Methodology occupies a very important place in any kind of research. The vehicle of research can not perform its function without it, since it is methodology that lays out the way that formal research is to be carried out and outlines the detailed descriptions of variables and procedures adopted. Methodology is the description of procedures or techniques adopted in a research study or investigation. It outlines the entire research plan. It includes the description of techniques or methods and tools, the researcher has used for collecting, organizing and analyzing the data.

The details of the method adopted, research design, stages of the study, variables of the study, tools used, sample selected, and procedure adopted in the experiment and statistical techniques used for the analysis of data are given below

3.1.0. Method Adopted

Experimental method was adopted for the present study. Experimental research is the most conclusive of scientific methods. It is the only type of
research that directly attempts to influence a particular variable and can really test hypothesis about cause and effect relationship. An experiment usually consists of two groups of subjects, an experiment group and a control group, although it is possible to conduct an experiment with only one group or with three or more groups.

3.2.0. Research Design

In this study, Non-equivalent pre test, post test control group design was used. The most common reason that experimental design can not be employed is the randomization of subjects to experimental and control groups is impossible and that a control or comparison group is unavailable, inconvenient or too expensive. Quasi-experimental designs can be used effectively in these circumstances. These designs provide reasonable control over the most sources of invalidity and they are usually stronger than the pre-experimental designs.

Non-Equivalent Pretest-Posttest control Group Design

This design is very prevalent and useful in education, since it is often practically difficult to randomize subjects. The researcher in such occasions uses intact, already established groups of subjects, gives a pre test, administers the treatment conditions to one group and then gives the posttest. The design can be represented by the figure 3.1
The study was carried out in three stages. The first stage was the pretest stage, in which the learners were tested on intelligence and achievement in the selected topics of physics of class IX. The second stage was the conduct of experiment. The experimental treatment, i.e. teaching through concept Attainment Model was given to one group (Experimental group) of students. The other group (Control Group) of students was taught through conventional teaching method. The third stage was the post-test stage. In this the learners were tested on achievement in the specified content and as well as the attitude of learner towards the teaching strategy.
The design of the study is represented in the figure 3.2.

Diagram 3.2. Design of the Study

3.3.0. Variables of Study

Variables are the conditions or characteristics that the experimenter manipulates, controls, observes or desires. The present study involved independent and dependent variables.

Independent Variable
In experimentation, the manipulated variable is called as independent variable “It is under the direct control of experimenter who may vary it in any direction (Sarc 1979).” “In experimental studies the condition that is varied is referred to as the independent variable. If the effect of teaching strategy is measured by means of an achievement test, then the score on the test is referred to as the dependent variable (Travers, 1964).” The present study measures the effectiveness of concept attainment model of instruction with traditional method. Therefore the independent variables (experimental variables) are the concept attainment model of instruction and traditional method.

**Dependent Variable**

The dependent variables are the conditions or characteristics that appear, disappear or change as the experimenter introduces, removes or changes independent variable (Best, 1983). Here student performance (achievement) is the dependent variable. There is a chance of many variables that affect/ influence the dependent variable. Achievement in physics of students can be affected by their intelligence and pre-physics concept understandings etc. But for the present study, the difference in achievement that would have been caused by these variables was made minimum by adopting the statistical technique ANCOVA.
3.4.0. Tools Used for the Study

The tools used in the present study were:

1. Raven’s standard progressive matrices scale set.
2. Student liking scale by Malhotra and passi.
3. Lesson transcripts based on concept attainment model of instruction and traditional method (Developed by investigator)
4. Achievement test in physics (Developed by investigator)

Measurement of Intelligence

Intelligence tests are available in verbal and non-verbal forms. Verbal tests on the whole, place a premium on the language ability of the individuals. Verbal tests may underestimate the intellectual capacity of children who speak a different dialect or for whom the language of the test is not their mother tongue. Thus children who have language difficulties or who come from another cultural background may be at a disadvantage when taking the test.

Therefore a verbal test is of doubtful value when common measures of intelligence of pupils drawn from widely differing backgrounds are required. So the investigator decided to use a non-verbal test of intelligence for the present study.

