CHAPTER: III

PLAN & PROCEDURE
OF THE STUDY
PLAN AND PROCEDURE OF THE STUDY

3.0 INTRODUCTION

In the planning of a study, the investigator attempts to select the research design most appropriate to the particular problem under consideration as the blue prints which are prepared by the architect for the massive construction of the massive buildings, any gov't., before determining and applying policy, has to plan it very carefully. In the same way, the clear and systematic statement of the procedure avoids all the difficulties in the way of research and helps the investigator to achieve the aim and objectives of the study because planning includes the possibilities of better performance in all jobs.

According to Claire Selltiz and others (1962), "a research design is the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in the procedure. The quality of research depends not only on the adequacy of the research design, but also on the fruitfulness of the measurement procedure employed." Thus, procedure of the study is of the prime importance in attacking any research problem in a scientific manner. The procedure of research followed by the researcher has been classified into following heads:

3.1 Method of Study
3.2 Sample of Study
3.3 Selection of the Tools
3.4 Construction of the Tools
3.5 Administration of Various Tools
3.6 Scoring of Various Tools

3.7 Procedure of the Study

(a) Content Analysis

(b) Survey Methods of the Constructivist Pedagogy

(c) Development of Instructional Material

(d) Field Based Experiment

(e) Evaluation

(g) Research Design

(i) Phase I- Development of Instructional Material

(ii) Phase II- Implementation of Developed Instructional Material in Orientation of Pupil Teachers

(iii) Phase III- Assessment of Effectiveness of Developed Instructional Material

3.8 Statistical Techniques

Brief procedure of the study followed in present research has been presented through a flow chart given in the next page.
Method of the study

Sampling Design

Institute of Agra City

Development of Tools

Collection of Data

Editing and collection of Data

Data Processing

Interpretation of Data and Findings

Report Writing

Experimental Research

Probability Sampling

Simple Random Sampling

Probabilistic Sampling

Reaction Scale

Willingness Scale

Achievement Test

Group Intelligence Test

Mean

S.D.

C. R. Value

Coefficient of Correlation

Fig. 3.1 Procedure of the Study
3.1 Method of Research

Selection of a research method depends upon the nature of the study as well as the objectives to be achieved. So keeping the nature of the problem in mind the method of experimental method of research has been used. Experimental methods what will be, or what will occur, under carefully controlled conditions. Experimental research is used to determine and evaluate the adequacy and effectiveness of the educational and instructional objectives through the measurement of their outcomes. After evaluation the efficacy of objectives, suggestions are made for the formulation, execution and modification of educational programmes and classroom practices (John, W. Best).

The experimental research is not considered a precise method of research in the field of education because of the complex nature of the human beings and problems of controlling the experimental variables. However, in spite of all such difficulties experimentation has been but the various use in solving educational problems. Campbell and Stanley (1963) are of the opinion that:

"The experiment is only mean of the setting disputes regarding education practice, the only way of verifying educational improvement and the only way of establishing a cumulative tradition in which improvement can be introduced without the danger of a faddish discard of old wisdom in favor of inferior novelties."

3.2 SAMPLE OF THE STUDY.

Selection of the sample is an integral part of every research project and its success depends upon the right selection of the sample. Great care should be taken in the selection of the sample. Good (1952), has very rightly remarked "sampling is an essential part of all scientific procedure".
Chapter-III Plan and Procedure of the study

Generalizability of the research findings is of course depends upon the sampling. The concept of sampling makes the research findings economical and accurate because the study of the total population is not possible and it is also impracticable because of the practical limitations of time factor, labor and human resource etc.

Therefore, it becomes necessary for the researcher to select the sample from the population under study. The most important aim of the sampling is to obtain maximum information about the phenomena under study with the least sacrifice of money, time and energy or to make the research efficient.

3.2.1 Description of the Population and Its Element

A population refers to any collection of specified group of human beings or non-human being entities such as objects, educational institutions, time units’ geographical green, prices etc. Population means the entire mass of observation from which a sample is to be drawn. The sample observation provides only an estimation of the population characterization. In other words, population, in broad sense is to include all sets of individuals’ objects or reaction that can be described as having a unique pattern of qualities. Population of the present study consists of male and female students of the age group of 13 to 16 year of class XI Biology students and pupil teachers of B.Ed. level.

3.2.2- SAMPLING TECHNIQUE

In the present study, the non probability sampling technique was preferred for the selection of the sample. Under non probability sampling technique two methods viz. accidental and purposive sampling methods were used in present study. Institutions were selected by accidental method where as XI grade Biology students were selected by purposive method.
3.2.3. Size of Sample

In present study 40 pupil teachers and 60 students of class XI (Biology) were selected as the sample. Present study is an experimental study therefore a very large size of sample could not be taken. All the pupil teachers who opted Biology method were selected from Faculty of Education, DEI, Dayalbagh Agra and all Biology students studying in class XI were selected from Krantikari Vasudev Inter College of Agra city.
3.2.4. JUSTIFICATION OF SIZE OF SAMPLE

It appears that to conduct a study on a sample of 100 units (60 school students and 40 pupil teachers) is inadequate, but this can be justified, considering the nature of the study.

Experimental research needs similar experimental conditions for all members of experimental group from many institutions. In the same way the controlled group should also have equal control so as the factors affecting the controlled groups can be minimized therefore selecting controlled groups from many schools/Institutions is not practical. Thus maximum possible numbers of pupil-teachers and students from selected institutions have been taken up as sample for the present study.

3.2.5 PROCEDURE OF THE SAMPLE SELECTION

The procedure of selection of sample is as follows.

(a) Selection of the Institute.

For the purpose of collection of data, the investigator selected institutions of Agra city. Krantikari Vasudev Inter College was selected as a sample institution as it has sufficient number of students of Biology at XI level. There were 60 students of Biology in this school. No other senior secondary school of Agra city has this much of Biology students at senior secondary level. This was the only school from where researcher could get the size of sample as per his need. Convenience of experimentation was another important reason for selecting this school. Faculty of Education, Dayalbagh Educational Institute, Agra was selected as sample institute for the selection of pupil-teachers because this is the biggest institute of B.Ed. in Agra city from where researcher could get enough sample units. There are 40 pupil teachers of Biology subject in the Faculty of Education,
DEI Agra. Convenience of Experimentation (orientation) was another important cause of selection of this institute.

