsive force

C. Momentum

D. Inertia

7. What happens to the force of attraction between two objects when the distance between them is increased?

A. Increases

B. Decreases

C. Remains the same

D. None of the above.

8. Which of the following colour has minimum deviation when composite light is split up into its component colours.

A. Violet

B. Red

C. Green

D. Blue

9. Statement 1. A stone is being dropped from a height.

Statement 2. A stone is being released from a catapult.

Which of the following is true regarding the above statements?

A. In both cases work is done by Potential Energy.

B. In both cases work is done by Kinetic Energy.

C. Work is done by P.E. in the first case and K.E. in the second case.

D. Work is done by K.E. in the first case and P.E. in the second case

10. A man was firing a bullet from a rifle supporting it with his shoulder. When the bullet was fired from the rifle he felt pain on his shoulder. This is because:

A. The rifle moved backwards due to the force of reaction exerted by the bullet.

B. The rifle moved backwards due to the force of action exerted by the bullet

C. The rifle moved forward due to the force of action it was exerting on the bullet.

D. The rifle moved forward due to the force of reaction it was exerting on the bullet.

11. What happens when break is applied to a fast moving bicyle?

A. It comes to rest immediate

B. It moves forward for sometime and gradually comes to rest.

C. It goes on moving

D. It moves forward faster.

12. A parachute can slowly land on ground because of:

A. friction of atmospheric air.

B. density of atmospheric air.

C. pressure of atmospheric air

D. gravitational attraction of earth.

13. In an experiment a rope is inserted through a glasstube and a stone is tiled on the tope end of the rope. A weight hanger with a few weights on it is tied to the lower end of the rope. When the glass tube is rotated, the stone begins to rotate in a circular path.

If the radius of the circular path of the stone is directly proportional to the speed of rotation, which of the following would you expect to observe as the speed of rotation is increased.

A. The stone moves away from the tube and the weight hanger moves up.

B. The stone comes closer to the tube and the weight hanger moves down.

C. The stone remains rotating through the same circular path.

D. The stone breaks away from the thread and flies off.

14. Property of certain materials by virtue of which light of longer wavelength is emitted by absorbing light of shorter wavelength:

A. Fluroscence

B. Conductivity

D. Phosphorescence

C. Colour sensitivity

15. We know that sky is blue. But often the sky in the urban area is grey in colour. This may be because:

A. Red light is scattered ten times more intensely than blue light.

B. Blue light is scattered ten times more intensely than red.

C. Scattering is same for all colours.

D. Scattering is not happening in urban sky.

16. What happens to viscosity when temperature is increased?

A. Increases

B. Decreases

C. Remains the same

D. None of the above

17. A brush is being immersed in water. Then which of the following statements is correct?

A. Its bristles will remain in the same position.

B. Its bristles will come close together because of surface tension of water.

C. Its bristles will come close together because of viscosity of water.

D. Its bristles will spread out.

18. The sky appears blue because:

A. Red light is scattered more

B. Blue light is scattered more

C. Scattering is same for all colours

D. Scattering is not happening.

19. The rising and setting sun appears red because during sunrise and sunset:

A. The sunlight is not scattered.

B. All the colours are equally scattered.

C. Sunlight has to traverse great distance through the earth's atmosphere so blue colour is lost due to scattering.

D. Sunlight has to traverse great distance through the earth's atmosphere and red colour is lost due to scattering.

20. When a boy observed the sky in a rainy evening, he saw a rainbow in the sky. But when he did the same observation on a sunny evening be could not see the rainbow

Which of the following conclusions do you think, can be justified?

A. During summer season sunlight is dispersed by water drops in the atmosphere.

B. During rainy reason sunlight is dispersed by water drops in the atmosphere.

C. During summer season sunlight is not dispersed in the atmosphere.

D. During rainy season sunlight is not dispersed in the atmosphere..

21. (i) a blotting paper absorbs ink.

(ii) a burning lamp absorbs oil

The above statements are daily life examples of:.

A. Capillarity

B. Gravity

C. Surface tension

D. Viscosity

22. In an experiment, a boy pulled a table along a rough surface. He found it hard to pull it. He repeated the experiment by pulling it along a smooth surface. Less force

was necessary for this. He repeated the experiment pulling the table along surfaces having different smoothness and concluded that as the smoothness of the surface increases, less force is needed to pull the table

Which of the following statements is true with respect to the above experiment?

A. Friction is caused by the smoothness of the surfaces in contact.

B. Friction is caused by the roughness of the surfaces in contact.

C. Friction is caused by the similarity of the surfaces in contact.

D. Friction is caused by the difference of the substances in contact.

23. Plants can absorb water from soil because:

A. Capillary force is doing work against gravity.

B. Surface tension is doing work against gravity.

C. Frictional force is doing work against gravity.

D. Viscosity is doing work against gravity.

24. The force of attraction between a proton and an electron is:

A. gravitational force..

B. nuclear force

C. electrostatic force

D. magnetic force

25. Consider an experiment where an object of mass 2kg is hung from the hook of a spring balance. The reading of the spring balance is 2 kg. Now the balance is allowed to fall such that the object and balance falls simultaneously. The balance shows zero reading.

