BASIC STATISTICS:

A LOOKING BEYOND APPROACH I

FOR EDUCATION AND SOCIAL

SCIENCE STUDENTS

INTRODUCTION TO BASIC EDUCATION STATISTICS

In our world today characterized by multiple applications of sciences and technology, the use of the field of statistics seems to be the most recurring decimal in application. Statistics in the recent past has offered vital assistance to dissimilar subjects like medicine, sociology business administration, accountancy, zoology, rural development and social works, and indeed public health and education, In spite these applications of statistics and its rapid development, so many people:laymen and professionals alike see it through different perspectives. A statistician is sometimes thought of as a person who manipulates

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(For Education and Social Science Students)

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TABLE OF CONTENTS

UNIT ONE

INTRODUCTION TO BASIC EDUCATION STATISTICS

In our world today characterized by multiple applications of sciences and technology, the use of the field of statistics seems to be the most recurring decimal in application. Statistics in the recent past has offered vital assistance to dissimilar subjects like medicine, sociology business administration, accountancy, zoology, rural development and social works, and indeed public health and education, In spite these applications of statistics and its rapid development, so many people: laymen and professionals alike see it through different perspectives. A statistician is sometimes thought of as a person who manipulates numbers in order to prove a point. On the other hand some students of sociology or other social sciences has tended to adore the statisticians a demi-god or someone who with the aid of magical computer can make a study-scientific. This of course may be as a result of the mathematical application of statistics. Statistics has existed before man was created and it became an aspect of man's culture; nothing could be done by man that is not statistical.

But in this exposition we are going to discuss statistics as a special field of study especially in the global filed of social sciences, and education. Before we get into the definition of the concept statistics we shall in the words of Blalock H.M. Jr. (1979) – state what statistics is not. Statistics first of all is not a method by which one can prove almost everything one wants to prove. There is nothing inherent in statistical methods to prevent the careless or intellectually dishonest individual from drawing his or her own conclusions in spite of data, however and one in course of a study like this is guard against possible misuses, of this tool.

Statistics is not simply a collection f fact. If it were there would hardly be much point in studying the subject. Nor is statistics a substitute for abstract theoretical thinking of for careful examination of exceptional cases. Finally statistics is not a substitute for measurement of the careful construction of an interview schedule or other instruments of data collection. Having stated what statistics is not, one would then ask what statistics? Of Course the Aristotelian dictune may help. "Initio disputandi est definition nonomis" (for any discussion to be intelligible it must start with the definition of terms).

Definition of statistics

As a matter of fact, the definition of statistics is an uphill task, it is indeed difficult to say precisely and satisfactorily what a statistics stands for. This is because satisfactorily what statistics stands meaning as many as the perspectives from where the statisticians conceives denominator for all the definitions ever knows that is, that statistics is a body of methods or approaches meant for decision making to solve human problems in socio-cultural plane. Let us explore a bit some of these revelations.

A professor of social research Norman R. Kurtz (1983) believed that statistics is a body of methods; these methods are used to assemble, describe, analyses numerical data pertaining to various aspects of social life. For example statistics are used to describe such things as the number of members in an average family, relationship between family size and amount of income and the correspondence between amount of family income measure of attitudes. These characteristics above are called variables.

A social statistician, Nwabookei P. O (1991) said statistics is collection, compilation, distribution, presentation, and analysis of data or information. Taking a pragmatic approach Blalock (1976) see statistics, as the summarizing of information in such a manner as to make it more usable. And secondly as playing an inductive role which involve either making generalizations about some population, on the basis of a sample drawn from this population, or formulating general laws on the basis of repeated observations. Walpole (1968), said. "The science of statistics deals with methods used in the collection, presentation, analysis, and interpretation of data."

Hence we can convincingly say that statistics is a body of methods of collection, compilation, distribution, presentation and analysis of data or information for decision making to solve man's social problems in his social life. The statistician is basically concerned with the chance outcomes that occur in scientific investigations.