**Group assignment (Experimental and Controlled Groups)**

Experimentation involves the comparison of the effects of a particular treatment with that of a different treatment or of no treatment. In a simple conventional experiment, reference is usually made to an experimental and to a controlled group.

**(A) Experimental group.** An experiment is conducted on a sample or group of subjects. The group which is assigned to the experimental variable or treatment is termed as experimental group.

**(B) Controlled Group.** The effectiveness of experimental variable is examined by comparing with controlled variable. The group which is allotted to controlled variable is termed as controlled group.

A more adequate experimental design is the parallel or equivalent group technique in which the relative effects of two treatments are compared on the basis of two or more groups, which are equated in all relevant aspects. In an educational experiment, the groups being compared are generally equated on chronological age, I.Q., sex, general background of the subject and any other factor considered relevant to the problem under investigation.

Comparison of guidelines differences between the two groups thus, the main steps in the parallel group methods as follows.

1. Selection of equivalent group
2. Applying the experimental factor
3. Comparing the results
4. Interpreting and reporting the results
The initial step of selecting equivalent group is a crucial one due to the varying degrees of indirected and acquired characterization in the members of any group. The controlled factors usually considered are intelligence, sex, race, personality etc.

In the present study the groups of Biology students of XI grade were divided into two groups on even and odd basis. Then the investigator administered General Mental Ability Test developed by Dr. S. S. Jalota on both the groups. Both the groups were not significantly different on intelligence. The mean difference between the intelligence score of experimental and controlled groups was insignificant at .05/.01 levels of significance.

After matching the groups on intelligence, investigator gave orientation about constructivist approach to the experimental group with the help of the developed instructional material, where as the controlled group was given orientation without the help of the developed instructional material.

3.3. SELECTION OF THE TOOLS.

Success in research depends on the availability of the tools and techniques of sufficient precision to measure the phenomena under the study. The selection and development of research tools and instrument are most critical steps of any investigation, which call for a deep insight and perspective of overall field of the research design.

According to John W. Best, "Skills in choice and use of research instrument is crucial to the success of the study and validity of the results and conclusions."

In any research the selection of tool largely depends on the kind of data used. Research tools should be selected in accordance with the objective of the study, information required and suitability of the specific age group of the subject to be studied. A researcher therefore must possess considerable knowledge about a wide variety of
techniques and instruments, he/she must be familiar with the nature of the data that they proceed, and its advantage and limitation, the assumption upon which their use is based and the extent of their reliability, validity and objectivity, if the existing tools do not meet his/her must specific needs, he/she supplements or modify or construct his/her own tools.

To fulfill the purpose of the study, the researcher first collected the list of available tools related to the dependent and independent variables. After reviewing thoroughly the available tools, the researcher selected most suitable tools for the work and also took the decision to construct the tool to measure the reaction and willingness of pupil teachers towards the constructivist approach for which no readymade standardized tool was available.

3.3.1 SELECTION OF INTELLIGENCE TEST

For the selection of the Intelligence test the Investigator first surveyed the related literature and found several Verbal, non verbal and other tests. There are several intelligence tests available for the measurement of intelligence table no. 3.1 represents the list of the available tests that had frequently been used in India.
Table 3.1 - TABLE OF VARIOUS TOOLS FOR MEASURING INTELLIGENCE

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of the test</th>
<th>Authors</th>
<th>Year</th>
<th>Age</th>
<th>Reliability</th>
<th>Validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Verbal Group intelligence Test</td>
<td>Psychological Lab Allahabad</td>
<td>1955</td>
<td>13-14 years</td>
<td>0.97 Spearman Brown Formula</td>
<td>---</td>
</tr>
<tr>
<td>2</td>
<td>P.S.M General Intelligence Test</td>
<td>---</td>
<td>1957</td>
<td>13-20 years</td>
<td>0.87(split half) 0.91(Test-retest)</td>
<td>0.60</td>
</tr>
<tr>
<td>3</td>
<td>Verbal Intelligence test</td>
<td>R.K.Ojha &amp; Ray Chaudhary</td>
<td>1958</td>
<td>13-20 years</td>
<td>0.64-0.87 (Split Half) 0.68-0.91 Kuder richarden</td>
<td>---</td>
</tr>
<tr>
<td>4</td>
<td>Group Verbal Intelligence test</td>
<td>CIE Delhi</td>
<td>1961</td>
<td>14 years</td>
<td>0.94 (Split Half) 0.87 (Test-retest)</td>
<td>0.37-0.77</td>
</tr>
<tr>
<td>5</td>
<td>Group Intelligence test</td>
<td>Prayag Mehta</td>
<td>1962</td>
<td>12-14 years</td>
<td>0.88 (Split Half)</td>
<td>Predictive Internal &amp; Factorial</td>
</tr>
<tr>
<td>6</td>
<td>General Intelligence Test</td>
<td>S. S. Jalota</td>
<td>1972</td>
<td>13-18 years</td>
<td>0.84</td>
<td>---</td>
</tr>
<tr>
<td>7</td>
<td>General Intelligence Test</td>
<td>Ram Narash Singh</td>
<td>1967</td>
<td>13-16 years</td>
<td>0.90(split half) 0.80(Test -Retest)</td>
<td>0.30-0.74</td>
</tr>
<tr>
<td>8</td>
<td>A Group test of Intelligence</td>
<td>R.K. Tandon</td>
<td>1971</td>
<td>16 years</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>9</td>
<td>A Group test of intelligence</td>
<td>R.K. Tandon</td>
<td>1971</td>
<td>10-16 years</td>
<td>0.93 (Split Half)</td>
<td>0.36-0.59 Examination Marks</td>
</tr>
<tr>
<td>10</td>
<td>Group Verbal Intelligence Test</td>
<td>R.C. Gupta</td>
<td>1980</td>
<td>18-19 years</td>
<td>0.87(Split Half) 0.92(Spearman Brown formula)</td>
<td>0.50</td>
</tr>
<tr>
<td>11</td>
<td>Mixed Group Intelligence Test</td>
<td>R.N. Shivasvata</td>
<td>1986</td>
<td>Adults</td>
<td>0.80 test retest</td>
<td>0.88</td>
</tr>
<tr>
<td>12</td>
<td>General Intelligence test</td>
<td>S.M.Mohim</td>
<td>---</td>
<td>9-15 years</td>
<td>0.98 (Split Half) 0.89(Test Retest)</td>
<td>0.56-0.63</td>
</tr>
</tbody>
</table>

