CHAPTER-III

RESEARCH DESIGN OF THE STUDY

Research or re-searching is a logical, objective and formal application of scientific attitude for the search of a new and much useful, productive and reliable knowledge founded by a well defined and proper systematic approach which can produce the same or similar known results, to solve the similar problematic situation, with equal perfection each and every time it is applied to do so. In achieving the reliable procedure, on to which any one can rely on again and again, one has to follow well defined and systematic procedure to solve the problem, which at last produces a method or technique which ensure solution to that problem or the similar one, by creating known similar solution to the problem. Research design is a systematic procedure adopted by a researcher so that the result obtained by the study conducted can be reliable enough to attain solution to the same problem, if faced in the future or in production of similar product again if basic norms of research method are followed utmost care to solve the problem or to investigate for some result. In simple words, research design is a mapping strategies which includes systematic framing of objectives of investigation, procedure involved for collection of evidences (data), analysis of evidences found and reporting in for findings as per objectives of research were frame, which accounts in for better reliability and validity of the findings reported by the study.

Thus, it can be inferred that research design is a systemic and well defined plan and procedure of study that has to be followed by the researcher for collection and analysis of data so that the objectives of the research may be achieved accurately, efficiently and economically as possible as it can. It can be defined as an arrangement of pre-defined conditions for collection and analysis of data in such a manner that aims to combine relevance to the research purposes with minimum flaw and economy in procedure of research. Best (1989, p.36) defined research design as;

Research design is comparable to the blue print, which the architect prepares before the bids are let and buildings commence. The initial draft proposal is subject to modification in the light of analysis by the student and his or her project adviser.
McMillan (1989, p.30) described the importance of research design as:

Research design refers to the plan and structure of the investigation used to obtain evidence to answer research questions. The design describes the procedure for conducting the study, including when, from whom and under what condition the data will be obtained.

The Research design or the proper research strategy in the field of research forms the foundation upon which all future work can be built. A design of research does not only consist of an ordered sequential step-by-step procedure but it can also be considered as the planning stage of research in which obtained certain desirable solution or result is usually made more logical by visualising its practicability and efficiency in producing the same, known result with equal exactness, as it is expected by previous experiences. The selection of research procedure or the methodology to follow is decided keeping the close eye on the objective of research or the expected result which is desired by following it. This objective of selecting or testing the method is achieved by formulating appropriate research hypothesis which also provides a base to the design and test the research work. Research design stands for advance planning of the method to be adopted for collecting the relevant data and the techniques to be used in its analyses, keeping in view the objectives of research and availability of staff, time and money. (Kothari 1990, p.45)

In the simplest terms, research design is a research strategy which maximises the efficiency or desired results by minimum possible effort or chance of failures. It can be defined not only as a method of clarification of working procedure, tools or technique involved or procedure to obtain and to interpret obtained result, but also as a precautionary method to provide knowledge and clarify the risk and general chance of errors involved in the methodology to be taken in consideration of research, so as to minimise the chance of error in it. Research design involves several steps which describes and provide detail to each and step followed by the researcher from basic formation of objectives, hypothesis, data collection, analyzing the data, interpretation of data and proper reporting and application the findings of the research so that it may be used by the mass population with equal efficiency. Following are the various aspects of the research design which have been followed by the researcher in the present study:
3.1 METHODS USED IN INVESTIGATION

Research is initiated with the process of defining the problem and when the problem is well defined, it becomes necessary to adopt a suitable method which would be appropriate to solve the objective of the research with maximum accuracy and approach that can be later on adopted in solving such problem or similar problem with the known or desired results. In research field, method adopted to test the hypothesis should consist of procedure of formulation of problem, defining its objectives to which the research is going to be conducted, defining of the important terms and validation of the tools for data collection and their analysis and interpretation in simpler context so that it can be generalized and can be used in similar kind of research or solving similar problems in research field. Generally following methods of researches are used frequently in conducting the researches in educational field:

1) Historical method.
2) Experimental method.
3) Descriptive method.

3.1.1 Historical Method - Historical research attempts to conduct a research on the events of history which are beneficial in one form or another to the present generation too. The objective historical research includes collecting relevant information from the various relevant sources, keeping in mind the objectives for which it is been collected and unlike other methods of research methods established facts and findings to some context are interrelated and validated with most probable causes and consequences which results into establishment of the fact concerning to
that event and also the most probable suggestion which can be a actual probability for establishment of some other theory or fact. This is usually conducted by the supported interpretation of existing facts by relevant literature of that time which can be more authentic and appropriate to describe the historical event to reach for any more synthesised and appropriate theory which can be more relevant in present time.

3.1.2 **Experimentation Method** -Experimental Method of research includes as orderly procedure of conducting experiment such that the new experiences may be achieved with the proper completion of goal of verifying, refuting or establishment of formulated research hypothesis which can interpret some relevant conclusion, which may not only be useful to the persons included in concerning field only, but also to majority of general people, so that it may enable them to solve out or to adjust them in the changing situations of life. Experimental approach of research provides ample control and establishes a systematic and logical association and interrelation in between the manipulated and observed factors to reach in for some specific conclusion.

There remains simple experience which if taken as it comes, is called accident and if it is sought for, experiment. The true method of experience first lights the candle (hypothesis) and by means of that candle shows the way (arranges and delimits the experiment), commencing as it does with experience duly ordered to digested, not bungling or erratic and form it deducing axioms (theories) and from established axioms to new experiment (*Francis Bacon, 1620*). Experimental method is a strong method to develop the insight to observe and to evaluate causal-effect relationship in between various factors or variables involved in any study where relevant outcome is noticed when the treated variables are either regulated or observed and manipulated to explore effect of that manipulator or its impact on any other factor or variable.