Statistics is subdivided into two; Descriptive and inferential or inductive statistics. Descriptive statistics is the body of methods used to assemble, organize, and display distributions of variables (called data).

Descriptive statistics involve such measurement like (1) The meas central tendency. (2) The measures of variability (3) The mea relative standing or position and (4) The measures of association relationship.

INFERENTIAL STATISTICS

The second category of statistical methods is inferential statistics are used to used to infer the characteristics of a population observations made on a sample. Inferential or inductive statistics it possible to representing the population. The social research relies on the inferential statistics because ordinarily the study populations is too difficult and expensive.

IMPORTANCE OF STATISTICAL RESEARCH

Theoretical Model
Proposition

Make decisions about
The fit data and theory

Variables and
hypotheses

HISTORY OF STATISTICS

Statistics has history as old as man on earth and even beyond, some statisticians contended. In early biblical times statistics was used to provide information related to taxes, words, agricultural crops, and even athletic endeavors. The – church form early times uses a lot of statistical records.

Inferential statistics, depending largely on the theory of probability has made its greatest impact since the 16^{th} century. Statistics today is as a result of active research of many scientists for over five hundred years behind.

Walpole (1967) believed that it was perhaps unquenchable thirst for gambling that led to the early development of probability theory. The over zealous gamblers of the old in an effort to maximize their winnings approach the mathematician for the development of an optimum strategy. The answer to the problems of the gamblers were supplied by the great mathematician like Pascal, Leibnitz, Fermat, and James bernoulli.

Some others include Demoivre who discovered the equation for normal distribution in 1733. It was the normal distribution that formed the basis for the theory of inductive or inferential statistics. These bell shaped distribution is also known as Guassian distribution in honor of Guass (1777 – 1855) who derived its equation from a study of errors in repeated measurement of the same quantity Laplace linked statistics to astronomy for the first time.

In the 19^{th} century a statistician from Belgium, Adolph quetelet (1796-1874) apply statistical method to education and sociology.

In the field of social sciences, the most prominent statistician was Sir Francis Galton (1822-1911). His most notable contributions were in the fields of heredity and eugenics where he successfully and with Karl Pearson (1857-1936) developed the theory of sampling.

Statistics in the twentieth century ushered in developments of methods for decision-making based on small samples by William S. Gosset. This was discovered while working for an Irish brewery who could not grant his permission to publish his results for fear of competitors. Gosset therefore published his results under the name "Students"

It then answers t-distribution. Further contributions on small sample theory and also in experimental designs were discovered by Sir

of fig.1. Fig.1.

Ronald Fisher known as F-distribution and he is regarded as the most outstanding statistician till date.

There are several noteworthy statisticians in the wold today still working on new theories and applications of statistics. Today statistics is shifting from classical approach to estimate theory to Bayesian approach. Professors Adichie and Onubuogu and some Africans statisticians are still working on objective information provided by the random sample.
Statistics become a separate programme of study in the 1950s in the western World. The availability of electronic Computers is certainly a major factor in the modern-development of statistics.

In the future, we shall see many new theories developed. Productive research is been anticipated in the areas of mathematics statistics, probability, the theory of games, linear programmes stochastic processes, and experimental designs. Today, nothing could be said to be useful to a research worker than the application of statistics.

BASIC CONCEPTS

The measure of central tendency tells us much but it does not by any means give us the total picture of the sample we have measured. We need, in addition to know about the typical performances of a group of students to have an idea of how individual learners very amongst themselves and how each leaner stands in relation to the typical performance.

Let us take two illustrations. Suppose that we have two distribution scores on the same test, each with a mean of 105. In the first of these, the highest score is 115 and the lowest is 95. The second distribution on has a highest score of 135 and a lowest score of 75. The range of the first distribution is 21 and that of the second distribution is 61. We recognize immediately that there is a difference between the two scores in variability.

The distribution for two such groups when ploted resemble those of fig.1.

Fig.1. two tests with the same Mean 105. But with different ranges (dispersion).