3.3.2 JUSTIFICATION OF THE SELECTED INTELLIGENCE TEST

The analysis of the table reveals that most of the tests are not suitable for the age group of the subject of the present study. Only three tests viz. P.S.M. General Intelligence Test, Verbal Intelligence Test by R.K. Ojha & Ray Chaudhary and Group Verbal Intelligence Test of R.C. Gupta are selected.
Test by Dr. S. S. Jalota were suitable for the age group of the selected sample. Out of the three tests, Group Intelligence test of Dr. S. S. Jalota was given preference because,

- It is valid and reliable test, developed in Hindi for students in the range of 13-18 years.
- This test includes different broader areas related to intelligence.
- Scoring procedure of the test is very easy.
- It has been used widely by the researchers and suitable in Indian conditions.

3.3.2.1- Description of the Group Intelligence Test

The verbal intelligence test was developed by Dr. S. S. Jalota. This test includes broad areas related to intelligence. These are (1) Vocabulary (2) Classification (3) Number (4) Analogue (5) Reasoning. The items of the test were mixed and arranged in an empirically determined order of increasing difficulty.

3.3.2.2- Profile of the Group Intelligence Test

Jalota's General Mental Ability Test is standardized on a large sample. It can be easily applied on Hindi or English speaking students. Detailed profile of the test is given below.

<table>
<thead>
<tr>
<th>Tool</th>
<th>Group of the material labeled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constructed by</td>
<td>Dr. S. S. Jalota</td>
</tr>
<tr>
<td>Year</td>
<td>1972</td>
</tr>
<tr>
<td>Nature</td>
<td>Group Intelligence Test</td>
</tr>
<tr>
<td>Group / individual</td>
<td>Both</td>
</tr>
<tr>
<td>Age range</td>
<td>13-18 years</td>
</tr>
<tr>
<td>structure</td>
<td>Multiple questions</td>
</tr>
<tr>
<td>Time</td>
<td>20 min.</td>
</tr>
</tbody>
</table>

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3.3.2.3. PSYCHOMETRIC PROPERTIES OF GROUP INTELLIGENCE TEST

3.3.2.3.1 Reliability of the Group Intelligence Test.

The reliability of intelligence test has been calculated by the findings of correlation between the odd and even halves scores of the tested population. These correlation coefficients were corrected for length with the Spearman–Brown formula, and are given in table. The reliability coefficient found was uniformly high for all the targeted classes. The reliability co-efficient have been given in the table 3.2.

Table-3.2 Showing ODD-EVEN item scores correlation as a measure of empirical reliability correlated for length.

<table>
<thead>
<tr>
<th>Class</th>
<th>VIII</th>
<th>IX</th>
<th>IXa</th>
<th>X</th>
<th>XI</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>335</td>
<td>379</td>
<td>201</td>
<td>363</td>
<td>178</td>
</tr>
<tr>
<td>r</td>
<td>.703</td>
<td>.873</td>
<td>.906</td>
<td>.908</td>
<td>.845</td>
</tr>
<tr>
<td>rtt</td>
<td>.879</td>
<td>.932</td>
<td>.953</td>
<td>.979</td>
<td>.916</td>
</tr>
</tbody>
</table>

3.3.2.3.2 Validity of Group Intelligence Test.

The validity of revised test has been reported on the basis of a factor analysis of inter-elements scores, which gave a pattern of three centroid factors. When obliquely rotated to simple structure, these exhibited an identification of the Verbal Numerical and Reasoning factors.

Table-3.3 Validity of Group Intelligence Test

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>V-.9033</td>
<td>-</td>
<td>.5841</td>
<td>.6386</td>
</tr>
<tr>
<td>N-.8004</td>
<td>-</td>
<td>-</td>
<td>.5913</td>
</tr>
<tr>
<td>R-.8565</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Chapter-III Plan and Procedure of the study

Procedure of Construction of Tools

Definitions the terms → Survey of available tools → Categorization of tools

Fig. 3.4 – Processing Construction of tools

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3.4 Construction of the Tool to Measure the Reaction and Willingness of Pupil Teachers towards the Constructivist Approach.

To achieve the objectives of the study following three tools were developed by the investigator:

1. Reaction Scale towards the Constructivist Approach (RSTCA)
2. Willingness Scale towards the Constructivist Approach (WSTCA)
3. Achievement Test for XI Grade Biology students

3.4.1 DEVELOPMENT OF REACTION SCALE TOWARDS THE CONSTRUCTIVIST APPROACH

3.4.1.1 Survey of related tools for measuring reaction towards constructivist approach (RSTCA).

The reaction scale towards the constructivist approach was developed in the following steps. In order to obtain reliable and valid results, the selection of appropriate tool is the primary condition in research work. The investigator surveyed the test available in the field of constructivist approach but could not find any suitable tools for measuring the reaction of pupil teachers towards the constructivist approach. Hence the investigator decided to construct his own reaction scale.

3.4.1.2 Deciding the areas for reaction scale towards the constructivist approach.

Researcher consulted various reference materials such as books, educational journals, web pages and other literature on constructivist approach. The reaction scale was developed to study the reaction of pupil teachers towards the constructivist approach. The scale includes the dimensions like students’ interest in teaching and learning through constructivist approach, classroom situation, comparison of constructivist approach to traditional approach, use of aid practicability of constructivist approach.
3.4.1.3 Types of test items-

The present reaction scale is a five point scale. Responses categories are; strongly agree (SA), Agree (A) Undecided (U), Disagree (D) and Strongly Disagree (SD). In these response categories the subject is required to select the most appropriate response category indicating his/her reaction.

3.4.1.4 Preparation of first draft of the Reaction scale towards the constructivist approach.

The preliminary draft consisted of 35 items on different dimensions. Out of 35 items, 31 were positive items and 4 were negative items.