3.1.3 **Descriptive Method** -Descriptive method or research is generally used to describe characteristics of a population or a phenomenon which is to be studied under certain circumstances or situations. Descriptive research methodology does not answer to the question about how/when/why any character occurred in nature or any phenomenon took place in nature, rather it primarily concerns about the ‘what’ aspect of any phenomenon or character. Descriptive method can also be used as a method to determine the status of any phenomenon under any investigation or research.
Thus, descriptive researches can be assumed more realistic in approach and covers much more research area what the experimental research does. This method of research basically includes description about any phenomenon or event without any factual manipulation into it and thus, these types of researches are found to be of more use to the future researchers. These type of researches are frequently been used as a basis of causal-effect relationship, where one variable affects the other variable at one extent or another and this effect is been described in these researches. That is, these researches although possess low validity aspect in them but can be used frequently in differential conditions understanding the creative use of facts or findings proposed by these researches directly or indirectly.

The field of humanistic sciences or education, also contains unnoticeable and change prone qualities which are hard to estimate and even harder to interpret into some universally accepted law or truth, hence advantages of using descriptive research methods are found to be more successful and appropriate in the field of education. The present study is also an exploratory, descriptive study which deals with the investigation of relationship of Scientific Creativity of XI grade students with their Intelligence, Personality and Study Habits classified further on internal categorization of predictor variables and on gender of sample included in the study. To solve the purpose of this study a large sample was required to determine the Scientific Creativity of XI grade students. Hence, the present study adopted ‘Normative Survey Method’ type of descriptive research, which includes attempts to describe and interpret what exists at present in the form of conditions, practices, processes, trends, effects, attitudes and beliefs etc. As it was considered best for the present research problem hence, the same was adopted in the study.

3.2 POPULATION OF THE STUDY

The term ‘population’ refers to a well defined group of units or individual who have one or more characteristics in common that are of interest to the investigator. The population may be all the individuals of a particular type or more restricted part of the group. For the present study, all the full-time XI grade students of all the three geographical regions of Uttar Pradesh(viz. Eastern region, Central region and Western region) constituted the population of the study.

3.3 SAMPLING AND SAMPLING PROCEDUR

Sampling is a representative proportion of the population selected for
observation and analysis. The validity and reliability of the study depends on the extent to which the sample is true representative of the population. To study the whole population in order to arise at some generalization would be impracticable, if not possible. The process of sampling makes it possible to draw valid inferences or generalization on the basis of careful observation within a relatively small proportion of the population.

Miller (1977) has rightly pointed out that the essential requirement of any sample is that, it is a representative as possible of the population or universe from which it has been taken. As such, the present study is based on the data collected from the carefully selected representative sample. The sample was selected so as to match the requirements of the study and help in meeting with the purpose of the study. Ary-et-al. (1972) proposed a view that when the population consists of a number of subgroups or strata that may differ in the characteristic being studied, it is often desirable to use a form of sampling called **Stratified Random Sampling**.

The population of the present study may be conveniently stratified into following three strata from where the data of the study was collected:

1) Eastern Region of Uttar Pradesh.
2) Central Region of Uttar Pradesh.
3) Western Region of Uttar Pradesh.

Since, the students under these strata may differ from each other in terms of Scientific Creativity, Intelligence, Personality and Study habits, the **Stratified random sampling** method was judged as the best choice for selecting the subjects from the population. Since, the total number of secondary schools of these three regions was very large; therefore, it was difficult to collect data on such large sample. Hence, the investigator decided to draw a representative sample from this population of secondary school students, from schools under the affiliation of U.P. Board. Sampling was conducted in two stages, in the first stage; the investigator obtained a list of schools of both boys and girls secondary level schools affiliated under U.P. Board from all the three regions. In the second stage, male and female secondary school students were selected from the selected schools. For selecting the students, a list of all the secondary schools was prepared and on random selection basis 5-5 schools
from each region was selected to collect data. After selection of the schools, it was decided to include all the valid and complete available data from the students in the study. However, in some schools some teachers\administration did not cooperate, thus, the final number of students selected as the sample to collect data can be classified as below:

<table>
<thead>
<tr>
<th>Region</th>
<th>Students from District</th>
<th>Males</th>
<th>Females</th>
<th>Total Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern Region</td>
<td>Allahabad, Varanasi.</td>
<td>110</td>
<td>108</td>
<td>218</td>
</tr>
<tr>
<td>Central Region</td>
<td>Lucknow, Sitapur.</td>
<td>104</td>
<td>98</td>
<td>202</td>
</tr>
<tr>
<td>Western Region</td>
<td>Bareilly, Sahjahanpur.</td>
<td>101</td>
<td>96</td>
<td>197</td>
</tr>
<tr>
<td>Total</td>
<td>3x2 districts</td>
<td>315</td>
<td>302</td>
<td>617</td>
</tr>
</tbody>
</table>

A total of 617 secondary school students with biology in their science stream were selected as sample of the study and data was collected from them. This sample being sufficiently large and drawn in random manner may be reasonably considered representative of the total population of male and female secondary schools students constituting Eastern, Central and Western region of Uttar Pradesh.

3.4 VARIABLES

Variable or variate refers to such facts which can be measured directly in the quantitative terms and which varies in amount or magnitude. A variable is a feature or aspect of an event, function or process that by its presence and nature, affects some other events or process which is being studied, on basis of which further classification of dependent, independent, controlled or intervening variable are classified.

According to Kerlinger(1986), ‘Variable is a property that takes on different values.’

The present study involves three kinds of variables, which are as under:

1) Dependent Variable.
2) Independent Variable.
3) Controlled Variable.

1. **Dependent Variable**- According to Tuckman (1978), “**Dependent variable is that factor which is observed and measured to determine the effect of independent variable.**”

   In the present study, the dependent variable is Scientific Creativity of XI grade students, which will be measured by the standardized tool to assess scientific creativity of adolescence students of science stream, developed by K.S.Misra.