UNIT TWO

MEASURES OF CENTRAL TENDENCY

Assuming an instructor had given a hundred item multiple choice examination to a class of thirty students, he could summarize the performance of the class by indicating the typical scores or how many of the hundred questions most students had answered correctly.

He could also describe hoe the scores spread out along the 100 – point scale or how students tended to differ from one another.

The characteristics used by this instructor to describe his test scores represent the two major types of descriptive statistical measures we are going to discuss in this unit- measures of central tendency and measures of variability.

MEASURES OF CENTRAL TENDENCY:

One of the vital information that a research worker has to seek is that of finding out from the data what responses or values can be regarded as typical of the sample of people and things he has studied.

If a class is tested in spelling, what level of performance can be said to be representative of that class? If the height of the members of a class are measured, what height can be representative of that class? A summary of information of the sort demanded by these questions wold provide some basis for describing the characteristics of the group in items of spelling ability and heights. Such typical responses or values are referred to as MEASURES OF CENTRAL TENDENCY. There are three main measures of central tendency – The MEAN, MEDIAN and MODE.

The Mean:

One of the most commonly employed measures of central tendency is the mean. The mean is actually the arithmetic average of a set of scores. If, for example you wish to determine the average height of each individual, add all the heights and divide by the number of students in the group. Suppose we have five heights in metres 1.0,1.2, 1.5, 1.8 and 2.0, the mean would be $\frac{1.0+1.2+1.5+1.8+2.0}{5} = \frac{7.5}{5} = 1.5m$

The equation for mean is $$\bar{x} = \frac{x}{N}$$

From the calculation, $$x = 7.5$$
$$n = 5$$
$$x = \frac{7.5}{5} = 1.5m$$

in educational and psychological research, the mean is used as an index of central tendency more often than any other measure.

Finding the mean of ungrouped data

If we have a set of ten scores: 10, 12, 8, 11, 10, 8, 12, 19, 9, 7, we organize them into a frequency distribution.

x	F	Fx
13	1	13
12	2	24
11	1	11
10	2	20
9	1	9
8	2	16
7	1	7
Total	**N = 10**	**fx = 100**

$$\bar{X} = \frac{fx}{N}$$

$$= \frac{100}{10}$$

Calculating the mean for a grouped data:

A grouped data is a set of scores whose interval size is more than 1. If we have a set of scores with a wide range, it is better.

Class Interval	**Mid x**	**F**	**Fx or mid x**
56-58	57	2	114
53-55	54	3	162
50-52	51	4	204
47-49	48	6	288
44-43	45	8	360
41-43	42	10	420
38-40	39	12	468
35-37	36	10	360
32-34	33	8	264
29-31	30	6	180
26-28	27	5	135
23-25	24	4	96
20-22	21	2	42
		N=80	fx = 3093

Fig (1) $\bar{x} = \frac{fx}{N} = \frac{3093}{80} - 38.7$

To organise the scores into grouped frequency distribution. We first group the scores into class interval in order to reduce the number to a manageable size. We then proceed to list them point of each class interval, multiply with the frequency of the number of scores in the set. This procedure deals with large number and makes computation cumbersome.

Method 2:

Class Interval	F	X^p	fx^p
56-58	2	6	12
53-55	3	5	15
50-52	4	4	16
47-49	6	3	18
44-46	8	2	16
41-43	10	1	10
38-40	12	-1	-10
35-37	10	-1	10
32-34	8	-2	-16
29-31	6	-3	-18
26-28	5	-4	-20
23-25	4	-5	-20
20-22	2	-6	-12
	N=80		$Fx^p = 9$

Fig (ii)

Method 2 in fig (ii) takes care of these large numbers. The procedure states with an arbitrary origin (AO) or reference point. The steps are as follows:

(i) Take the midpoint of one of the intervals as our AO. It makes no difference which interval it takes but the interval about the middle of the distribution is more preferable. In this example, the mid-point of the interval 38-40 = 39, is taken as our AO

(ii) Another column (x^p) is set up and reads "X prime "it is defined as the deviation from the AO. Since the interval 38 – 40 is taken, there is deviation from AO and a zero is placed in the column x^p for this interval. Interval 41 – 43 deviates + 1 from the AO, we enter 1 in column x^p for that interval. This is continued upward until each interval has a value. The same as done for the intervals below. This time there is a minus sign in front of each of our deviations.