3.4.1.5 Experts' opinion.

The first draft containing 35 items was given to thirteen experts for their opinion. As the aim of scale is to measure reaction of pupil teachers towards the constructivist approach, it was pertinent to choose experts from related field such as faculty members of different departments of university and teacher educators. Scale along with the objectives was given to all the experts. The experts were requested to modify, change, delete or add any item, which they considered as irrelevant and vague or not measuring the dimension under which it has been put.

The experts finally gave their suggestions. Experts' responses and suggestions were taken into consideration while giving the final shape to the reaction scale.

3.4.1.6 Editing-Modification.

On the basis of experts' suggestions, the first draft of reaction scale towards the constructivist approach was modified; the revised draft of reaction scale had 30 items.
3.4.1.7 Try out of the Reaction scale towards the constructivist approach.

To ensure the suitability of the second draft of reaction scale to measure the reaction of pupil teachers towards the constructivist approach, it was tried out on 30 pupil teachers of Biology group of B.Ed. level. During administration, the researcher enquired about the difficulties in understanding the items. On the basis of their response few test items were further reconstructed.

3.4.1.8 Final Draft of the Reaction scale towards the constructivist approach.

After making necessary modifications, the final draft of reaction scale was prepared, which had 30 items, belonging to different areas of educationists reactions towards the constructivist approach.

3.4.1.9 Reliability of the Reaction scale towards the constructivist approach.

Reliability refers to the consistency of measurements. To determine the reliability of reaction scale test-retest method was used. The final draft of reaction scale was administered on a group of 30 pupil teachers of Biology group. The test was again administered on the same sample after 2 months. The coefficient of reliability was computed by correlation between first scores and second scores. The value of the reliability coefficient of reaction scale is +0.61. The reliability coefficient was found to be significance at 0.01 level of significance, so it can be inferred on the basis of reliability coefficient that scale is reliable.

3.4.1.10 Validity of the reaction scale towards the constructivist approach.

The validity of the test means, that each items of the test must measure what it intended to measure. Validity of test also enhances its dependability and applicability. The validity
also provides a direct check on how well test fulfils its functions. The reaction scale confirms its content validity because it was developed by using proper steps of tools construction.

In the scale for measuring reaction, content validity was considered of great importance because no other relevant and comparable criteria could be available. Content validity is often seen as a prerequisite to criterion validity, because it is a good indicator of whether the desired trait is measured. If elements of the test are irrelevant to the main construct, then they are measuring something else completely, creating potential bias.

3.4.1.11 TIME LIMITS

There was no specific time limit for this test but 20-25 minutes are sufficient to complete the test.

3.4.2. DEVELOPMENT OF WILLINGNESS SCALE FOR IMPLEMENTATION OF THE CONSTRUCTIVIST APPROACH

3.4.2.1 Survey of the related tools for measuring the willingness towards the constructivist approach.

In order to obtain reliable and valid results, the selection or development of appropriate tool is the primary condition in research work. The investigator surveyed the tests available in the field of constructivist approach but could not find any suitable tools for measuring the willingness of pupil teacher towards the constructivist approach. Hence, the investigator decided to construct the required test of his own. Investigator developed the willingness scale towards the constructivist approach in the following steps.
3.4.2.2 Deciding the areas for willingness scale.

For developing the willingness scale, researcher consulted various reference materials such as books, research reports, educational journal and other literature related with discipline of education. This scale covers many aspects, like planning of lesson, classroom interaction, utility of developed instructional material, comparison of traditional and constructivist approach, interest of pupil teachers to apply constructivist approach, pupil teacher’s interest in constructivist classroom teaching, and feasibility of constructivist approach for classroom teaching.

3.4.2.3 Types of test items.

Present willingness scale is a five point scale. In this scale every item is in statement form. Both positive and negative statements are included in the scale to add variety and reduce the pupil teacher tendency to report as per functionally. Five response categories are provided for responding to every item. These are; strongly agree (SA), Agree (A) Undecided (U), Disagree (D) and Strongly Disagree (SD). In these response categories the subject is required to select the most appropriate response category indicating his/her willingness for implementation of constructivist approach in his/her classroom.

3.4.2.4 Preparation of first draft of willingness scale towards the constructivist approach.

Preliminary draft consists of 32 items on different dimensions and 28 items are positive and out of these 4 items are negative.

3.4.2.5 Expert opinion.

The first draft containing 32 items was given to fifteen experts for their suggestions. As the scale is to measure willingness for implementation of constructivist approach, it was
pertinent to choose judges from related field. All the experts were requested to feel free to add, modify, delete and change any items which they consider is irrelevant or vague or not measuring the dimension under which it has been put.

3.4.2.6 Try out of the willingness Scale towards the constructivist approach.

The preliminary draft containing the selected items was administered on 25 units of sample. The language problem was found in reaction scale so certain modifications were made in the language of some item to make them free from ambiguities and complexity.

3.4.2.7 Final Draft of willingness Scale towards the constructivist approach.

On the basis of tryout and suggestion given by the experts some changes were made. On the basis of opinion of the experts, nine items were dropped, four new items were added and language of ten items was rectified, so final draft consisted of 30 items, distributed into six dimensions. Final draft also consists of general information and clear cut instruction for respondents.

3.4.2.8 Reliability of willingness scale towards the constructivist approach.

For determining the reliability of the present willingness scale the test-retest reliability was measured by calculating coefficient of correlation between two sets of scores achieved from the two time administration of the scale. The willingness scale was administered on same students after an interval of one month. The co-efficient of correlation was calculated between the two sets of scores by using Pearson’s Product Moment Method which was found +. 85.
3.4.2.8 Validity of willingness Scale towards the constructivist approach.

In case of present scale, for measuring willingness for implementation of constructivist approach, the content validity was considered of great importance because no other relevant and comparable criteria could be available. Content validity is often seen as a prerequisite to criterion validity, because it is a good indicator of whether the desired trait is measured. If elements of the test are irrelevant to the main construct, then they are measuring something else completely, creating potential bias. Thus the investigator had to depend largely on the content validity of the test. He/ She had to be satisfied with what ever evidences were obtained through the expert opinion for purpose. The test was given to 15 expert of D.E.I. Agra, to read and judge whether each item of the test measured different areas of constructivist approach.

