METHODOLOGY AND DESIGN OF THE STUDY

Research is a systematic effort in the direction of solution of a problem having direct or indirect bearing on human welfare. It is systematic because it involves certain steps to be taken in a definite order. There may be more than one approach to solve a problem, some of them being better than others. Which approach or methodology is followed largely determines the dependability of research findings. So, the success of a researcher lies in his choice of methodology to be followed. Methodology includes all the plans, techniques and strategies follow in carrying out a research study. From the very beginning the investigator has been very particular to see that no loop-hole is left in the methodology followed in the present investigation. This chapter reports the details of the design of the study including technique of sample selection, development of research tools, techniques followed in data collection and analysis.

Plan of a research study entails overview of the total layout including a consideration of how the work is to be executed. It is at this stage that decisions crucial for the accomplishment of the aims of the study as what measures of gathering data are to be used, how population is to be defined and sampled, what controls are to be applied, what kind of data pertinent to the study are to be collected and finally how it is to be analyzed are made. Needless to say that without proper planning difficulties to be encountered during the progress of the work cannot be anticipated and resolved. In fact, successful completion of the study without preplanning becomes not only difficult, but impossible. Lastruecil defines as, “the function of a research design is to organize the procedures of study so that error is minimized, effort is economized and

relevant evidence is gathered efficiently". A considered discussion of all those aspects in respect of the present study is embodied in this chapter.

3.1. Methodology

The method adopted for the present study can be categorized as descriptive statistical in nature. Descriptive research describes and interprets the current status, it is concerned with conditions or relationship that exist, practices, that prevail, beliefs, points of view or attitudes that are held, processes that are going on, effects that are being felt or trend that are developing. The process of description as employed in this research study goes beyond mere gathering and tabulation of data. It involves an element of interpretation of the meaning or significance of what is described. Thus, description is combined with comparison or contrast involving measurement, classification, interpretation and evaluation.

The use of inferential statistics has been made in deducing results from different statistical techniques employed for investigating the relationship between Science achievement, personal, environmental and institutional factors with the above mentioned goals to be achieved. This study was designed to be executed in different steps given below.

3.2.Population

A population, in statistical terms, may be defined as any identifiable and well specified group of individuals. A population may be finite or infinite. A finite population is one in which all the members can be easily counted. An infinite population is one whose size is unlimited and therefore, its members cannot be counted. Similarly, a population may be real or imaginary. A real population is one which actually exists and an imaginary population is one which exists only in the imagination. In psychological and educational research on many occasions the

population is imaginary. Generally it is not possible to study the entire population in a single research study. There are two reasons for this, (i) when the population is very large it is not possible to contact every individual unit,(ii) when dependable results can be obtained by studying a small portion of the population, there is no use of wasting time and money. One very important use of inferential statistics is in drawing of inferences about larger populations on the basis of information's obtained from smaller groups selected from the population. To state in other words, we wish to make statements or generalizations about the population on the basis of information's obtained from the study of one or more samples. The extent to which we can do this with reasonable accuracy depends on the adequacy or representativeness of the sample. To study the whole population is rather impracticable; a statistical process called sampling makes it possible to draw useful inferences or generalization on the basis of careful observations or manipulation of variables, within a relatively small proportion of the population. The process of sampling generally refers to the method of selecting a small part or specimen of a large universe of subjects, in order to study some quality or characteristic of the whole. So, sampling is one of the most fundamental aspects of the total methodology followed in particular research study. It is an act of determining how many elements in a population are to be sampled, and how they are to be selected.

Since the present study has been conducted on class 9th, all the students studying in class 9^{th} in Central U.P. constitutes the population of the study. This study was carried out in various secondary schools at four districts of Central U.P. namely Barabanki , Lucknow , Sitapur and Faizabad .