2. **Independent Variable** - According to Tuckman (1978), “**Independent variable is that factor which is measured, manipulated or selected by the investigator to determine its relationship to an observed phenomenon (dependent variable).**”

   Independent variable represents the input or causes that are to be tested to see their affect on dependent variables. In present study, following variables were selected and measured as independent variables:

   (A) **Intelligence**: Intelligence has been measured by the test of Verbal Intelligence (VIT) developed for adolescent students by R.K.Ojha and K.RayChowdhury.

   (B) **Personality**: Personality of secondary school students was estimated by the tool adopted by S.D.Kapoor (Form-A; Hindi version) originally constructed by Cattle for 16 personality factor (16PF) evaluation of adolescent students.

   (C) **Study Habits**: Study Habits of adolescent students was estimated by the Study Habit Inventory (SHI-MS) developed by M.Mukhopadhyay and D.N.Sansanwal.

3) **Controlled Variable**: All the variables in a situation or in a person cannot be satisfied at the same time. Some variables should be neutralized to guarantee that they will not have a differential or moderating effect on the dependent variable. A number of factors may affect the relationship between and independent and dependent
variable in a complex manner. In the study, students’scientific creativity may be affected by numbers of factors like locality, educational qualification of their parents, board in which they study etc. Therefore, in the present study board in which students of XI grade study was considered as the controlled variable. The board of their study has been controlled by restricted it to XI grade students of U.P. board only.

3.5 DESCRIPTION OF THE TOOLS USED

3.5.1 Test of Scientific Creativity—The standardized tool of Scientific Creativity developed by K.S.Misra, was used by the researcher which assess scientific creativity on the dimensions of Fluency, Flexibility, Originality and Inquisitiveness with the help of following five sub tests, namely:

1. Consequence Test.
2. Unusual Test.
3. Product Improvement Test.
4. Inquisitiveness Test.
5. Guess Cause Test.

Out of these five tests, first, second and fifth have two items each. And the maximum time limit for every test is three minutes and maximum time limit on the whole test is 15-20 minutes.

Scoring of the Test - These sub-tests were evaluated on the criteria of Fluency, Flexibility, Originality and Inquisitiveness. As there is no right or wrong responses in the test various factors on which evaluation of the responses marked should be kept in mind. Fluency in the test is represented by number of relevant and unrepeated ideas which any one can produce, the relevancy of fluency factor is judged on the basis of appropriateness of the response when considered in relation to once the test problem. Unrepeated idea in the test is the idea, which is used once in the test and is been expressed only once in its kind. Whereas flexibility, is the capability of any individual to produce various ideas and different thought in a given particular situation related to various fields. More the number of the thought aroused from various fields, more will be its flexibility. It is generally related to the number and variety of thoughts or ideas which any individual produces in order to find solution to
a problem.

Originality of the thoughts is represented by the uniqueness and the novelty of the response any individual produces in any problematic situation. Responses on their uniqueness in situation in test and to a certain ratio taken as sample size are treated to be original. Inquisitiveness of any individual according to the test is the ability to ask different questions about unfamiliar phenomenon and objects. Inquisitiveness donates to the keenness to know the unknown.

Reliability of the Test - The following are the details of mentioned and calculated reliability of sub test and overall test of Scientific creativity used to estimate scientific creativity of XI grade adolescent students:

Table-3.02

Table showing mentioned reliability of 5 Sub-testsof Scientific Creativity.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description of Sub-tests</th>
<th>Reliability coefficientof sub tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Consequence Test</td>
<td>0.57331</td>
</tr>
<tr>
<td>2.</td>
<td>Unusual Use Test</td>
<td>0.63180</td>
</tr>
<tr>
<td>3.</td>
<td>Product Improvement Test</td>
<td>0.78889</td>
</tr>
<tr>
<td>4.</td>
<td>Inquisitiveness Test</td>
<td>0.54169</td>
</tr>
<tr>
<td>5.</td>
<td>Guess Cause Test</td>
<td>0.50181</td>
</tr>
</tbody>
</table>

Table-3.03

Table showing estimated coefficient of reliability for the testof Scientific Creativity.

<table>
<thead>
<tr>
<th>Name of the test</th>
<th>Coefficient of test-retest reliability(2 months interval; n=370)</th>
<th>Coefficient of split half reliability.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test for Scientific Creativity.</td>
<td>Test : 0.71, Retest : 0.79</td>
<td>0.83</td>
</tr>
</tbody>
</table>
Table-3.04

Table showing mentioned validity of 5 Sub-test of Scientific Creativity Test.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description of Sub-tests.</th>
<th>Coefficient in the test. (mentioned)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Consequence Test.</td>
<td>0.69439*</td>
</tr>
<tr>
<td>2.</td>
<td>Unusual Use Test.</td>
<td>0.82054*</td>
</tr>
<tr>
<td>3.</td>
<td>Product Improvement Test.</td>
<td>0.80362*</td>
</tr>
<tr>
<td>4.</td>
<td>Inquisitiveness Test.</td>
<td>0.60316*</td>
</tr>
<tr>
<td>5.</td>
<td>Guess Cause Test.</td>
<td>0.71074*</td>
</tr>
</tbody>
</table>

(* significant at 0.01 level)

Validity of the test or procedure is a criterion which tells us about the degree to which a test measures the variable for which it is designed for. The researcher computed concurrent validity coefficients for the five sub-tests and overall test for scientific creativity which was estimated to be 0.78 on overall five subtests of the scientific creativity, which proved to be valid enough to use the test for estimation of scientific creativity of the sample involved in the study.