There are individual and group tests of intelligence. Individual tests are mainly used in clinical settings for the diagnosis of learning difficulties
while group tests are used largely for selection purpose in education. Correlation between individual and group test is fairly high and it is felt that they are each measuring the same kind of ability. For a study of present type, it is better to use a group test of intelligence because of its importance and obvious merits over the individual test of intelligence. Hence it was decided to use a non-verbal group test of intelligence for the measurement of intelligence. By considering the qualities of a good group intelligence test, the investigator decided to use Raven’s progressive matrices sets A, B, C, D, and E for measuring intelligence of students in the sample of present study. Raven’s standard Progressive Matrices sets answers sheet and scoring key are provided in appendix - E

**Raven’s Progressive Matrices sets A, B, C, D & E**

The test was intentionally chosen as an easy test to measure the cognitive functioning of the students. The standard progressive Matrices (Sets A, B, C, D, and E) is a test of person’s capacity at the time of test to apprehend meaningless figures presented for his observation, see the relations between them, conceive the nature of the figure completing each system of relations presented and by doing so, develop a systematic method of reasoning.

Raven’s progressive matrices (Sets A, B, C, D and E) is a test for adults and children which requires testees to complete matrices in which
every square, but one, has been filled in according to a certain pattern. When the testee has worked out the principle, he or she can then select the missing part of the design from a number of possible alternatives. Raven designed the test as a measure of Spearman’s ‘g’ factor, that is, the ability to understand relations among abstract items.

The test consists of sixty problems divided into five sets of twelve. In each set first problem is self-evident. The problem which follows become progressively more difficult. The five sets provide five opportunities for grasping the method of a person’s capacity for intellectual activity. As the five sets of items forming the scale, each begin with easy problems and end with difficult ones. The scores obtained will not be reliable, if the scale is used with a single time limit which does not enable everyone to finish.

The problems are in the form of patterns, with a bit missing. A number of alternatives (six for first two sets A and B and eight for the last three sets C, D, & E) are given from which the correct answer has to be chosen. All of them appear to be correct but there is only one correct answer, the child has to choose correct answer and put an ‘X’ mark in the box provided against each problem in the answer sheet separately given to them.

Everyone, whatever his age, is given exactly the same series of problems in the same order and is asked to work at his own speed, without interruption from the beginning to the end of the test. A person’s total score
provides an idea of his intellectual capacity, whatever his nationality or education.

In a study on the effect of timing on predictability on Raven’s test scores, Thampuratti (1969) arrived at the conclusion that twenty minutes seem to be the most satisfactory time span to complete the test, for the purposes of prediction of intelligence of pupil at the secondary level. From the original studies on SPM, Raven’s (1948) Foulds and Raven (1948) found reliabilities ranging from 0.83 to 0.93, with the higher values being associated with younger subjects, SPM correlates 0.86 with the Terman-Merril scale and has been found to have a ‘g’ saturation of 0.82.

The test is a popular measure used in Indian schools. Nair (1967) in a study on selected sample in Kerla, found that the split half reliability varied from 0.79 to 0.86 while the test-retest reliability varied from 0.89 to 0.91.

**Assessment of Student Liking**

Student’s liking was be assessed with the help of student’s liking scale developed by Malhotra and Passi. This scale was developed for students from IX to XI grade. The scale comprises of 30 statements. A five point scale is given against each statement which are Strongly agree, Agree, Undecided, Disagree and Strongly disagree. The students read the statement and choose an appropriate alternative form given five alternatives. These statements were related to the teacher behaviour with students inside the
class, teacher behaviour with students outside the class, teacher behavior with colleagues, and teacher behaviour with management. There is no fix time limit in responding the statements given in the scale. The test-retest reliability coefficient for different aspects ranged form 0.86 to 0.94.