3.4.3. ACHIEVEMENT TEST

John W Best (1977) states that test of ability or achievement attempts to measure what an individual has learnt and his present level of performance. Achievement test scores are used in evaluating the influence of course of study, teacher’s teaching method and other factors considered to be significant in educational practice. The test was developed to measure the level of achievement of students of Biology taught through traditional & Constructivist approach.

3.4.3.1 Preparation of the First Draft of Achievement test.

The first draft of the tools was developed in consultation with the experts in the field of Biology and measurements & evaluation.

The main purpose of this discussion with expert was to obtain their suggestion with respect to.
1. Inclusion of any other items in tool if possible.
2. Deletion of any items which are not relevant.
3. Omission of any items which are not relevant.
4. Examination of the distribution of marks among the items of achievement tests getting suggestion for improvement.
5. Examination of the scoring method.
6. Examination of the relationship between the items and the objectives.

3.4.3.2 Preparation of test items.

Taking decision about the various units & objective types of items the researcher collected the test items, and statement from a prescribed books of class XI. For selection of the various test items the following consideration were kept in mind.

1. Items were selected from entire range of the selected topics of Biology.
2. In framing the items the emphasis was placed on the knowledge understanding & application of facts, concepts, principles, laws as such related to the subject under the study.
   1. Up-to-date fact and information were taken into consideration.
   2. The items were selected in order of increasing complexity.

3.4.3.3 The first draft of Achievement test.

Initially 68 items were selected in first draft. The first draft included the all the multiple choice questions, the items were drafted in the form of multiple answer.

3.4.3.4 Expert opinion. After drafting first draft, experts' opinion were sought so as to judge the appropriateness and suitability of test items as well as to invite their suggestions for affecting improvement in the test. The following experts were considered.
1. The teachers who were teaching the subject of Biology at higher secondary level.
2. The teachers teaching Biology method at secondary teacher Training level.
3. The psychologists and educationist working in the university as experts in test construction.
4. On the basis of the suggestions given by various experts the changes were made in the test.

3.4.3.5 The Pilot Testing of Achievement Test.

Pilot study was conducted to ensure that the test developed could effectively reflect the level of achievement of the students of the respective classes and also to ensure the feasibility of test administration, the language used instructions number of items, total time requirement and such other factors. The achievement tests were administered on a small group of 30 students.

The investigator felt that administration of Biology achievement test in English would cause difficulty. Hence the investigator drafted that test in both languages, English as well as Hindi. The students were encouraged to express any difficulty faced in understanding the specific item in the test or instructions given. All the observations were properly recorded.

3.4.3.6 Item analysis of Achievement test.

Item analysis is very essential in test construction. For any test, Item analysis means analyzing each item of the test for its adequacy. Since the purpose of the test was not to prepare a standardized test therefore, a rigorous procedure of item analysis was not followed for the test under preparation in the present frame of reference. The item analysis was made keeping in view of the ambiguity and complexity of test items.
Following modifications were made in the tool.

1. The language in some items was simplified.
2. Some items were deleted.
3. Some of the items were modified.
4. Instructions were made clearer.

3.4.3.7 Preparation of the final draft of Achievement test.

After making the necessary modifications and relevant changes in the item, those were rearranged in the final draft of achievement test. Number of items in the final draft of achievement test is 50. The duration to complete the test was fixed to 40 minutes.

3.4.3.8 Scoring procedure of Achievement test.

Whole achievement test consists of 50 objectives type questions. For objective type test items, score one was assigned for correct answer of each item, while zero was assigned for each wrong response. It is learnt from the above that distribution of marks for each item is same and maximum marks for this test are 50.

3.4.3.9 Reliability of achievement test.

The second most important characteristic of measuring tool is reliability. Green (1955) says "a test is said to be reliable when it functions consistently so in other words reliability means consistency or accuracy to which tests agree with itself". A test cannot be valid unless it is reliable but it may be reliable without being valid. Regarding the method of establishing reliability of test Mouly (1970), says that "test-re-test method is only feasible approach for establishment of the reliability of the test".

After preparing the final draft of achievement test, the investigator administered the achievement test on a sample of 25 students of XI grade. Scoring was done according to...
the scoring key. After fifteen days the test was re-administered on the same sample. Scoring was done again using the scoring keys.

The degree to which a test is reliable can be represented by a coefficient of reliability. The investigator therefore, correlated the two sets of scores by Product Movement Method. The value of "r" was found .76; this shows that the test is reliable.

3.4.3.10 Validity of the Achievement test.

Validity of a data gathered refers to the degree to which it measures what it was intended to measure. Before using any measuring device, its validity must be assessed; otherwise the effort will prove futile. In general a test is valid if it measure what it claims to measure. Validity can also be thought of as utility.

World (1970), "the validity defines a degree to which it is intended in effect, this definition says that there are many different kinds of test validity. As the purpose of the test changes, so does the degree to which it is valid. A test may be highly valid for purpose and, moderately valid for other purpose, and totally invalid for still other purposes. A clear picture of this must be examined before proper administration and interpretation take place.

Achievement test was constructed in proper procedure. The content selected for the test was decided by content analysis of instructional material developed by researcher. Thus present test covers the entire content of instructional material, secondly the test is constructed keeping in mind the objectives of research therefore the present test consists of construct validity.
3.5. ADMINISTRATION OF THE VARIOUS TOOLS

In order to administer the tools for data collection, researcher first approached the Dean, Faculty of Education DEI & the Principal of respective college and introduced himself, explained the purpose of his study and sought permission for data collection. After getting the permission from the Dean and the Principle researcher administered the tools. The data collection was done according to the planned schedule. Intermediately gaps were given to maintain the curiosity and interest of the students as well as to compensate the unseen situations.

Before starting the administration of the tools, proper seating arrangement was made and students were asked to sit at ease. The researcher introduced himself to the students & pupil teachers, explained propose of data collection and gave a short orientation about the task to be done, students were motivated to take interest in responding the to developed tools.

3.5.1 Administration of Reaction Scale towards the Constructivist Approach.

Reaction Scale was administered in group after making clear instructions, the pupil teachers were asked to start to answer the questions of the scale. There was no time limit of the scale, but the pupil teachers finished their work within 20 minutes and submitted the scale to researcher. Researcher thanked and assured them that collected data will be used for research purpose only.