3.3 Sample

The problem of actual selection of the sample of required type and size becomes indeed very crucial of any systematic and scientific method of enquiry. Adequate sampling design involves a number of considerations such as nature and characteristics of the populations from which the sample is to be drawn, accessibility of the subjects chosen, availability of time and resources at the disposal of the investigator and appropriateness of the statistical treatment of the data etc.

3.3.1 Sampling Procedure

The selection of the sample in the present investigation has been done by going through two stages.

Selection of schools (Random Sampling Technique):

The first stage involved the selection of schools from the list of more than two hundred schools of the Central U.P. Twenty-one schools were selected by choosing every 10^{th} school randomly from the list, using simple random sampling technique . The pupil of these schools would represent the whole of the population. The selection of the schools was made keeping in mind the maximum representation of the population of the study according to their school management type and gender.

Selection of students (Incidental Sampling Technique) :

In the second stage sampling, the representative sample of the study was selected through incidental sampling technique, as per the convenience and economic point of view of the investigator . The data were collected from class 9^{th} students of government and private managed schools. The total numbers of participants were 2006.

3.3.2 Size of the sample

The worth of a study is judged by several criteria including the size of the sample. The number of units to be included in a population sample, by and large, depends upon the purpose of the study, the use of results in decisions making and the statistical techniques to be used. There is, however, little doubt that other factors being equal, larger the sample, the greater should be the accuracy of results.

The main sample and the sub-sample were sufficiently large as also representative of the student of secondary schools in general as would be evident from table 3.1 and brief description that fallows:

Table 3.1 Description of the sample

S. No.	Sample used for	Size
1.	Development of Science achievement test	300
2.	Study of Science achievement of students and their	
	a. Personal Factors	2006
	b. Environmental Factors	2006
	c. Institutional Factors	2006

3.3.3 Sample used for the development of Science Achievement Test

Science achievement test was administered on 300 secondary school students (150 male and 150 female) randomly sampled from five secondary schools, out of which two were girls schools, two were boys and the rest was co-educational schools, located in rural and urban areas of Barabanki district. These school belong to different categories of management and range from good to poor in regard to standard of performance of their pupil. Thus, the sample selected for the Science achievement test constituted a cross-section of secondary school students.

3.3.4 Sample used for the study of relationships between Science achievement and Personal, Environmental & Institutional factors

The sample used for study of secondary schools students' achievement in Science formed the main sample of the study in view of the objective of the investigation which sought to find its relationship with some other student characteristics such as their personal, environmental and institutional factors. All 2006 students were involved in the study of relationship between Science achievement and their personal , environmental and institutional factors. An examination of the particulars of students under study contained in table 3.2 revealed that the numbers of the male and female students were 1080 and 926 respectively. All 2006 students who participated in the investigation were studying Science as one of their academic subjects at standard 9^{th} level.

It should be mentioned that these students were selected from twenty-one different secondary schools located Central U.P. Out of these, one were girls' schools, eighteen were co-education and the rest were boys' schools.

Again, these schools constitute different categories of management; some of them were Government managed and some were managed by Private agencies.

Also, the sample schools range from very good to poor in their performance. For instance, some English medium schools are running on the lines of public schools and had a very high reputation and were considered to be prestigious. Pupils in these schools were paying high tuition fee and belong to well to do families with a high socio-cultural background. Some schools were, generally poor in quality; the pupils in these schools came from lower socio-economic strata of the society.

Table 3.2 Distribution of main sample by school, gender, school types and medium of instructions.

S. N.	Name of School	Male	Female	No. of Students	Type of School	Medium of Instructions
1.	Govt. Girls Inter College Barabanki	00	129	129	Govt.	Hindi
2.	Rani Laxmi bai Smarak Inter College Kuruali, Barabanki	45	55	100	Private	Hindi
3.	Greenfield Academy, Chandauli, Barabanki	33	17	50	Private	English
4.	Govt. Inter College Barabanki	71	00	71	Govt.	Hindi
5.	Baba Gurukul Academy, Barabanki	60	90	150	Private	English
6.	Lucknow Public School, Lucknow	100	50	150	Private	English
7.	M.K.S.D.I. College, Lucknow	46	07	53	Govt.	Hindi
8.	G.I.C. Nishatganj, Lucknow	40	00	40	Govt.	Hindi
9.	R.U.A.I.C. Matiyari, Chinhat, Lucknow	32	38	70	Govt.	Hindi
10.	Kishore Devyani Public School, Lucknow	43	07	50	Private	English
11.	Peice Convent Progressive School, Chinhat, Lucknow.	31	33	64	Private	Hindi
12.	Raj Kumar Inter College, Lucknow	43	30	73	Private	Hindi