The validity of the scale was established by computing the correlation between the student’s liking and teacher ratings, correlation coefficient range form 0.76 to 0.82. Also the correlation between the students liking and principal’s rating was computed and the correlation coefficient ranged from 0.72 to 0.80 indicating that the students liking scale was valid. Each item is scored on a five point scale distributed on strongly disagree, disagree, undecided, agree and strongly agree with scores 1, 2, 3, 4, 5 respectively. The possible range on the scale is from 30 to 150. Students Liking scale is provided in appendix – D.

**Lesson transcripts based on Concept Attainment Model**

The investigator prepared lesson transcripts for the physics topics of 9th standard CBSE textbook. Lesson transcripts were prepared according to concept attainment Model and Conventional Method of teaching for each selected physics topic. Thus, ten lesson transcripts were prepared based on Concept Attainment Model and Conventional Method. The prepared lesson transcripts were shown to experts in the field of Education and physics and
appropriate modifications were made. The details regarding the preparation of the lesson transcripts are given below.

The investigator tried to follow the syntax of concept attainment model (Reception model) for the preparation of the lesson transcripts.

**Syntax of the Reception Model of Concept Attainment:**

**Phase 1: Presentation of data and identification of the concept**

- Teacher presents labeled examples
- Students compare attributes of positive and negative examples
- Students generate and test hypotheses
- Students state a definition according to the essential attributes.

**Phase 2: Testing the attainment of the concept**

- Students identify additional unlabelled examples as ‘yes’ or ‘no’
- Teacher confirms student’s hypotheses
- Teacher names the concept
- Teacher restates definition according to essential attributes
- Students generate examples

**Phase 3: Analysis of thinking strategies**

- Students describe thoughts
- Students discuss role of hypotheses and attributes
- Students discuss type and number of hypotheses
• Teacher evaluate the strategies

  Concepts Attainment Model is designed to teach concepts only. Four steps have been identified in planning and organizing Concept Attainment lessons. They are

  a. Selecting the concept,
  b. Analyzing the concept,
  c. Determining objectives, and
  d. Preparing examples.

  There are four activities involved in the first step of selecting a concept. They are

  a. Locating the concept,
  b. Deciding if it is a concept,
  c. Deciding if it worth teaching, and
  d. Deciding if it is appropriate for the learners.

  The second step is analyzing the concept in terms of

  a. Its essential attributes and non-essential attributes
  b. Its type.

  The third step is determining objectives of teaching concept attainment model can be employed towards several educational ends, which can be broadly classified into a general objective
‘teaching a concept. It may mean any or all of the following specific behavioral objectives:

i. Students will correctly recognize unlabelled examples.
ii. Generate new examples of the concept,
iii. Locate example of the concept in textbook or other resources.
iv. Locate an example and describe the essential attributes as they appear in this new concept, and
v. State the concept rule.

The last step in preparing a lesson is preparing examples. The ‘yes’ examples should contain all the attributes of the concepts. The ‘no’ examples should contain none of the attributes or only some of the attributes. If the concept is conjunction, the ‘yes’ examples must be introduced firstly; if the concept is disjunction, ‘no’ examples should be introduced firstly. It is necessary that the medium selected for presenting the examples should be a suitable one.

Keeping the key aspects of Concept Attainment Model explained above, the investigator prepared 10 lesson transcripts for teaching physics concepts of standard IX.

The selected physics concepts were
1. Motion
2. Inertia
3. Acceleration
4. Force
5. Gravitation
6. Work
7. Power
8. Sound
9. Evaporation
10. Change of States

The age of the students, their intelligence level and previous knowledge were also taken into consideration while lesson transcripts were prepared. The media for presenting the examples were demonstrations, exhibiting objects, diagrams, charts, pictures and verbal examples.

After the lesson were prepared, the investigator made a teaching analysis using the following questions, prepared by Joyce and Weil (1978).

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. In teaching a conjunction concept, did the teacher begin with ‘yes’ examples?

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’ examples?