3.5.2 Administration of Willingness Scale towards the constructivist approach.

Willingness scale was given to the pupil teachers. The researcher read out the instructions loudly before the pupil teachers and made it clear that there was no time
limit for the willingness scale but the test would take about 20 minutes. As soon as the pupil teachers completed their work, the test paper answer sheets were collected.

3.5.3 Administration of Group Intelligence Test.

Intelligence test was administered to equate the experimental & controlled group in on some criterion variable. Necessary instructions were given to the students about the test. The time required for the test was 20 minutes.

3.5.4 Administration of Achievement Test.

Achievement test was administered on XI grade students twice in experimental and controlled group at pre and post stage. Necessary instructions were given to the students by the researcher about the test. There was no time limit for the test, however about 20-30 minutes were assumed to complete the test. Students were asked to answer every item. As soon as the students completed their work the answer sheets were collected.

3.6. SCORING PROCEDURE OF THE VARIOUS TOOLS.

After the administration of various tools scoring was done according to the instructions given in the manual of tools, scoring procedure were as follows.

3.6.1 Scoring of the Group Intelligence Test.

For scoring the test, instructions given in the manual were followed. In scoring credit of one point was given for each correct answer, zero for each incorrect answer, no mark was deducted for wrong answer. Scoring keys were used to assess the responses. The number of correct answers was counted which served as the raw scores of a subject.
3.6.2 Scoring of Reaction Scale towards the constructivist approach.

Reaction scale is in the form of 5 point rating scale. In reaction scale, against each statement or question five choices were provided 5 squares were given in the statement form. Repsonse categories are strongly agree (SA), Agree (A) Undecided (U), Disagree (D) and Strongly Disagree (SD). In these response categories the subject is required to select the most appropriate indicating his/her reaction. But for negative items in this scale the scoring is done in reverse manner.

<table>
<thead>
<tr>
<th>Responses category</th>
<th>Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree (SA)</td>
<td>5</td>
</tr>
<tr>
<td>Agree (A)</td>
<td>4</td>
</tr>
<tr>
<td>Undecided (U)</td>
<td>3</td>
</tr>
<tr>
<td>Disagree (D)</td>
<td>2</td>
</tr>
<tr>
<td>Strongly Disagree (SD)</td>
<td>1</td>
</tr>
</tbody>
</table>

3.6.3 Scoring of Willingness Scale towards the constructivist approach

Willingness scale is also a five point rating scale and it also contains statement form questions and scoring method is followed as given in the reaction scale.

3.6.4 Scoring of Achievement Test.

This test was administered at pre and post levels of implementation of instructional material. It had objective type questions. One mark was assigned for correct response and zero was awarded for incorrect answers. There was no provision of minus marking
3.7 **Procedure of the study.** Following procedure was adopted in the present study.

![Diagram of procedure]

**Fig. -3.5 Procedure of the study**
3.7.1 Content Analysis of Biology Text Book In View Of Constructivist Approach.

Before developing instructional material researcher had to decide some topics of class XI Biology text book. Text book of Biology, written by Dr. Ramesh Gupta was considered for content analysis. On the basis of the selected topics researcher had to make some lesson plans. Therefore, investigator selected some topic from XI Biology text book. These topics cover almost all the units of the book. The list of selected topics is given in the appendix of the thesis.

3.7.1.1 Steps of Content analysis

(a) Mention of facts.

The first step in the process of content analysis is the mentioning important facts. Only those facts should be mentioned which are useful in the solution of the problem. Irrelevant facts should not be mentioned since they hinders the function of analysis and adversely affects its objectivity. Analysis based upon relevant facts makes it easy to prepare tables.

(b) Formation of Tables.

In order to make content analysis simple and scientific several types of tables are used in it. These tables are prepared before their actual use. During the course of analysis it facilitates noting of facts in proper places, besides this, the use of tables makes it improbable to miss any fact concerned with the analysis. These tables again make it easy to classify facts.

(c) Formation of the outlines of study.

After the preparation of tables, an outline of the study is prepared. For this purpose the concerned variables are noted down in a list. After it, on the basis of different variables,
facts are coded in the process of determination of variables and coding of facts, the researcher gets help from the information extended by the respondents.

(d) Formation of classes.

This is the next step after preparation of the list of variables since classes or categories are fixed on the basis of variables. The classes should be sufficient in number so that different facts may be classified in different categories. Each variable should be placed in a different class. A class should not include two or more variables.

(e) Deciding the Method of study.

The decision concerning the proper methods of study is very important in any Educational research. It requires a deep insight in the subject. The same methods should be consistently adhered to in the entire course of research.

(f) Formation of Definitions.

All the variables and categories to be used in a study should be clearly defined. This improves the objectivity and exactness of a study. Besides the definitions help us in determination of the validity of study. Again the definitions make the function of analysis easy and simple.

(g) Use of the Adopted Method.

The last step in the process of content analysis is the actual use of the adopted method. This should be done according to the nature of study minor modifications may be made whenever required.

3.7.2 DEVELOPMENT OF INSTRUCTIONAL MATERIAL

Researcher developed instructional material based on constructivist approach in the following steps.

(a) Content analysis.

(b) Selection of topics appropriated for constructivist approach after introductory analysis of class XI Biology text book.

(c) Preparation of lesson plans based on constructivist approach
Chapter III Plan and Procedure of the study

Fig. 3.6 Steps of development of instructional material
The philosophy about learning that proposes learners need to build their own understanding of new ideas has been labeled constructivism. Many psychologists such as Jean Piaget, Elearnor Duckworth, George Hein and Howard Gardener have explored these ideas in depth. In Biological Science Curriculum Study (BSCS) (a) test whose principal investigator is Roger By bee, developed an instructional model for constructivism called the "Five Es".