13.	G.I.C. Sanda, Sitapur.	113	87	200	Govt.	Hindi
14.	Priya Day Public School, Sitapur.	46	54	100	Private	Hindi
15.	Maharishi Vidya Mandir Senior Secondary School, Sitapur.	55	45	100	Private	English
16.	Adarsh Janta Inter College, Rusham, Sitapur.	20	13	33	Private	Hindi
17.	P.D.D.U.M.S.S. G. Inter College Bapunagar, Shahpur, Sitapur.	48	25	73	Private	Hindi
18.	G.I.C. Faizabad	81	69	150	Govt.	Hindi
19.	Adarsh Inter College, Faizabad.	66	84	150	Private	Hindi
20.	Faiz-e-Aam Inter College, Sohawal, Faizabad.	48	52	100	Private	English
21.	Udai Public School, Faizabad.	59	41	100	Private	English
	Total	**1080**	**926**	**2006**	**21**	**21**

3.4 Data collected for the study

The following base line data were collected for carrying out the present investigation:

1. Data used for development of Science achievement test.
2. Scores of the students related to personal factors.
3. Scores of the students related to environmental factors.
4. Scores of the students related to institutional factors.

3.5 Tools used

The dependability of research findings are not only determined by planning, methodology, data analysis and interpretation but also on tools that are used to collect information's or data. In a research study, while selecting research tools many considerations have to be kept in mind such as objectives of the study, the amount of time to be devoted for the study, availability of suitable tests, their statistical characteristics etc.

The tools used for collection of the data mentioned above included the following:

1. Science Attitude Scale (SAS) by Grewal, A. was used to collect the data regarding attitude of the sample towards Science.
2. Science Achievement test (SAT), this test was constructed and developed by investigator for the present study.
3. A Personal and Environmental Information Questionnaire, this questionnaire was prepared by investigator to collect the data regarding personal and environmental factors.
4. School Information Questionnaire, this information questionnaire was prepared by investigator to collect the data regarding institutional factors.

Brief descriptions of these tools are given as:

3.5.1 Science Attitude Scale

The Science Attitude Scale is a dependable tool for measuring student's attitude towards Science. It appears to be useful for teachers of Science, guidance workers and research scholars. The Science attitude scale consist of 20 statement (10 positive and 10 negative statement) . It is a five point rating scale having reliability

0.86 as reported by the developer and as calculated by split half method. The scale appears to have content validity. The attitude score of a subject is the sum total of scores on all the twenty items of the scale. For each student a total score on the scale can be obtained by summating his scores for the individual items. Thus a maximum of 80 scores can be obtained by a subject. However, the administration of the test reveals that the scores ranged from 25 to 70.The summation of score earned by a student on all statements was taken as his attitude score. A copy of the scale is given in Appendix-I.

3.5.2 Science Achievement Test

The achievement test in Science for class IX students that is used in the present study was constructed by the investigator. This is a very comprehensive test based on 16 common chapters of class VIII Science text book of U.P Board and C.B.S.E. Board. The test consists of 75 items of multiple choice type representing achievement at various areas of Science such as Physics, Chemistry and Biology of eighth class of U.P. Board and C.B.S.E. Board. Science Achievement Test is divided in three sections, Physics, Chemistry and Biology : Physics contains 35 items, Chemistry contains 20 items and Biology contains 20 items. The total score on the test as a whole was used as a measure of achievement in Science. All the items in the test were arranged in order of difficulty, the easy items being placed in the beginning and this was done to motivate the students. The difficulty values of items in the test between the range of .25 to .85. Similarly, each item had a discriminating power greater than 0.30. The test was based on the latest syllabus prescribed by the directorate of education, U.P. & NCERT. This test had a fairly high content validity and its reliability is found to be 0.87. A copy of the Science Achievement Test is given in Appendix-II.