Which of the conclusions do you think, is justified?

A. The balance shows zero reading because the object is detached from it.

B. The balance shows zero reading because work is done against gravitational attraction.

C. The balance shows zero reading because the object and balance is falling towards the earth.

D. The balance shows zero reading because freely falling bodies experience weightlessness. .

26. In an experiment a loop of wire is immersed in soap solution in a beaker. When it is taken out a layer of soap solution is formed on it. A piece of wet thread with both ends tied together is placed on it. The thread is shapeless. But when the soap layer inside the thread is pricked with a needle, the thread become circular in shape. This is because:

A. The thread exerts equal force on cell sides of the soap layer.

B. The thread exerts unequal force on all sides of the soap layer.

C. The soap layer exerts equal force on all sides of the thread.

D. The soap layer exerts unequal force on all sides of the thread.

27. A book is placed on a table. It was observed that the book rotates when the table is rotated. In this experiment centripetal force for rotation of the book is given by frictional force between the book and the table. The book was found to be thrown away when the speed of rotation of the table was increased.

    Which of the conclusions can be justified based on the above experiment?

    A. The book rotates slowly when the table is rotated faster.

    B. The book rotates faster when the table is rotated slowly.

    C. The book was thrown away because the centripetal force was balanced by friction.

    D. The book was thrown away because beyond a speed limit centripetal force cannot be balanced by friction.

28. Consider the case of a ball rolling on an imaginary road. The road considered here is supposed to be frictionless. Which of the following statements is correct?

    A. It comes to rest after sometime..

    B. It goes on moving infinitely with the same speed..

    C. It slows down but goes on moving.

    D. It speeds up and goes on moving.

29. What happens to surface tension when temperature of a liquid increases?

    A. Increases

    B. Decreases

    C. Remains the same

    D. None of the above

30. Why does a person riding a bicycle tilt it while moving on a curved road?

    A. to obtain speed

    B. to obtain energy

    C. to obtain centripetal force

    D to obtain centrifugal force

31. An electric bell is placed inside a bell jar. We can hear the sound of the bell when current is passed through the circuit. However, when air is gradually removed from the bell jar, sound decreases even though we can see the gong vibrating at the same speed

    A statement is given below concerning the above experiment.

    'Air is required for the sound waves to travel'.

    Which of the following should be done to verify this statement?

    A. Place the jar at a distance and find out if sound can be heard.

    B. Bring the jar closer and find out if sound can be heard more clearly.

    C. Evacuate the jar completely and find out if sound can be heard.

    D. Fill the jar again with air and find out if sound can be heard.

32. The lowest value of relative density is:
    A. Zero
    B. One
    C. Less than one
    D. Greater than one.

33. You are to conduct an experiment to determine whether an iron nail kept in contact with any pole of a magnet will acquire magnetism.

    If the iron nail gets magnetised when touched by a bar magnet, you would expect to observe that:
    A. The iron nail attracts iron filings if touched.
    B. The iron nail repels iron filings if touched.
    C. The iron nail attracts iron filings kept at a distance.
    D. The iron nail repels iron filings kept at a distance.

34. When a man is riding a bicycle, the back wheel of the bicycle is rotated and the bicycle moves forward. But if the back wheel is rotated with the bicycle placed on its stand, it will not move forward. Again, the moment the wheel touches the ground, the bicycle moves forward.

    This is because:
    A. When the wheel rotates in contact with the ground, gravitational force acts in the opposite direction of motion.
    B. When the wheel rotates in contact with the ground the gravitational force acts in the same direction of motion.
    C. When the wheel rotates in contact with the ground the frictional force of the ground acts in the opposite direction of motion.
    D. When the wheel rotates in contact with the ground the frictional force acts in the same direction of motion.

35. Capillary fall occurs when:
    A. Cohesion is greater than adhesion.
    B. Adhesion is greater than cohesion.
    C. Both cohesion and adhesion are the same.
    D. Cohesion is different from adhesion.

36. A liquid drop is always spherical because:
    A. A spherical drop will have more freedom of movement.
    B. A spherical drop will have minimum surface area.
    C. A sphericaldrop will have maximum surface area.
    D. A spherical drop will have less freedom of movement.

37. In an experiment, a scientist placed an object at the equator and found its weight. Then he placed it at the poles and found its weight. From the data be found the

weight of the object when it is placed at the centre of the earth. He concluded that the object had different weights in the three instances.

Which of the following assumptions is implicit in this experiment?

A. The weight of the object is negligible at the centre of the earth.

B. Acceleration due to gravity is the same at all places on the earth's surface.

C. Acceleration due to gravity is different at different places.

D. Weight is not determined by acceleration due to gravity.

38. Which of the following is the phenomenon occuring when the natural frequency of the body undergoing forced vibration is equal to the natural frequency of the forcing body.