7. Did the teacher ask the students to contrast the attributes of the ‘yes’ examples with those of the ‘no’ examples?

8. Did the teacher present labeled examples?

9. Did the teacher ask the students to generate and test the hypothesis about the identity of the concept?

10. Did the teacher ask the students to state the essential attributes of the concept?

11. Did the teacher ask the students to name the concept?

12. After the concept was agreed upon, did the teacher present additional examples 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 examples to fit the concept?

15. Did the teacher ask the students to justify their examples by identifying the essential attributes?

16. Did the teacher ask the students to describe the thinking process they used in attainment the concept?

17. Did the teacher ask the students to reflect on the roles of the attributes and concepts in their teaching strategies?

18. Did the teacher ask the students to evaluate the effectiveness of their strategies?

Based on the suggestion of the experts, some changes were made in their form and content of the lesson transcripts. One of the Model lesson transcripts is presented below and rest of the Model lesson transcripts with examples of concept are given as Appendix – B & Lesson Transcript based on traditional method is given as appendix – C

**Lesson Transcript**

**Name of Concept - Motion**

**Standard:** IX

**Method:** Concept attainment Model (CAM)

**Type:** Reception Oriented CAM
Objectives: Knowledge, Understanding, Application

Class Concept: Relational/ Primary? Abstract

Definition of Concept: Motion of an object means the change in its position with respect to an observer.

Explanation of Concept: If an object does not change its position with respect to other surrounding objects, we say that object is at rest. On the other hand if object changes its position with respect to surrounding object we say that the object is in motion.

Phase I- Presentation of Data and Identification of Concept

Teacher Presents Labeled Examples in form of positive and negative examples. Where positive examples are in the category of Yes and negative examples are in the category of No.

i. The fan is steady  
No

ii. When I started fan, I saw its blades were moving  
Yes

iii. The bird in the branch of tree.  
No

iv. I saw the bird flying in sky  
Yes

v. A vehicle at parking place  
No
vi. Vehicles were running on road when I was at the stop.  

vii. Hanged wet clothes on the rope.  

viii. I saw the clothes going to and fro when wind was blowing.  

ix. Sleeping horse  

x. A horse rider taking it towards battle place.  

xi. The bits of paper were on the floor.  

xii. I saw the bits of paper moving towards window due to cool breeze.  

Students Compare Attributes in Positive and Negative examples:  

Pupil observes carefully all examples and tries to find out characteristics which are present in positive examples and absent in negative ones.  

Students Generate Hypothesis: On the basis of your search. You try to mention the characteristics of concepts which are in mind. We will call it as a hypothesis. Teacher asks pupils to generate hypothesis. If they get difficulty in generating it, teacher asks whether they need the help of more examples. One their refusal, teacher ask about their hypothesis.  

Student 1: Negative examples contain all non-living things.
**Teacher:** Don’t make conclusion form single statement or only negative statement but observe all examples and then formulate it.

**Student 2:** In all negative examples the objects are stationary while in positive examples something is moving. Some sort of movement is there in blades of fan, birds, clothes etc. So I can say that my hypothesis is that of are moving objects.

**Teacher:** Whatever you are saying is partially correct. You pay attention over other part of positive examples also.

**Student 3:** Other than movement there is the presence of observer also, in positive examples whereas it is not present in negative examples.

**Teacher:** So combine these two things, movements and observer and then generate hypothesis.

**Student 4:** There is change in movement of an object in presence of observer.

**Students Test Hypothesis:** From various examples you have generated hypothesis in your mind. To test validity of this hypothesis, again I am presenting few more examples you observe them carefully and test it. If it is going to be changed, don’t worry. You record changed hypothesis. Note the reasons behind its change.

**Examples:**

i. **At night I saw the moon was going forward in clouds.**  
   Yes
ii. As wind was blowing heavily I saw some fruits were falling down.

Yes

iii. Different vehicles were standing on the both side of railway crossing when the gate was closed

No

Student state on Definition According to Essential Attributes:

By studying many examples you’ve tried to formulate hypothesis which has been further confirmed with the help of few more examples. With the help of these characteristics now you try for making the definition of concept in mind.

Student 1: Objects are moving some where and observer is observing it.