(iii) Multiply each of these its x^p and enter the product in the column fx^p.

(iv) Sum this column (fx^p)

(v) The mean is then computed by substitution in this equation.

$$\bar{x} = (AO) \quad + fx^p \quad (i)$$

L= the interval size,

Then $X = 39 + \frac{-9(3)}{80}$

$$= 39 + \frac{-27}{80}$$

$$39 + (-.3375)$$

$$= 39 - .34 = 38.66$$

$$= \underline{38.7}$$

The answer is the same as in method 1. Usually, there is a sight difference between the mean obtained by this procedure and that obtained by adding all the scores and dividing by N. The difference is brought about by error of grouping but has no practical signification.

Averaging Mean:

Often, we are given the means of two or more samples and we wish to find the mean of the measures combined into one group. This is done by computing the weighted mean. Suppose a test is given to three groups with the following results.

$\bar{x} = 60$ $\quad N_1 = 10$

$\bar{x} = 60$ $\quad N_2 = 10$

$\bar{x} = 60$ $\quad N_2 = 10$

$\bar{x}$ and N. stand for the mean and number of the individuals in the groups 1,2,3 respectively. We wish to find the mean of the three groups combined

X	N	x
60	10	600
50	60	3000
40	30	1200
	N = 100	X=4800

$$\bar{X}_1 = \frac{\Sigma X}{N} \quad \frac{4800}{100} = 48$$

This mean cannot be obtained by averaging the three sample means. In this case, the average of the three means would be 50 only when the number in each sample is identical can the means of the sample be average directly to obtain the mean of the total groups.

The median:

Another measure of central tendency employed in statistics is the median. By definition, the median is the midpoint in a set of ranked scores. Thus if all scores of students who have taken a test were ranked (highest to lowest) and point was selected such that the same number of scores were both above and below it, the point would be the median. In other words, the median is the point in a frequency distribution on either side of which lie 50 percent of the cases. The calculation of the median is very simple. Let us examine the scores,

7,9,11,12,13,13,15

The middle score is 12 and is therefore the median of this set of scores. In an even number of scores 5, 6, 7, 9, 11, 12, 14 the median is the sum of the two middle numbers divided by 2 i.e. $\frac{9+2}{2} = \frac{20}{2} = 10$

This illustrates that the median is not necessarily a score but a point that divides a distribution into two equal halves. The median for a set of scores might have a decimal point even though all the students obtained whole numbers with no decimals. For example, the median for these our scores 10, 11, 12, 13 would be 11.5.

Finding the median of Grouped Data:

When a set of data is grouped in class intervals, the median is still the score point below and above which 50 percent of the scores fall. The calculation is a bit more complex than in the ungrouped data. To illustrate this calculation, we use a distribution which has 80 scores. We are looking for the score point blow and above which would lie 40 scores.

Score Limits	Exact limits	F	Cumf
56-58	55.5-58.5	2	80
53-55	52.5-55.5	3	78
50-52	49.5-49.5	4	75
47-49	46.5-49.5	6	71
44-46	43.5-46.5	8	65
41-43	40.5-43.5	10	57
38-40	37.5-40.5	12	47
35-37	34.5-37.5	10	35
32-34	31.5-34.5	8	25
29-28	28.5-31.5	6	17
26.28	25.5-28.5	5	11
23-25	22.5-25.5	4	6
20-22	19.5-22.5	2	2

If we look at the cumf we would notice that the score we are looking for would fall at the interval with exact limits of 37.-40.5. That interval contains 12 scores as is shown on the column.

The total number of scores up to and including that class interval is 47 counting from below the frequency column. The total number of scores below that class interval is 35. We therefore need 5 scores from the class interval that contains 12 score points.