3.7.3. The BSCS 5E Instructional Model

3.7.3.1 Engage

These experiences mentally engage the students with an event or question. Engagement Activities help students to make connections with what they know and can do. During the Engagement phase, the teacher can:

• Create a need to know/create an interest
• Assess prior knowledge
• Focus on a problem/ask questions

3.7.3.2 Explore

Students work with one another to explore ideas through hands-on activities. Under the Guidance of the teacher, students experience a common set of experiences that helps them clarify their own understanding of major concepts and skills. During the exploration Phase, the students:

• Investigate
• Develop awareness/practice skills
• Design, plan, build models, collect data
<table>
<thead>
<tr>
<th>5ES</th>
<th><strong>SUGGESTED ACTIVITY</strong></th>
<th><strong>WHAT THE TEACHER DOES</strong></th>
<th><strong>WHAT THE STUDENT DOES</strong></th>
</tr>
</thead>
</table>
| **Engage** | ➢ Demonstration  
➢ Reading  
➢ Free Write  
➢ Analyze a Graphic Organizer  
➢ KWL  
➢ Brainstorming | ➢ Creates interest.  
➢ Generates curiosity.  
➢ Raises questions.  
➢ Elicits responses that uncover what the students know or think about the concept/topic. | ➢ Asks questions such as, Why did this happen? What do I already know about this? What can I Found out about this?  
➢ Shows interest in the topic. |
| **Explore** | ➢ Perform an Investigation  
➢ Read Authentic Resources to Collect Information  
➢ Solve a Problem  
➢ Construct a Model | ➢ Encourages the students to work together without direct instruction from the teacher.  
➢ Observes and listens to the Students as they interact.  
➢ Asks probing questions to redirect the students’ investigations when necessary.  
➢ Provides time for students to puzzle through problems. | ➢ Thinks freely but within the limits of the activity.  
➢ Tests predictions and hypotheses.  
➢ Forms new predictions and hypotheses.  
➢ Tries alternatives and discusses them with others.  
➢ Records observations and ideas.  
➢ Suspend judgment. |
| **Explain** | ➢ Student Analysis & Explanation  
➢ Supporting Ideas with Evidence  
➢ Structured Questioning  
➢ Reading and Discussion  
➢ Teacher Explanation  
➢ Thinking Skill Activities (compare, classify, error analysis) | ➢ Encourages the students to explain concepts and definitions in their own words.  
➢ Asks for justification (evidence) and clarification from students.  
➢ Formally provides definitions, explanations, and new labels.  
➢ Uses students’ previous experiences as basis for explaining concepts. | ➢ Explains possible solutions or answers to others.  
➢ Listens officially to others’ explanations.  
➢ Questions others’ Explanations.  
➢ Listens to and tries to comprehend explanations the teacher offers.  
➢ Refers to previous activities.  
➢ Uses recorded observations in explanations. |
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Table 3.4- 5 E Activities

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Amit Gautam
• Test predictions and form new predictions

3.7.3.3 Explain

Students explain their understanding of the concepts and processes they are learning. Teacher helps the students to clarify their understanding and introduce information related to the concepts to be learned. During the explanation phase, teachers and students:
• Clarify understanding
• Define concepts or terms
• Share understanding for feedback
• Listen critically to one another
• Form generalizations
• Refer to previous activities

3.7.3.2 Elaborate

These activities challenge students to apply what they have learned and extend their knowledge and skills. During the elaboration phase, students
• Build on their understanding of concepts
• Use knowledge of concepts to investigate further—extension
• Apply explanations and skills to new, but similar, situations
• Provide practice and reinforcement—application

3.7.3.2 Evaluate

Students assess their own knowledge, skills, and abilities. Evaluation activities also allow teachers to evaluate students’ progress. During the evaluation phase, students
• Draw conclusions using evidence from previous experiences
3.7.4. Preparation of lesson plan based on Traditional approach.

In this phase researcher developed lesson plans based on traditional approach on Bloom’s approach. Daily lesson planning as the name suggested, is the planning made for the instructional work carried out by the teacher on a day to day basis. However the term daily lesson planning is not much in use, it has been replaced by the term lesson planning for conveying the same meaning. The duties of a teacher demands from him actual classroom teaching. He has to teach daily one or more subject to one or more classes in his school.

In simple word lesson planning means planning the daily lesson related with a particular unit of a subject to be covered by the entire teacher in a specific school period for the realization of some stipulated instructional objectives. It is a kind of
Chapter - III Plan and Procedure of the study

theoretical chalking out of the detail of a journey which a teacher is going to perform practically in a classroom, along with his students. In the field of lesson planning, bloom's approach is quite popular it is the outcome of the idea propagated by B.S Bloom in relation to the teaching learning process. According to Bloom "education may be regarded as a popular process involving educational objectives, learning experiences and evaluation devices."

Bloom's evaluation approach and lesson planning.

The Bloom's evaluation approach consists of the following systematic steps for the lesson planning.

- Content of teaching points- in the first column of lesson planning, the subject matter or content is written in the form of main teaching points.

- objectives specifications- it concerns with the writing of educational and instructional objectives in clear end conserve behavioral terms

- Teaching activities- in the column of lesson planning all those activities are mentioned which a teacher will perform for the realization of the stipulated objectives.

- Students' activities- the activities undertaken by the students by the realization of teaching learning objectives are mentioned.

- Teaching aids- different types of teaching aids used for providing desirable teaching learning experience are mentioned in the step.

- Evaluation- in this step of lesson planning mentioned in evaluation technique or the device used for mentioned finding out. It aims at the extent to which stipulated objectives have been realized through the teaching learning act. The
result for such evaluation provides needed feedback to both students and the teacher for bringing desirable improvement in the process of teaching and learning.

Bloom’s approach is a good approach based on sound psychological principles and theories of teaching and learning. It provides for the proper statement for the proper objectives in behavioral terms. The students’ and teachers’ activities are mentioned separately and are related as well as integrated for the realization of the stipulated objectives.

3.7.4.1 Limitation of Bloom’s approach

Bloom’s approach has some demerits Limitations

- Bloom’s approach does not take into consideration the mental process and mental abilities for writing out of educational objectives.
- The approach makes the task of the lesson planning quite rigid and mechanical and this kills the initiation, originality and creativity of both the teacher as well as student.
- This approach is highly structured and demanded by the teacher’s role in the teaching learning process.
- The task of integration among objectives learning experience and evaluation devices demands greater responsibility on the part of the teacher and students.

3.7.4.2 Review of lesson plans by subject experts.

Prepared lesson plans were given to 5 experts of related field, all the expert were requested to feel free to make any correction and to give any suggestion. The format
and all related material was also given to them so that they can make comprehensive review in the developed lesson plans.

3.7.4.3 Modifications in lesson plans.
After review of lesson plans by the subject experts the lesson plans were modified in the light of their suggestion.