Student 2: Objects are not steady. They are changing their place. They are displacing form one place to another which happens in the presence of some observer.

Teacher: In all above examples change of place is with respect to some observer, if this phenomenon has been given the name of motion. You try to define motion.

Student 3: Motion of any object means the change in its position with respect to an observer.

Phase II: Testing Attainment of Concept

Student Identify Additional Unlabelled Examples as Yes/No
The hypothesis which you have generated to check your creativity again I am presenting few more examples before you. These are of both types; Positive as well as negative ones; But now I am not going to tell you its kind. You have to find out whether they belong to characteristics of concept or not.

**Example** - **Teacher**: The bullock cart is moving fast on the road was realized to Ram who was driving it.

Pupil answers - Yes

**Example** - **Teacher**: The blades of a wind mill in my farm started rotating rapidly due to cyclone.

**Student**: It is partially correct because though there is movement but observer is not mentioned

**Example** - **Teacher**: Joker in circus was playing with ball by making it to move up and down.

**Student**: Yes

**Example** - **Teacher**: A child sitting on swing is moving it to and fro again and again rapidly.

**Student**: Yes
Teacher confirms Hypothesis, Names Concepts and Restates Definition According to Essential Attributes.

Today we have studied one of concept in physics subject with the help of number of examples. From them you generated hypothesis which you told me when it was asked. Your hypothesis was correct one. Name of concept in my mind is ‘Motion’. By motion we mean, change of place in a object. This change of place takes place with reference to certain observer. There should be some observer as well as change of place in object. These two things are the essential components, of a motion. In the absence of any one the definition holds partially true.

It objects changes its position with respect to surrounding object we say that object is in motion. Teacher writes definition on black-board.

Students Generate Examples: Now you give few examples of the concept motion on your own.

Student 1: While I was taking water out form well I found that pulley was rotating around the axis. So pulley is in motion.

Student 2: In foot ball match captain noticed that ball crossed the boundary line. Foot ball possess motion.

Student 3: I saw the clouds were moving forward in the sky. The cloud is motion.

Student 4: I saw the leaves of tree were falling in tank.
Phase III: Analysis of Thinking Strategies

Students Describe Thoughts

Student Discuss Role of Hypothesis and Attributes

Student Discuss Type and No. of Hypothesis

Let’s discuss about your thinking procedure. When numbers of examples were presented what mental activity took place? How you’ve analyzed them? Did you reach to the characteristics of concept immediately? Or you required more time to form them? Were they easy or difficult?

Student 1: Madam, when I observed first example I didn’t understand anything. I thought that example was very simple, and then what the thing may be? So I read next example and compared positive as well as negative examples. Immediately I found that objects were moving, this may be the characteristics which strengthened with further examples.

Student 2: I didn’t reach up to characteristics of concept at beginning; after reading all examples comparing positive, negative examples. I came to know characteristics. The idea of observer came in mind at the same time. It was confirmed by another set of examples.

Student 3: I thought that objects were nonliving so concept may be related with it, but when I saw bird I made a change in it. Again I read all positive examples. This time I got that the observer is present in all positive examples. Which is absent in negative ones. So characteristics may be the
Enrichment of Concept: Today we’ve studied the concept of motion. If any object does not change its position with respect to other surrounding objects, we say that object is at rest.

On the other hand, if an object changes its position with respect to a surrounding object, we say that it is in motion. For example, the motion of animals with respect to fixed objects on earth is called locomotion. Motion can be any of the following three kinds:

i. Translational Motion: If every particle of the body has the same displacement, then the motion possessed by it belongs to translational motion, e.g., a train moving ahead.

ii. Rotational Motion: If different particles of the body revolve in circles about the same axis, then the motion possessed by that body is called rotational motion, e.g., a spinning top or an electric fan.

iii. Oscillatory Motion: If an object performs the same set of movements again and again, it is said to belong to oscillatory motion, e.g., the pendulum of a clock or the needle of a sewing machine.
Achievement test can be defined as a test designed to measure the effects of specific teaching or training in the area of curriculum. The concepts selected for the study were selected from the CBSE prescribed IX standard text book and these were Motion, Inertia, Acceleration, Force, Gravitation, Work, Power, Sound, Evaporation and Change of States. Since no specific achievement test in the topics selected was available, to test the effectiveness of experimental teaching strategy on the student’s performance in physics, an achievement test on the concepts from the above topics was prepared by the investigator. Keeping in mind the nature of procedure adopted for the experiment, achievement test in physics was prepared in the form of unit test for each selected topic. Thus achievement test as a whole consisted of ten unit tests related to topics selected for the study. Achievement test along with instrumentation and key is given as appendix A.