3.5.3 A personal and environmental information questionnaire

The personal and environmental information sheet was prepared by the investigator. This sheet contains such questions requiring the subjects to give information on their parental education, father's occupation, family size, Science resources available at home, exposure to media, time spent on Science home work, gender and participation in sports activities. A copy of the questionnaire is given in Appendix-III.

3.5.4 School information questionnaire

This questionnaire was used to gather information regarding the school, like types of management, medium of instruction and facilities in the school i.e. school resources, qualification of teacher's, teacher's training, teacher's experience etc. A copy of the questionnaire is given in Appendix-IV.

3.6 Methods of data collection

In order to collect the systemic data, it was essential to approach subject personally and the investigator did the same. In this regard first of all, prior permission from the principals of the schools (from which the data were collected) was obtained and a schedule of administering the test was fixed with them. To seek cooperation of principals and teachers of these schools the investigator received introduction letter from his Supervisor and Head of the department of education, Integral University, Lucknow. After contacting students, the investigator explained the objectives of the study to them. The respondents were assured that the information provided by them would be kept confidential. Then, the investigator distributed all the tests and information sheet among the students. They were also asked to go through the general instructions given on the top of the front page of the booklet form tests, before filling the given entries. Lastly, the students were asked to

read the questions and statements carefully and requested to give their responses. Doubts and confusions were made clear by the researcher before moving to the next item. The investigator also gave full freedom to the student to ask meaning of the words or sentences which are beyond their understanding, except in case of Science achievement test. Moreover, there was not any kind of undue stress and control over the student at the time of completion of the tests. After completion, it was collected from the students before permitting them to leave the room, the booklets were carefully checked by the investigator whether all the items were answered or not. If any blanks were left the students were asked to complete the same before leaving the class.

3.7 Hurdles in data collection

Unfortunately, the data collection work was delayed due to many unforeseen difficulties. The main difficulties encountered were as follows:

1. **Non-Cooperation of teachers and principals**

   One of the main hurdles that the investigator encountered during the data collection of students emanated from the lack of cooperation of teachers and principals. Many of the senior teachers did not allow the investigator to enter in the class room.

2. **Holidays & Vacations**

   Winter vacations, gazetted holidays, half-working days on weekends in the local schools, short periods on Friday in some schools, functions of the schools, inspection days etc proved to be other obstacles in smooth collection of data.

3. **Examination problems**

   Moreover, various examinations such as terminal, monthly and class tests also proved hurdles in the normal work of data collection.

4. **B.Ed. Trainers**

   There was a great rush of B.Ed. trainers in almost every school which, in turn, jeopardized the normal activities of schools.

3.8 Statistical techniques Employed

The analysis of the data was done by employing the following statistical techniques which were chosen only after the investigator found them to be most appropriate and compatible to the data. Each statistical method is based upon its own specific assumptions regarding the nature of the sample, its universe and research conditions. These factors are considered in advance. Following statistical measures were used for analysing the data.

1. Determinations of reliability and validity of achievement test in Science using known techniques.
2. Computation of means and standards deviations.
3. Use of linear measure of correlation (Pearson Product Moment Coefficient of Correlation).
4. Use of F-test (to see the significant difference between many means).
5. Use of the t-test for measuring the significance of the difference between means.
6. Use of the Duncan's post hoc test for measuring the significant pair difference between means.

It may be relevant here to mention assumptions underlying the use of the product moment correlation and the t-test and how they satisfied before the use of these techniques.