3.5.2 Test of Intelligence—The Verbal Intelligence Test (VIT) constructed by R.K.Ojha and K.Ray Chaudhary was used to estimate intelligence of the sample taken in the study. The overall test is divisible into eight sub-tests with different type of questions in it. Total of 112 questions are included in the standardized verbal intelligence test meant for age group of 13 to 20 years of age. Following table describes the sub tests included in VIT, number of questions included in it, reliability as mentioned in the test and split-half reliability of the test calculated by researcher:

Table-3.05

Table showing sub tests included in VIT, number of questions and mentioned reliability of the test:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Sub-tests</th>
<th>No. of Items</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Classification</td>
<td>15</td>
<td>0.81</td>
</tr>
</tbody>
</table>
### Table 3.06

Table showing calculated Coefficient of Reliabilities for Test for Intelligence (VIT).

<table>
<thead>
<tr>
<th>Name of the test</th>
<th>Coefficient of test-retest reliability (2 months interval; n=370)</th>
<th>Coefficient of split half reliability (n=370)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal test for Intelligence</td>
<td></td>
<td>0.70</td>
</tr>
<tr>
<td>Test</td>
<td>0.65</td>
<td></td>
</tr>
<tr>
<td>Retest</td>
<td>0.74</td>
<td></td>
</tr>
</tbody>
</table>

Validity of the test as mentioned in the test was found to be in between 0.310 to 0.574 level of validity which when estimated by concurrent method of validity estimation by researcher was found to be 0.71 which was found significantly valid for application of test to estimate Intelligence of XI grade students.

### 3.5.3. Test of Personality

The test of Personality was conducted with the help of 16-Personality-factor (16-PF) inventory adopted by S.D.Kapoor (Form-A, Hindi Version) and originally constructed by Cattell. Questionnaire contained 187 multiple choice questions (three multiple choice based) the most appropriate among the three options provided to subject, was to be marked as the answer on the answer sheet provided to subject. Answers marked on these answer-sheets were later evaluated with the help of two scoring/evaluating sheets, each of which evaluates for eight personality traits of the subject. Total 16 personality factors (16-PF) were examined by the questionnaire which are briefly described as follows:
Table-3.07

Table showing description of 16 personality-traits examined by the questionnaire in the study.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description of traits.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor A.</td>
<td>Schizothymia vs. Cyclothymia. Liking for people vs. Stubborn or Ego Strength vs. Dissatisfied Emotionally</td>
</tr>
<tr>
<td>Factor B.</td>
<td>Less Intelligent vs. More Intelligent; concrete thinking vs. bright, abstract thinking; low and high scholastic mental capability.</td>
</tr>
<tr>
<td>Factor C.</td>
<td>Affected by feelings vs. Emotionally stable. Capability for immediate integration and control of emotional impulse and bodily reactions vs. incapability.</td>
</tr>
<tr>
<td>Factor E.</td>
<td>Humble vs. Assertive.</td>
</tr>
<tr>
<td>Factor F.</td>
<td>Sober vs. Happy-go-lucky; surgency vs. desurgency or depressive anxiety; cheerfulness vs. restraint and worry resulting for inhibition consequent to exposure to punishment and deprivation.</td>
</tr>
<tr>
<td>Factor G.</td>
<td>Expedient vs. Conscientious; Character or Super-Ego Strength vs. Lack of internal Standards. Positive injunctions against idleness, neglect of responsibility etc vs. frivolity, emotional dependency and general spinelessness.</td>
</tr>
<tr>
<td>Factor H.</td>
<td>Shy vs. Venturesome; Adventurous, automatic, resilience vs. Inherent, withdrawn Schizothymia (Parmia vs. Threctia). Parasympathetic immunity to threat(hence casualness) vs. threat reactivity (associated with lower threshold.)</td>
</tr>
<tr>
<td>Factor I.</td>
<td>Tough minded vs. Tender minded; Emotional Sensitivity vs. Tough Maturity (Premsia vs. Harria).</td>
</tr>
<tr>
<td>Factor L.</td>
<td>Trusting vs. Suspicious Paranoid Schizothymia vs. Trustful Altruism (Protension vs. Inner relaxation,) Paranoid Projection and tension vs. absence of projecting tendencies and tension.</td>
</tr>
<tr>
<td>Factor M.</td>
<td>Practical vs. Imaginative; Hysteric Unconcern(or ‘Bohemianism’) vs. Practical Concernedness (Autia vs. Praxernia). Autonomous, self absorbed relaxation (attention to ideational over sensory stimulation) vs. incapacity to dissociate feelings or inadequacy.</td>
</tr>
<tr>
<td>Factor N.</td>
<td>Forthright vs. Shrewd; Sophistication vs. Rough simplicity (Shrewdness vs. Naivete). Quick, competent, realistic vs. vague, sentimental, incontinent.</td>
</tr>
</tbody>
</table>
Factor O.  Placid vs. Apprehensive; Anxious insecurity vs. Placid Self Confidence (Guilt Proneness vs. Confidence). Formally called free floating anxiety; timid, inadequate and self-abasing at positive pole.


Factor Q2.  Group Dependent vs. Self-Sufficient; Independent Self-Sufficiency vs. Lack of Resolution.

Factor Q3.  Undisciplined Self Conflict vs. Controlled; Will control and Character stability.

Factor Q4.  Relaxed vs. Tense; Nervous Tension.

Reliability of 16-PF Scale adopted by S.D.Kapoor—Reliability and Validity of 16-PF questionnaire was estimated before the final collection of data to cross-check its reliability and validity. The reliability and validity of 16 PF questionnaires can be summarized as follows:

Table-3.08

Table showing mentioned reliability of 16-PF questionnaire used in the study.

<table>
<thead>
<tr>
<th>Factors</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability</td>
<td>.83</td>
<td>.69</td>
<td>.73</td>
<td>.81</td>
<td>.86</td>
<td>.66</td>
<td>.79</td>
<td>.58</td>
<td>.62</td>
<td>.76</td>
<td>.62</td>
<td>.84</td>
<td>.58</td>
<td>.69</td>
<td>.59</td>
<td>.77</td>
</tr>
</tbody>
</table>

Table-3.09

Table showing calculated Coefficient of Reliabilities for 16-PF Personality Test.