We shall take $\frac{5}{12}$ x3 (i)

$= \frac{5}{4} = 1.25$

If we add 1.25 to 37.5, we will have 38.75. This is scores point below and above which 40 scores fall. The formula for computing the median is:

$$L + (\frac{N}{2} - F) \qquad \text{(i)}$$

L = Lower exact limit for the class interval containing the median.

$\frac{N}{2}$ = Half of the total number of scores in the distribution.

F = Cumf of the class interval below is that containing the **median.**

f = frequency of the class interval containing the median.
i = interval size.

Alternatively, if we subtract the remaining score points which is from the upper exact limit of the class interval containing the median, we shall have 40.5- 1. 75 = 38.75

The Mode:

The mode of a set of scores is the score that has the highest frequency. For example, if we have a set of 20 scores distributed as follows

X	F	
20	1	
18	2	the mode of this
17	2	distribution is 15
16	3	which occurred 7
15	7	times in the set.
14	3	
13	2	
	N=20	

The mode of a set of ungrouped scores, is the score that has the highest number of occurrence of frequency.

In a grouped distribution, the mode is the midpoint of the class interval that has the highest frequency. e.g.

X	F	
30-32	1	the mode of this
27-29	1	distribution is the
24-26	3	midpoints of the class
21-23	5	interval that has a
18-20	8	frequency of 8. The
15-17	5	class interval is 18 - 20
12-14	4	and its midpoint is
9-11	2	$\frac{18+20}{2} = \frac{38}{2} = 19$
6-8	1	

Bimodal Distribution:

Sometimes one comes across a distribution that has two modes, such distribution is said to be BIMODAL. An achievement test scores of a class of students made up of extreme abilities i.e, very fast learners and very slow learners, would likely yield a bimodal distribution. That would be a sign that the group is not homogenous.

X	F
95-99	3
90-94	5
85-89	8
80-84	4
75-79	8
70-74	2

AN ESTIMATED MODE

This is the actual mode of a distribution that has an undetermined mode. It can be estimated by the use of the formula

Mo	=	3Mdn – 2M where
Mo	=	Mode
Mdn	=	Median
M	=	Mean.

USES OF THE VARIOUS AVERAGES

(1) It is the average that takes account of all the scores in data. It reflects the values of extremely high and extremely low score in a data. As a result, it is the values of the best average to find when the purpose is to get an average that reflects the values of all the scores in the data. For example, to evaluate the performance of a child in a given subject during the session, the teacher has to get the arithmetic mean of all the tests that count towards the student's final evaluation of the year.

(2) When further cautions are required in the process of analysing a set mathematical manipulation standard deviation, rho.

THE MEDIAN

(1) When the purpose of an operation is to give an average which is not affected by extreme figures in the set of data, the median would be the average to use. For example, the following are annual salaries of five primary school teachers: N2, 200.00; N2, 600.00; N3, 000.00 N3, 200.00. If we compute the mean, the average salary will be N3,650.00. the last extreme high salary (N8, 200.00) swells up the average and gives a distorted view of the actual situation.

We shall then say that when a set of data contains a few extremely high or few extremely low scores relative to the majority of the scores, the most appropriate with information relating to salaries of workers, house rents, ages of people, test scores in a badly skewed distribution.

(2) When a distribution is open-ended i.e its upper limit or lower limit is not known, the median would be the best average to calculate eg

Ages				F
18 years and above				10
15	-	17		30
12	-	14		46
9	-	11		33
Below		8 years		11
			N =	130

To find an average age of such a group the median would be preferable.