Before r is computed the data is tested to see if two conditions exist. The first of these conditions is that we have linear regression. This means that our points on the scatter gram tend to fall along a straight line. The second condition that we should look for its

homoscedasticity. By this we mean that the standard deviations of the arrays tend to be equal.

In the present study it was assumed that the data is linear. Consequently, product moment correlation was found out between total distributions of scores of the variables put into correlation.

When the analysis of t test is used, the following assumptions should be met:

1. The individuals in the various sub-groups should be selected on the basis of random sampling from normally distributed population.
2. The variance of the subgroups should be homogeneous.
3. The sample comprising the groups should be independent.

3.8.1 Formula used

3.8.1.1 Pearson Coefficient Correlation (r)

Of the several mathematical methods or measuring correlation, the Karl Pearson's method, popularly known as Pearson's coefficient of correlation (r) is most widely used in practice. The formula for computing r is

$$\mathbf{r} = \frac{\Sigma xy}{\sqrt{\Sigma x^2 \times \Sigma y^2}}$$

Where x and y stands for deviation of X and Y series of samples from their means X and Y, i.e. x= (X-X) and y= (Y-Y).

The value of the coefficient of correlation as obtained by the above formula shall always lie between ±1.

3.8.1.2 Calculation of Mean

"The mean of a distribution of scores is the value on the scores scale corresponding to the sum of the scores divided by their number or size of sample."

The mean is the sum of separate scores or measures divided by their numbers.

For calculating value formula is used ,

$$\boldsymbol{M} = \mathbf{A} + \frac{\boldsymbol{\Sigma f(x')}}{\mathbf{N}} \times \mathbf{i}$$

3.8.1.3 Calculation of Standard Deviation (S.D.)

"The square root of the variance is called the root mean square deviation or the standard deviation."

For calculating value formula is used

$$\boldsymbol{S.D.} = \frac{\mathbf{1}}{\boldsymbol{N}} \sqrt{\boldsymbol{N(\Sigma X^2) - \Sigma(X)^2}}$$

3.8.1.4 Calculation of t-value

For testing difference between means of two samples, general definition of t is

$$t = \frac{\bar{X}_1 - \bar{X}_2}{S_{DX}}$$

Where $\bar{X}_1$ and $\bar{X}_2$ are two means of samples of size N_1 and N_2 and S_{DX} is the standard error of difference. The means $\bar{X}_1$ and $\bar{X}_2$ are given as

$$\bar{X}_1 = \frac{\Sigma X_1}{N_1} \qquad \text{And} \qquad \bar{X}_2 = \frac{\Sigma X_2}{N_2}$$

For homogeneous data

$$S_{DX} = \sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}}$$

For pooled variance

Degree of freedom = $(N_1 + N_2) - 2$

3.8.1.5 F–Test

When significance of the difference among several means is desired, F – Test is applied. Assume that we wish to study the effects of the r different experimental groups of size N.

The F – Test is defined as

$$F = \frac{\text{Variance between samples}}{\text{Variance within samples}}$$

Following procedures (steps) are adopted to calculate the variance between and within samples. For simplicity we assume here r = 4 samples.

Step 1: Mean of each sample

Sample	**Sample I** **A**	**Sample II** **B**	**Sample III** **C**	**Sample IV** **D**
	A_1	B_1	C_1	D_1
	A_2	B_2	C_2	D_2
	A_3	B_3.	C_3.	D_3.
	.	.	.	.
	.	.	.	.
	A_N	B_N	C_N	D_N
Total	ΣA_i	ΣB_i	ΣC_i	ΣD_i
Mean of each sample	$\bar{A} = \Sigma \frac{A_i}{N}$	$\bar{B} = \Sigma \frac{B_i}{N}$	$\bar{C} = \Sigma \frac{C_i}{N}$	$\bar{D} = \Sigma \frac{D_i}{N}$