3.5.0. Sample

In the present study random sampling and convenient sampling procedures were adopted to select the sample. The universe from which the sample was selected was 9th grade students of Mohindergarh city and its suburbs.
Selection of the schools

To collect the sample the investigator had written the names of sixteen schools which were having more than hundred students in class 9th, of Mohindergarh city (Haryana) and its suburbs on the separate slips. The slips were folded and then put into a box. After that one slip was picked by a child and name of the school written on that slip was noted. The selected slip was again put into the box. Again one slip was picked by a child and name of the school written on that slip was noted. In this way the two schools were selected. The name and type of the schools selected with this procedure were given in table 3.1

Table 3.1

Name and type of the school selected for the study

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Name of the School</th>
<th>Type of the School</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shri Krishna Sr. Sec. School</td>
<td>Co- education</td>
</tr>
<tr>
<td>2</td>
<td>Yaduvanshi Sr. Sec. School</td>
<td>Co- education</td>
</tr>
</tbody>
</table>

After selecting the schools, investigator approached to the institutions and permission was sought for conduction of experiment.

Selection of the students

For the selection of sample of students, the list of all the students of class 9th was obtained from daily attendance register of two selected schools
mentioned above. To do this investigator took the help of class 9\textsuperscript{th} in charge of each school. There were four sections A, B, C, & D of class 9\textsuperscript{th} having 30, 28, 30 and 28 students respectively in each section of Shri Krishna Sr. Sec. School.

Thus in total there were 116 students of class 9\textsuperscript{th} in Shri Krishna Sr. Sec. School. In Yaduvanshi Sr. Sec. School there were four sections i.e. A, B, C & D having 27, 30, 30 and 25 students respectively in each section. Thus in total there were 112 students in class 9\textsuperscript{th} of Yaduvanshi Sr. Sec. School. Thereafter using the process of random sampling, students of section A and B of Shri Krishna Sr. Sec. School and section A and section C of Yaduvanshi Sr. Sec. School were selected for experiment. Thus in total 115 students were selected for treatment and remaining section of two schools were kept in control group. The number of students along with their composition is given in table 3.2, 3.3, 3.4 & 3.5

**Table 3.2**

Names of the sample of schools and number of students drawn from each school
Table 3.3

Names of the sample schools and number of boys and girls drawn from each school

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Name of the School</th>
<th>No. of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shri Krishna Sr. Sec. School</td>
<td>Section A-30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Section B-28</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Section C-30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Section D-28</td>
</tr>
<tr>
<td>2</td>
<td>Yaduvanshi Sr. Sec. School</td>
<td>Section A-27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Section B-30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Section C-30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Section D-25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th>Shri Krishna Sr. Sec. School</th>
<th>Yaduvanshi Sr. Sec. School</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>62</td>
<td>66</td>
<td>128</td>
</tr>
<tr>
<td>Girls</td>
<td>54</td>
<td>46</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>116</td>
<td>112</td>
<td>228</td>
</tr>
</tbody>
</table>
Table 3.4

Names of the sample school and number of students selected for experimental and control groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>Shri Krishna Sr .Sec. School</th>
<th>Yaduvanshi Sr .Sec. School</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>Section A=30</td>
<td>Section A=27</td>
<td>115</td>
</tr>
<tr>
<td></td>
<td>Section B=28</td>
<td>Section C=30</td>
<td></td>
</tr>
<tr>
<td>Control Group</td>
<td>Section C=30</td>
<td>Section B=30</td>
<td>113</td>
</tr>
<tr>
<td></td>
<td>Section D=28</td>
<td>Section D=25</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>116</td>
<td>112</td>
<td>228</td>
</tr>
</tbody>
</table>