3.7.4.4 Try out of some lesson plan.
After the modifications the lesson plan were administered on the small group during the practice teaching of pupil teachers. The language problems were found in lesson plan so certain modifications were made in the lesson plans. Researcher also used some video related to constructivist and some ppts for teaching of these plans.

3.7.4.5 Preparation of final draft of the lesson plan.
The lesson plans were prepared in the final stage for their use in the real class situation

3.7.4.6 Phase II- Interactive phase.
In this phase researcher organized an orientation programme for the pupil teachers to see the effectiveness and reaction of pupil teachers towards the constructivist approach. Orientation schedule as given in annexure was followed by the researcher.
Phase II Interactive phase-Implementation of developed Instructional Material in orientation of pupil teachers

<table>
<thead>
<tr>
<th>Sample</th>
<th>Experimental Group</th>
<th>Controlled Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>Orientation of Constructivist Approach with the help of Developed Instructional Material.</td>
<td>Orientation of Constructivist Approach without the help of Developed Instructional Material.</td>
</tr>
<tr>
<td>Duration</td>
<td>10 periods (one period per day)</td>
<td>10 periods (one period per day)</td>
</tr>
<tr>
<td>Research Tool</td>
<td>1. Willingness Scale</td>
<td>1. Willingness Scale</td>
</tr>
<tr>
<td></td>
<td>2. Reaction Scale</td>
<td>2. Reaction Scale</td>
</tr>
<tr>
<td>Pupil Teachers N-20</td>
<td>Teaching by Pupil Teachers using Constructivist Approach in their Teaching Practicing School.</td>
<td>Pupil Teacher N-20</td>
</tr>
<tr>
<td></td>
<td>6 periods (2 periods for each approach)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Observation schedule</td>
<td></td>
</tr>
</tbody>
</table>

As pupil teachers were not much aware about the constructivist approach, pupil teachers were given an orientation about the constructivist approach. After this primary orientation the group was divided in two groups namely Experimental and Controlled groups.

So that the purpose of research; concepts of constructivist approach, importance of research can be made clear to them. This was a kind of primary orientation given to the participants of research for the purpose of set induction. After this primary orientation the group was divided into experimental and controlled. The groups were formed on the basis of even and odd assignment.
3.7.4.7 Experimental group.

After making two homogeneous groups of pupil teachers, researcher organized orientation programme which included what is constructivist approach? Pupil teachers showed their interest towards constructivist approach during this orientation programme. The experimental group was oriented about constructivist approach with the help of developed instructional material and was also explained all the steps of constructivist approach. After completing the orientation programme with the help of developed instructional material, researcher administered the Willingness Scale and reaction scale on the experimental group of pupil teacher. The Sample lesson plans developed on the basis of constructivist approach were also given to the students to use this approach in the class room in their teaching practicing school.

3.7.4.7 Controlled group.

The orientation programme was also conducted for this group. This programme included the orientation of constructivist approach without the help of developed instructional material and after completion of this programme the researcher administered Reaction Scale and Willingness Scale on the controlled group.

3.7.4.8 Phase III Post active phase.

The main aim of present phase is to assess of effectiveness of developed instructional material in classroom teaching at senior secondary school.
Phase III Post active phase—Assessment of effectiveness of developed Instructional material

<table>
<thead>
<tr>
<th>Sample</th>
<th>Treatment</th>
<th>Duration</th>
<th>Research Tool</th>
<th>Sample</th>
<th>Treatment</th>
<th>Duration</th>
<th>Research Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>School Students</td>
<td>Theoretical Exposure of Constructivist Approach</td>
<td>30 period (2 period per day)</td>
<td>Pre test (Achievement test)</td>
<td>School Students</td>
<td>No exposure of Constructivist Approach Teaching through Traditional Methods</td>
<td>30 period (2 period per day)</td>
<td>Pre test (Achievement test)</td>
</tr>
<tr>
<td>N=30</td>
<td>Teaching with the help of developed Instructional Material Based on Constructivist Approach.</td>
<td></td>
<td>Post test (Achievement test)</td>
<td>N=30</td>
<td></td>
<td></td>
<td>Post test Achievement test</td>
</tr>
</tbody>
</table>

3.7.4.10 Assessment of effectiveness of developed Instructional Material

After Administration of Intelligence test on school students, Researcher divided Biology students in two Homogeneous groups on the basis of the Intelligence test score. Thus the 60 students were divided in experimental and controlled group as per below given details

<table>
<thead>
<tr>
<th>Experimental Group</th>
<th>Controlled Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 School students</td>
<td>30 School Students</td>
</tr>
</tbody>
</table>

3.7.4.11 Treatment Given to Experimental Group

Experimental group was given orientation of constructivism approach after that the group was taught 12 lessons using the developed instructional material on constructivism approach. At the end achievement test was administered on the group.
3.7.4.12 Treatment Given to Controlled Group.

Controlled group of XI grade bio students was not given any orientation of constructivist approach and they were taught the same 12 lessons (developed on Bloom’s approach) covering the same content. At the end achievement test was administered on the controlled group.

3.8 STATISTICAL TECHNIQUES

Descriptive and inferential statistical techniques were used to analyses the data.

3.8.1 Descriptive Statistics.

Certain descriptive statistical techniques were applied to describe the nature and distribution of scores obtained through various tests. These were:

3.8.1.1-Mean.

The mean values were computed as a measure of central tendency of the distribution of scores of various variables. It was also used to compare the two group.

3.8.1.2-Standard Deviation.

This statistical technique was used for studying the variability in the scores and for calculating critical ratio.

3.8.1.3- Frequency Polygon.

Frequency Polygons were plotted to study the nature of distribution of scores as well as their scatterdness or concentration towards the mean in the sample as well as in the population.

3.8.1.4-Bar Diagram.

The bar diagrams were drawn to compare the degree (magnitude) of score of various variables.
3.8.2 INFERENTIAL STATISTICS

The following statistics were used in the present study to draw conclusions on the basis of the obtained results.

3.8.2.1 - Critical Ratio.

Critical Ratio was computed to know the significance of difference of mean of two groups.

3.8.2.2 - Coefficient of correlation.

The value of coefficient of correlation was computed mainly between various sets of scores to study the relationship between the dependent and independent variables.