<table>
<thead>
<tr>
<th>Name of the test</th>
<th>Coefficient of test-retest reliability(2 months interval; n=370)</th>
<th>Coefficient of split half reliability(n=370)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-PF Test.</td>
<td></td>
<td>0.87</td>
</tr>
<tr>
<td></td>
<td>Test</td>
<td>Retest</td>
</tr>
<tr>
<td></td>
<td>0.62</td>
<td>0.81</td>
</tr>
</tbody>
</table>

Validity of the 16-PF questionnaire used to estimate personality factor of the sample used in the study:
Table-3.10

Table to show mentioned Validity of 16-PF questionnaire used to estimate personality factor of the sample used in the study.

<table>
<thead>
<tr>
<th>Factors</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Validity</td>
<td>.92</td>
<td>.82</td>
<td>.85</td>
<td>.89</td>
<td>.93</td>
<td>.77</td>
<td>.89</td>
<td>.71</td>
<td>.74</td>
<td>.87</td>
<td>.74</td>
<td>.92</td>
<td>.70</td>
<td>.83</td>
<td>.72</td>
<td>.88</td>
</tr>
</tbody>
</table>

The validity consistencies as mentioned in the test range from 0.70 to 0.93. Researcher calculated concurrent validity for the test which was estimated to be 0.69, which was fair enough to use test for estimating personality factor of the sample used in the study.

3.5.4 Test of Study Habit–The Study Habit Inventory (SHI-MS), developed by M. Mukhopadhyay and D.N. Sansanwal was used in the study to estimate the study habits of the adolescence students taken as the sample in the study which includes 9 sub-tests which include 70 positive and negative items into it.

Scoring of the test: The test contains 70 items of which 52 are positive whereas 18 negative items are there in the test. All the responses are to be marked on the scale of always, frequently, sometimes, rarely and never which are to be scored with the following raw scores-

Table-3.11

Table showing marks allotted to response on nature of the item in the Study Habit Inventory (SHI-MS).

<table>
<thead>
<tr>
<th>Nature of the Items</th>
<th>Response given by the sample members.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Always</td>
</tr>
<tr>
<td>Positive Items</td>
<td>4</td>
</tr>
<tr>
<td>Negative Items</td>
<td>0</td>
</tr>
</tbody>
</table>

After scoring for every question in the inventory as mentioned above, all the marks provided to every responses of 70 questions were summed up to obtain the raw total for study habit of that particular student.
Reliability of the test for Study habits: The reliability coefficient as mentioned in the test was found to be 0.91. Whereas researcher founded reliability of the test 0.74 which was fairly high to consider the inventory to be reliable for study habit estimation of sample students. Reliability of the whole inventory was estimated by using split-half (even-odd) method.

**Table-3.12**

Table to show calculated Coefficient of Reliabilities for Test for Study habits.

<table>
<thead>
<tr>
<th>Name of the test</th>
<th>Coefficient of test-retest reliability(2 months interval; n=370)</th>
<th>Coefficient of split half reliability(n=370)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test for Study Habits(SHI-MS)</td>
<td>Test 0.73 Retest 0.84</td>
<td>0.74</td>
</tr>
</tbody>
</table>

Validity of the Study habit inventory (SHI-MS) used to estimate study habit factor of the sample used in the study:

**Table-3.13**

Table showing details of sub-test, number of questions included and mentioned validity of the subtests to estimate study habits.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Sub-tests</th>
<th>No. of Items</th>
<th>Mentioned Validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Comprehension</td>
<td>12</td>
<td>0.87*</td>
</tr>
<tr>
<td>2.</td>
<td>Concentration</td>
<td>10</td>
<td>0.49*</td>
</tr>
<tr>
<td>3.</td>
<td>Task Orientation</td>
<td>09</td>
<td>0.59*</td>
</tr>
<tr>
<td>4.</td>
<td>Study Sets</td>
<td>07</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Interaction</td>
<td>03</td>
<td>0.58*</td>
</tr>
<tr>
<td>6.</td>
<td>Drilling</td>
<td>04</td>
<td>0.55*</td>
</tr>
<tr>
<td>7.</td>
<td>Supports</td>
<td>22</td>
<td>0.59*</td>
</tr>
<tr>
<td>8.</td>
<td>Recording</td>
<td>02</td>
<td>0.50*</td>
</tr>
<tr>
<td>9.</td>
<td>Language</td>
<td>01</td>
<td>0.49*</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>70</td>
<td></td>
</tr>
</tbody>
</table>

(* significant at 0.01 level; Study sets can’t be classified on the norm of desirability and undesirability and thus its weightage and validation cannot be assessed.)
The mentioned validity of the study habit inventory was found ranging from 0.49 to 0.87 range, with the significance of 0.01 level whereas, the concurrent validity estimated by the researcher for the test of study habits was found to be 0.67 which was found fair enough to use inventory to estimate study habits of students used as the sample in the study.

3.6 COLLECTION OF DATA

Collection of data is the process of gathering and measuring information on variables of interest, in an established systematic fashion that enables one to answer stated research question, test hypothesis and evaluate outcomes on basis of objectives formed for research purposes. The primary goal of collection of data is to capture quality evidences which can be translated to rich data analysis which allow building a convenient and credible answer to questions that have been posed by research objectives.