Table 3.5

Names of the groups and number of boys and girls taken in each group

<table>
<thead>
<tr>
<th>Gender</th>
<th>Experimental Group</th>
<th>Control Group</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>63</td>
<td>65</td>
<td>128</td>
</tr>
<tr>
<td>Girls</td>
<td>52</td>
<td>48</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>115</td>
<td>113</td>
<td>228</td>
</tr>
</tbody>
</table>
3.6.0. Procedure of the experiment

The experiment was launched from the first week of July 2011 and it was continued till the third week of August 2011. The time was fixed in advance with the help of school administration. As mentioned above two sections of each school were assigned to the experimental group and the remaining two sections of each school were assigned to control group. In place of random sampling of students in experimental and control group, intact sections of class 9th were considered for experimental treatment and control group treatment due to administration problem in school.

Design of Experiment

The present study was experimental in nature and its design was based on the lines of non-randomized control group pretest- post test design. Schematic description of the design was as:

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-test</th>
<th>Treatment</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>O</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Control</td>
<td>O</td>
<td>----------</td>
<td>O</td>
</tr>
</tbody>
</table>

Pre-test conduction

The investigator made necessary arrangements with the principals of schools selected for the experiment. The Achievement test related to each concept was administered to both the groups just after the conducting the
intelligence test and just before teaching them each concept. The scores that were collected from the answer sheets comprised the pre-test scores.

**Learning by the experimental group**

The experimental group was taught by investigator with the help of the lesson transcripts based on Concept Attainment Model. There were ten lesson transcripts. Three weeks time was used for teaching the selected concepts of Motion, Inertia, Acceleration, Force, Gravitation, Work, Power, Sound, Evaporation and Change of States. Simple demonstrations, diagrams and verbal examples were used for presenting the selected 9th class physics concepts.

**Learning by the control group**

The control group was taught the same topics by the investigator in the conventional way. The time equal to experimental group, was used for teaching the control group.

**Post-test conduction**

Prior information regarding the post-test was given to both experimental and control group. The post-test related to each topic was administered to both groups, just after teaching each topic. The scores that were collected from answer sheets comprised the post-test scores. Just after the conduction of post test students liking was assessed with the help of students liking scale.
Achievement test scores (both pre-test and post-test) of the experimental and control groups are provided in the appendix – F

3.7.0. Statistical Techniques Employed for Data Analysis

The pre-test scores and post-test scores of the experimental and control groups were consolidated for statistical analysis. Since the experiment was conducted using intact, previously un-equated groups, the technique of analysis of covariance was applied for analyzing the data. Through covariance analysis one is able to effect adjustment in final and terminal scores which will allow for differences in some initial variables.

The details of analysis of data using ANCOVA and other relevant statistical techniques were complied and presented in the fourth chapter.

The objective wise data analysis was as follows:

1. For effectiveness of CAM in terms of physics concept understanding and to compare pre and post mean scores of physics concept understanding, the data was analysed with the help of correlated t-test.

2. For comparison of Adjusted mean scores of physics concept understanding of CAM group and Traditional method group by taking pre-physics concept understanding and intelligence
as covariates, the data was analysed with the help of ANCOVA.

3. For comparison of mean score of students liking, the data was analysed with the help of t-test.

4. For comparison of adjusted mean scores of physics concept understanding of males and females of CAM group by considering pre physics concept understanding as a covariate, the data was analysed with the help of ANCOVA.

5. For effect of treatment, sex and their interaction on physics concept understanding by taking pre-physics concept understanding and intelligence as covariates, the data was analysed with the help of 2×2 factorial design ANCOVA.

6. 2×2 factorial design ANCOVA was used for studying the effect of treatment, intelligence and their interaction on physics concept understanding by taking pre-physics concept understanding as a covariate.