Grand Mean $\bar{\mathbf{X}} = \frac{(\bar{\mathbf{A}} + \bar{\mathbf{B}} + \mathbf{C} + \bar{\mathbf{D}})}{\mathbf{r}}$

Step 2: Sum of squares between the samples (SSBS)

Sample	**Sample I** $(\bar{\mathbf{A}} - \bar{\mathbf{X}})^2$	**Sample II** $(\bar{\mathbf{B}} - \bar{\mathbf{X}})^2$	**Sample III** $(\bar{\mathbf{C}} - \bar{\mathbf{X}})^2$	**Sample IV** $(\bar{\mathbf{D}} - \bar{\mathbf{X}})^2$
	a	b	c	d
	a	b	c	d
	a.	b.	c.	d.
	.	.	.	.
	.	.	.	.
	a_N	b_N	c_N	d_N
Total	Na	Nb	Nc	Nd

Sum of squares between samples (SSBS) = N (a + b + c + d)

Mean sum of the squares of sample (Variance between samples)

VBS = $\frac{\mathbf{N}(\mathbf{a} + \mathbf{b} + \mathbf{c} + \mathbf{d})}{(\mathbf{r} - \mathbf{1})}$

Step 3: Total sum of squares within samples

Sample	**Sample I** $(\mathbf{A_i - \bar{A}})^2$	**Sample II** $(\mathbf{B_i - \bar{B}})^2$	**Sample III** $(\mathbf{C_i - \bar{C}})^2$	**Sample IV** $(\mathbf{D_i - \bar{D}})^2$
	a_1	b_1	c_1	d_1
	a_2	b_2	c_2	d_2
	a_3.	b_3.	c_3.	d_3.
	.	.	.	.
	.	.	.	.
	a_N	b_N	c_N	d_N
Total	$\Sigma\,(A_i - \bar{A})^2$	$\Sigma\,(B_i - \bar{B})^2$	$\Sigma\,(C_i - \bar{C})^2$	$\Sigma\,(D_i - \bar{D})^2$

Total sum of squares within the samples

(SSWS)= $\lfloor \Sigma\,(A_i - \bar{A})^2 + \Sigma\,(B_i - \bar{B})^2 + \Sigma\,(C_i - \bar{C})^2 + \Sigma\,(D_i - \bar{D})^2 \rfloor$

Mean sum of squares within samples (Variance within samples)

VWS = $\frac{\mathbf{SSWS}}{\mathbf{(N - r)}}$

All the results can be tabulated as follows

Source of variation	**Sum of square**	**Degree of freedom**	**Variances**
Between Samples	Sum of squares between the samples (SSBS)	r - 1	$\frac{\text{SSBS}}{\text{r} - 1}$
Within Samples	Total sum of squares within samples (SSWS)	N – r	$\frac{\text{SSBS}}{\text{N} - \text{r}}$
Total	SSBS + SSWS	N – r - 1	

F = $\frac{\left(\frac{\mathbf{SSBS}}{\mathbf{r-1}}\right)}{\left(\frac{\mathbf{SSWS}}{\mathbf{N-r}}\right)}$

3.8.1.6 Duncan's Post Hoc Test

In statistics, Duncan's new multiple range test (MRT) is a multiple comparison procedure developed by David B, Duncan in 1955. Duncan's MRT belongs to the general class of multiple comparison procedures that use the studentized range statistic q_r to compare sets of means.

Duncan's new multiple range test (MRT) is a variant of the Student-Newman-Keuls method that uses increasing alpha levels to calculate the critical values in each step of the Newman-Keuls procedure. Duncan's MRT attempts to control family wise error rate (FEW) at $\alpha_{ae} = 1 - (1 - \alpha_{pc})^{k-1}$ when comparing k, where k is number of groups. This results in higher FEW than unmodified Newman-Keuls procedure which has few of $\alpha_{ew} = 1 - (1 - \alpha_{pc})^{k/2}$.