Although collection of data is a primary process to follow in all sorts of researches weather it may be qualitative, quantitative, physical, business or humanities, the procedure and data collected may vary for which field is that data been collected for. Regardless the field of research or preferences the defining data (qualitative or quantitative) accurate data collection is essential to maintain the integrity of research. Both the selection of appropriate data collection instrument (existing, modified or newly developed) and clearly delineated instructions for their correct use reduces the likelihood of errors that may happen. Quantitative research methods demands for the random selection of the sample from the appropriate population and the method of random assignment of the selected sample members within the population is done on the basis of norms and principles demanded by the study (Duffy, 1985). Present study adopted randomized survey method to collect data which was collected with the help of different standardized psychological tools, whose scores and finding helped in evaluating psychological quantities of the sample considered in the study and in conclusion of result as per requirement of the research is demanded. Randomized survey method of data collection in research is considered an effective method of collecting authentic and purposive data in social-scientific researches which includes the capability to validate and immediate discriminate the obtained data as per requirement of the study demands. describes importance of survey
Survey research studies large and small populations (or universes) by selecting and studying samples chosen from the populations to discover the relative incidence, distribution, and interrelations of sociological and psychological variables (Kerlinger, 1973). Survey method of data collection involves scientific method to collect appropriate data for the qualities to be studied. Generally, surveys method gathers data at a particular point in specific period of time with the research intention of describing the nature of existing conditions or determining the relationships that exist between specific variables or events. Survey method is a method of obtaining important information from the sample of any population which indirectly includes all the qualitative aspects of population which is to be studied in the research. Survey method of data collection can be a measure to provide quick, less expensive and accurate meaningful data which can provide information regarding the large group of people.

Besides survey method of data collection is useful in describing the desired qualities to be considered as the basic characteristics of a large population, survey method is also an effective mean to collect data remotely also statistical techniques can be applied to the data collected by survey method very easily. Statistical techniques to determine validity, reliability, correlation, variance tests etc can be applied to the data collected on pre-decided purposes. Major problem of sampling error can be easily avoided with the help of collection of ample information from the units of individuals included in the research. In this research an information sheet was provided to sample students to collect vital information about the students included as the sample of the study. Students were instructed to fill in for this instruction sheets carefully before starting to response for the testsof the study. Preparation of information sheet and information collected by it is described as follows.

### 3.7 PREPARATION OF INFORMATION SHEET

To collect data from the sample selected from the population, it was felt essential that the important information on which the data will be further classified is necessary to be collected by sample. This information was collected by the sample students with the help of an information sheet in which a plea to provide necessary
information and conduct psychological test as instructed was done to sample students. It was also mentioned in the information sheet that this whole information and testing feedback will only be used for research purposes only, nowhere else, and thus they should answer to all the test questions with their full capability and calibre. The primary information such as gender of the individual, age of the individual, previous percentage etc. was very essential to take consider various aspects important for this study which were distinctly classified under different norms. Along with primary information of the individual included in sample, some other additional information like name of the candidate, school name, study hours in normal conditions, academic qualification of parents, geographical location of school etc was also collected by the sample students, which may be proved important in the study.

Following information was collected with the help of information sheet provided to sample students before answering the psychological test provided to them:

1. Name of the student,
2. Gender
3. Age of the student,
4. Name of School,
5. Division in previous (Class-X^{th}) class, with percentage,
6. Study duration in normal conditions,
7. Point of support in study,
8. Educational Qualification of father and mother.
9. Geographical location of school.

3.8 STATISTICAL TECHNIQUES USED

Present study aims for the intercorrelational, comparative and predictive aspects of the variables used in the study for which the researcher has found following techniques as the most appropriate statistical techniques available to treat the acquired data to conclude for the results as per objectives of the study demands. The following statistical techniques have been used for the treatment and analysis of data:

(1) **Measures of Relationship (Correlation)** -
   (a) Pearson Coefficient of Correlation.

(2) **Analysis of Variance (ANOVA)** -
(a) One Way Analysis of Variance.

(3) Measure of Prediction (Regression Analysis)-
(a) Stepwise method of Multiple Regression.

3.8.1. Measures of Relationship (Correlation)- In our day-to-day life we experience inter-relationship among variables associated with different phenomenon i.e. we experience effect of one factor on another factor in different ways. Statics provides an accurate and effective method to find and to analyse the effect of one variable on to other. This relation of one factor on another is termed as correlation. That is, Correlation is a statistical technique which donates such inter-dependence between two variates and measure the degree and direction of inter-relationship. L.R. Connor defines correlation as,

“If the two or more quantities vary in sympathy so that, movements in the one tends to be accompanied by corresponding movement in the other, then they are said to be correlated.”

Correlation is the relationship between two or more paired variables or two or more set of data. The degree of relationship is measured and represented by the coefficient of correlation. This coefficient of correlation may be identified by either the letter ‘r’ or the Greek letter rho (ρ) or other symbols, depending on the data distributions and the way the coefficient has been calculated. In the present study, following Coefficients of Correlation have been computed. Croxton and Cowden describes importance of correlation as,

“When the relation is of quantitative nature, the appropriate statistical tool for discovering and measuring the relationship and expressing it in brief formula is known as correlation.”

(a) Pearson’s Product- Moment Coefficient of Correlation (r)-In the present study, Pearson Coefficient of Correlation is used for evaluating and describing the relationship (if any) in between the variables taken in the study. Pearson’s Coefficient of Correlation may be thought as that value, which expresses the extent to which changes in one variance are accompanied by or are dependent upon changes in the second variable. According to Garrett, it may be used when:
(i) The distribution of two variables has a linear relationship.

(ii) The distribution in two variables is normal or at least not badly skewed.

(iii) The spread or scatter is the same for each column (or row) in the correlation table.