A. Natural vibration

B. Forced vibration

C. Resonance

D. Echo

39. In a wave motion (i) crest and trough are produced (ii) the particles of the medium move perpendicular to the direction of wave motion (iii) there is no pressure difference in the medium. Then the wave is a:

A. Transverse wave

B. Longitudinal wave

C. Electro magnetic wave

D. Radio wave

40. While travelling on top of a bus, a man accidently touched a live electric wire passing over him and got severe shock. Another man purposefully touched a live electric cable from his television but got no shock at all. This may be because:

A. The current through household appliances are at very low voltage.

B. The household cable had a plastic covering over it.

C. The second man was resistant to electric shock.

D. A man will not get electric shock inside his house.

41. You are to conduct an experiment to determine whether the rate of evaporation of a liquid is affected by an increase in the amount of heat given. You have the relevant apparatus to conduct the experiment.

If the increase in the amount of heat has an observable effect on the rate of evaporation in liquids, almost immediately after increasing the amount of heat you would expect to observe a notable change in the:

A. Temperature of liquid molecules.

B. Motion of liquid molecules

C. Amount of liquid vapour over the liquid surface.

D. Pressure of the liquid.

C. The force of action applied by the boat

D. The force of action applied by the person.

58. The phenomenon of magnetization of a magnetic substance under the influence of a magnet is called:

A. Magnetic flux

B. Magnetic Induction

C. Magnetic deflection

D. Electro magnetic relay.

59. Work is said to be done when:

A. Force is applied on a body but body is not displaced.

B. Force is applied on a body and body is displaced in the direction of the force.

C. Force is applied on a body and body is displaced in the opposite direction of force

D. None of the above.

60. The relative density of water:

A. Zero

B. Less than one

C. One

D. Greater than one.

C. Force of a moving body depends on mass and velocity

D. All the above assumptions are implicit in the experiment.

47. When a person get electric shock, his heart tends to stop. This is because:

A. He is having tension

B. Viscosity of blood decreases

C. Viscosity of blood increases

D. Pressure of blood decreases.

48. Water is taken in a glass tumbler and level of water is observed. It is seen that water level is slightly high where water touches glass. If the water is placed in a flat vessel the rise of water is less than if it is placed in a narrow vessel. If water is taken in a thin capillary tube the rise will be maximum.

Which of the following inference can be considered true with respect to the above experiment.

A. The rise of water depends on 'g'.

B. The rise of water depends on the surface area of water.

C. The rise of water depends on the viscosity of water.

D. The rise of water depends on the density of water.

49. Three statements regarding the properties of liquid molecules are given below:

(i) Liquid molecules have freedom of movement.

(ii) Liquid molecules cannot escape the liquid surface due to force of cohesion.

(iii) When heated, they get kinetic energy to overcome the force of cohesion.

Consider the above statements and find out which of the following are correct:

A. All the above statements are true.

B. All the above statements are false.

C. Statements (i) and (ii) are true.

D. Statements (ii) and (iii) are true.

50. "Soldiers do not march over hanging bridges"

Consider the above statement and find out which of the following is correct?

A. The statement is true because the bridge will collapse due to forced vibrations.

B. The statement is false because the bridge will not collapse due to forced vibrations.

C. The statement is true because the bridge may collapse due to resonance.

D. The statement is false because nothing will happen to the bridge.

51. Violin is called a source of sound because:

A. It is a musical instrument.

B. It produces sound due to mechanical vibrations.

C. It produces melodious sound than a drum.

D. None of the above.

52. A bat can travel safely at night without striking obstacles because:

A. bat can see in darkness.

B. bat can produce sound waves which pass through obstacles.

C. bat's skin is sensitive to obstacles.

D. bat can produce sound waves which reflect from the obstacles and reach back to the bat.

53. To clean a carpet we beat it with a stick. The principle involved here is:

A. Principle of inertia of rest.

B. Principle of momentum.

C. Principle of inertia of motion.

D. Principle of friction.

54. When we strike a steel tumbler half filled with water with a rod, sound is produced. Here sound is produced due to:

A. The vibration of steel tumbler

B. The vibration of water

C. The vibration of both steel tumbler and water.

D. The vibration of the rod.

55. 'Action and reaction are equal and opposite'.

Considering the above statement which of the following are correct?

A. They cancel each other because they are equal and opposite.

B. They do not cancel each other because they are equal and opposite.

C. They cancel each other because they are acting on the same object.

D. They do not cancel each other because they are acting on different objects.

56. In a wave motion ,

(i) Compressions and rare fractions are produced.

(ii) The particles of the medium travel in the same direction of wave motion.

(iii) The pressure and density of the medium is different at different points.

That wave is a:

A. Transverse wave

B. Longitudinal wave

C. Electro magnetic wave

D. Radio wave.

57. When a person is jumping ashore from a boat, the boat moves backward. This is because of:

A. The force of reaction applied by the boat

B. The force of reaction applied by the person