David B. Duncan developed this test as a modification of the Student-Newman-Keuls method that would have greater power. Duncan's MRT is especially against false negative (Type II) error at the expense of having a greater risk of making false positive (Type I) errors. Duncan's test is commonly used in agronomy and other agricultural research.

3.9 Null Hypotheses

The starting point in all statistical tests is the statement of null hypothesis (Ho), which is a 'no difference hypothesis'. In other words, null hypothesis states that there is no significant difference between the samples under study. It makes a judgement about whether the obtained differences between samples are due to some true difference or due to some chance errors. The null hypothesis is formulated for the express purpose of being rejected because it is rejected, the alternative hypothesis (H_1), which is an operational statement of the investigators research hypothesis, is

accepted. The tests of null hypothesis are generally called tests of significance, the outcome of which is stated in terms of probability figures or levels of significance.

If the difference between the experimental group and the control group is very small, the experimenter is likely to accept the null hypothesis, indicating the fact that the small difference between these two groups is due to sampling error or some other chance fluctuations. On the other hand, if the difference between the experimental group and the control group is too large, the experimenter is likely to refute or reject the null hypothesis, indicating the fact that the obtained differences are real differences between or among the samples under study.

3.9.1 Level of significance

In statistical method, levels of significance is an unavoidable term and is used to know whether a difference is to be taken statistically significant or not and depends upon the probability that the given difference could have arisen "by chance" usually a difference is marked "significant" when the gap between the two sampled means points to or signifies a real difference between the parameters of the population from which the samples were drawn. It must be kept in mind that the judgments concerning are never absolute, but on the contrary range over a scale of probability and our confidence increases as chances of wrong judgment decreases.

Investigators, experimenters and research workers have chosen several arbitrary standards for convenience that are called levels of significance of which 0.05 and 0.01 levels are most often used. The confidence with which an experimenter rejects or accepts a null hypothesis depends upon the level of significance adopted. When a t-value is 1.96 or more, we may reject the null hypothesis at 0.05 level of

significance and when a t-value is 2.58 or more, we reject the null hypothesis at 0.01 level of significance. Further, the 0.01 level is more accurate than the 0.05 level.

If the null hypothesis is rejected at 0.05 level, it means that 5 times in 100 replications of the experiments, the null hypothesis is true and 95 times this hypothesis would be false. In other words, this suggests that a 95% probability exists that the obtained results are due to experimental treatment rather than due to some chance factors. The 0.01 level suggests that 99% probability exists that the obtained results are due to the experimental treatment and hence, once in 100 replications of the experiments, the null hypothesis would be true.

3.9.2 One-tailed and two-tailed test of significance

Under the null hypotheses, difference between the obtained means (M_1-M_2) may be either plus or minus and as often in one direction as in other from the true (population) difference of zero.

One-tailed test is a directional test that indicates the direction of difference between the samples (control group & experimental group) under the study. When a hypothesis indicates a direction of difference rather than the mere existence of a difference. We generally use a one tailed test when a hypothesis states that the mean of the experimental group is not higher/lower than the mean of the control group then it is called a directional null hypothesis, which indicates a direction of difference. In this case, we are concerned with only one end of the distribution. Putting it in terms of a normal curve, we are concerned with only one end of the curve. In this situation, we apply one-tailed test for a one-tailed test. For this test at 0.05 level, the 5% area of rejection is either at the upper tail or at lower tail of the curve and the t-value is ± 1.64. For a one tailed test at 0.01 level, the t-value for rejection of the null hypothesis is ± 2.33.

A two tailed test is one in which the investigator is interest in evaluating the difference between the groups. The direction of difference is of no importance here. The null hypothesis states that the mean of the experimental group is equal to the mean of the control group, that is, there exists no difference between the means of the experimental group and control group. In this case, we are concerned with both tails of the distribution. For a two-tailed test at 0.05 level, the 5% area of rejection is divide equally between the upper and lower tails of the curve and the t-value is ±1.96. For this test at 0.01 level, the t-value is ± 2.58.