As the above mentioned condition has been satisfied in the present study, Pearson’s product moment coefficient of correlation was implied in the study. In the present study, $N$ was large and the assumption of equality scatters in columns (or rows) i.e. *homoscedasticity* was reasonable. Seeing, the above mentioned conditions the investigator has used the Pearson's coefficient of correlation. The basic formula for computing the Pearson's coefficient of correlation used can be described as follow;

$$ r = \frac{\sum xy}{N\sigma_x\sigma_y} $$

where,

- $r$ = Coefficient of correlation between $X$ and $Y$.
- $\sum xy$ = Sum of the products of deviated scores $X$ and $Y$ when deviations are taken from the mean of two distribution.
- $N$ = Number of period scores.
- $\sigma_x$ = Standard deviation of $X$.
- $\sigma_y$ = Standard deviation of $Y$.

When computation is done on raw scores it takes the form,

$$ r = \frac{\sum xy - \Sigma x \Sigma y}{\sigma_x \sigma_y} $$

where,

- $\Sigma xy$ = Sum of products of $X$ and $Y$.
- $\sigma_x$ = Standard deviation of $X$ in units of class interval.
- $\sigma_y$ = Standard deviation of $Y$ in units of class interval.
- $\Sigma x = \frac{\sigma fx}{N}$
- $\Sigma y = \frac{\sigma fy}{N}$
\( N = \text{Number of total scores.} \)

In the present study Pearson's Coefficient of Correlation have been computed for finding-

1. Correlation between Scientific Creativity and Intelligence of male students of XI grade.
2. Correlation between Scientific Creativity and Intelligence of female students of XI grade.
3. Correlation between Scientific Creativity and Personality of male students of XI grade.
4. Correlation between Scientific Creativity and Personality of female students of XI grade.
5. Correlation between Scientific Creativity and Study Habits of male students of XI grade.
6. Correlation between Scientific Creativity and Study Habits of female students of XI grade.

3.8.2. Measure of Variance— Although the set of central value of measurements tells very much about the basic fundamental characteristics of the sample studied, but it also does not, by any means, gives us all kinds of differences and inter-relation exhibited by the sample taken in consideration. Perfect homogeneity in any group in respect to any trait is nearly impossible to attain. Every group possesses certain discriminating characters into it which are equally important to be studied in researches. There can be extreme laggards at the one end of distribution and other at the other end of the distribution who may be irked by the slow process of the other individuals of the group. This inconsistency of certain trade in the sample taken indicates variability or dispersion, which is equally important to include and compute in the study for exact interpretation of result found.

In researches, researchers generally obtain more than two sets of measurement on the same experimenting variable, each sub-variable under its own set of condition and researcher wants to know whether there is any significant difference among the sub-variables included. This condition in the research is sort out by an effective statistical tool to analyse variance exhibited in between the sub-groups included in the
study named, *Analysis of Variance (ANOVA).*

**Analysis of Variance (ANOVA):** Analysis of Variance (ANOVA) is an effective way to determine whether means of more than two samples, are too different to attribute to the sampling error. It is an improvement over t-test. The t-test is used for testing the significance of difference between two means, F-test examines both in-between or among variance as well as within variance. The analysis of variance is associated with the design of experiments. In a simple from the analysis of variance is used to test the significance of difference between the means of a number of different populations. Following are the main considerations for using F-test:

(i) F-test considers the both type effects in terms of between or among variance and within variance.
(ii) The analysis of variance is used for more than one independent variance effect.
(iii) F-test can evaluate more than one main effect and interaction effects of two or more factors in one experimental situation.
(iv) The analysis of variance is used for more than one classification.

The variance is analyzed to obtain the F-ratio. It consists of following operations:

(1) The variance of scores for groups is combined into one composite group known as the total group variance \((V_t)\).
(2) The mean value of the variance of each of the groups, computed separately, is known as the within-group variance \((V_w)\).
(3) The difference between the total groups variance and the within groups variance is known as between- groups variance \((V_t - V_w = V_b)\).
(4) The F-ratio is computed as:

\[
F = \frac{V_b}{V_w} = \frac{\text{(between groups variance)}}{\text{(Within−groups variance)}}
\]

The logic of the F-ratio is as follows:

The within group variance represents the sampling errors in the distribution and is also referred to as error variance. The between groups variance represents the
influence of the variable of interest or the experimental variable.

The critical values of the F-ratio are found in the F-table which indicates the critical values necessary to test the null hypothesis as selected levels of significance.

There are two different degrees of freedom, one for $V_b$ (between-group variance) and other for $V_w$ (within-group variance). The degrees of freedom for the between group variance ($V_b$) is determined by the number of groups minus 1 ($k-1$) and the degrees of freedom for the within group variance is determined by sum of subjects minus the number of groups ($N-K$), where $K$ is the number of groups.

The calculation of $F$ involves finding the mean of the deviation from the mean, squared. Thus, the between group variance ($V_b$) is more commonly referred to as mean squared between ($MS_b$) and within-group variance ($V_w$) is referred as the mean squared within ($MS_w$). The formula then becomes:

$$F = \frac{MS_b}{MS_w}$$

Steps in the calculation of $F$-value:

1. The first step is to find the sum of the squared deviation of each person’s score for the mean of all of the subjects. This is known as the total sum of squares ($SS_t$) and can be found by using the following formula:

$$SS_t = \sum X^2 - \frac{\left(\sum X\right)^2}{N}.$$

2. The next step is to divide the total sum of squares into the between groups sum of squares ($SS_b$) and the within groups sum of squares ($SS_w$). $SS_b$ is calculated as follows:

$$SS_b = \frac{(\sum X)^2}{n_1} + \frac{(\sum X_2)^2}{n_2} + \cdots + \frac{(\sum X_n)^2}{N}.$$

where,

- $n$ = the number of subjects in a group
- $N$ = the number of subjects for all the groups combined.

3. The within-group sum of squares ($SS_w$) can be calculated by subtracting $SS_b$ from $SS_t$.
\[ SS_w = SS_t - SS_b \]

(4) To find the mean square between (MS_b) and the mean square within (MS_w), the SS_b and SS_w are divided by their respective degrees of freedom (df):

\[ F = \frac{MS_b}{MS_w} = \frac{SS_b/df_b}{SS_w/df_w}. \]

In the present investigation test of \textbf{ANOVA} has been implied for the following:

1. Comparison of Scientific creativity* of XI grade students** belonging to different categories of Intelligence (one way analysis).
2. Comparison of Scientific creativity of XI grade Students belonging to different categories of personality*** (one way analysis).
3. Comparison of Scientific creativity of XI grade Students belonging to different Study Habits (one way analysis).

\textbf{3.8.3. Measure of Prediction(Regression Analysis)} - Scientific investigations or Quantitative analysis always contains a very important and trustworthy method into their realm which is generally found diminished in other Qualitative or humanistic approach of research. This capability of predicting the effect or extent of their effect on other factors or vice versa is known as the capability of prediction.

Particularly this is true for a reason that statistical reasoning is basis of all prediction. Statistical ideas not only guide a researcher in framing statements of a predictive nature but also enables us to say something definite concerning the trust on to which any statement can be framed, moreover it also includes and defines the extent to which any predictive statement possesses error chance into it. \textit{M.M.Blair} defined regression analysis as,

\textbf{-------------------}

* Scientific Creativity was tested separately on 4 factors namely, Fluency, Flexibility, Originality and Inquisitiveness.
** The objective will be studied with reference to Male and female students separately.
*** Personality was tested by 16 factors namely A,B,C,E,F,G,H,I,L,M,N,O,Q_1,Q_2, Q_3 and Q_4
Regression analysis (prediction) is a mathematical measure of the average relationship between two or more variables in terms of original unit of data.”

Predicting and estimating the accuracy of prediction is still a tough job to conduct as the predictions are framed on the well and defined variables, conditions and interaction pattern of the variables, any minute change in any one of the properties may deviate the result from the assumed result done on the basis of prediction analysis. Predictions are obviously sound if they are proven correct again and again in a well defined or may be in a flexible pattern of predicting results before it actually takes place. The appropriateness of prediction clearly indicates that how often and upto what extent the result is predicted keeping in mind other variables included in activity. Wallies and Roberts described importance of regression analysis as,

“It is often more important to find out what the relation actually is, in order to estimate or predict one variable (dependent variable) and the statistical technique appropriate to such a case is called Regression (Prediction) analysis.”

Various methods of predictions can be used to predict the value of dependent variable from the given value of independent variable but according to many terms and conditions to be fulfilled for any particular prediction analysis, appropriate prediction method should be selected. Keeping in mind the various conditions needed for any particular prediction analysis like degree and nature of relationship estimated in research, limits of coefficient, independent of change of scale and origin and area of use and those fulfilled by the conducting research, researcher decided to conduct the prediction analysis of the research by the method of stepwise multiple regression. Stepwise multiple regression provides an answer to the question of what can be the best combination of independent (predictor) variable to predict the dependent (predicted) variable.

Stepwise regression follows the procedure of introducing, predictor variables entered in the regression equation in a stepwise or one at a time basis. Introduction of every dependent variable is then followed by analysis of the predicted variable and the difference observed in it because of the introduction of the independent variable each time. At every step in the analysis of the predictor variable that contributes separately.
something in increasing the multiple correlation (R) is entered, which is continued till variable introduced to the equation results into adding something to the regression equation, statistically. When no meaningful change in regression equation is observed by introduction of predictor variables, the analysis stops. It indicates that it is not necessary that all the predictor variable may enter the equation in stepwise multiple regression. In present study, Stata Graphic software was used to conduct prediction analysis for the variables involved in the study.

3.9 COMPUTATIONS

In the present investigation, all the primary calculations were conducted by Microsoft excel, SPSS and Stata Graphic software. These softwares are now a day have been used in for simple academics purposes and also in the field of advance studies and research, they serves as a boon to conduct lengthy and exhaustive numerical operations with no consumption of time and that too with maximum accuracy.

Majorly all the primary calculations like arranging data on some criteria, calculations to conduct statistical operations like calculating mean value, standard deviation, sorting of data etc has been conducted by Microsoft excel application which is generally available with primary window package for computers. Microsoft excel is a spreadsheet application developed by Microsoft for Microsoft windows. It includes features like calculations, graphing tools, pivot tables and a Microsoft programming language called visual basics for applications as per need. Microsoft excel executes all basic operations with the help of grid of cells arranged in number of rows and letter naming columns to organised data manipulation like arithmetic operations. Additionally many other features are also present in this computer application which are in easy to use and proved to be of great support to researcher.

Another computer application which was used for processing of data was SPSS. SPSS as previously assumed, is not any more an abbreviation of ‘Statistical Package for Social Science ‘as it itself is a trademark now. This useful data processor is useful in conducting complex statistical operations in minor as well as in major research purposes and as it works on code system as provided by its user or researcher in the beginning of data processing through SPSS, the results provided and presented by this software is also in code system and to encode these code can be a tough job to researcher if he is not clear in what coding is been provided to what variable and what
statistic will be appropriate to conduct what sort of statistical operations. Stata Graphic software was especially been used to predict the multiple regression equations from the predictor variables included in the study.

Computer has made researchers job to carry out hard and tedious job of research much easier from the previous times. But as it is believed every simple operation hides some complexity with it these techniques which are very much accessible and practical can only and only be used without error only when the primary and appropriate use of statistical technique is clear in the mind of researcher and a clear blue print of what result should be obtained and what technique should be applied to solve what statistical purposes along with preliminary know-how of software is equally important, because on that basis only the result can be interpreted which can be useful to general scholars or people. After making all the necessary computation and feeding data as per requirement of the research objectives, the data was processed and interpreted to summarize it in simple tabular forms for interpretations which are described in the following chapters of research conducted.