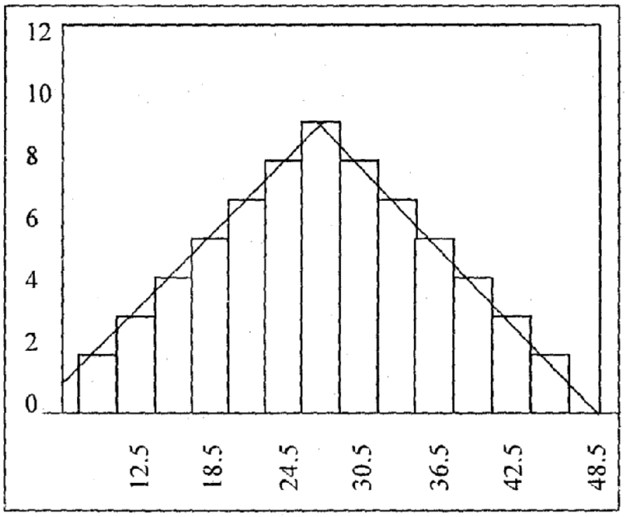
The mode

The usefulness of the mode lies in its being the easiest average to find in al large set of data. By more inspection, the score that occurs most frequently in the set can be identified when the data is organized into a frequency distribution. Apart from that, the mode is not of much use as it tells us nothing about the distribution of other scores in the set of data. The mode is very unstable. A change in the location of one case will bring a change in the mode of the distribution.

Values of Measures of Central Tendency:

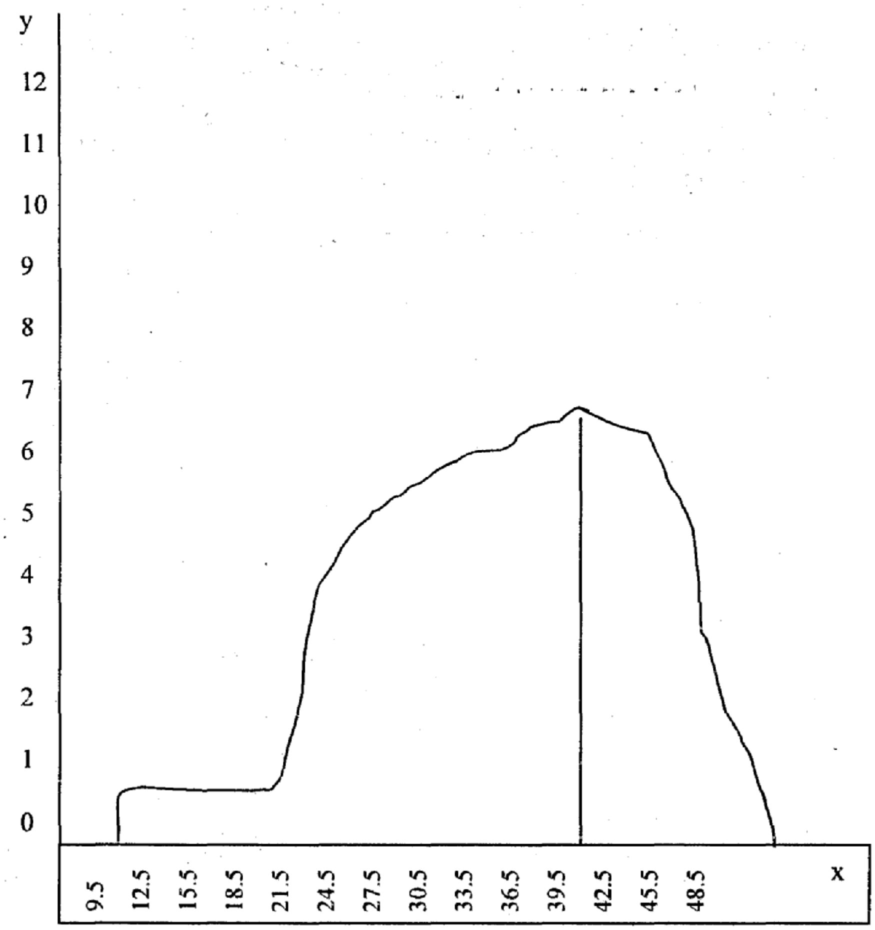
The values of the three averages or measures of central tendency – the mean, median and mode – can give us an identification about the summary of a given distribution is not shown.

(a) In a perfectly symmetrical distribution the value of the mean, median and mode are equal.



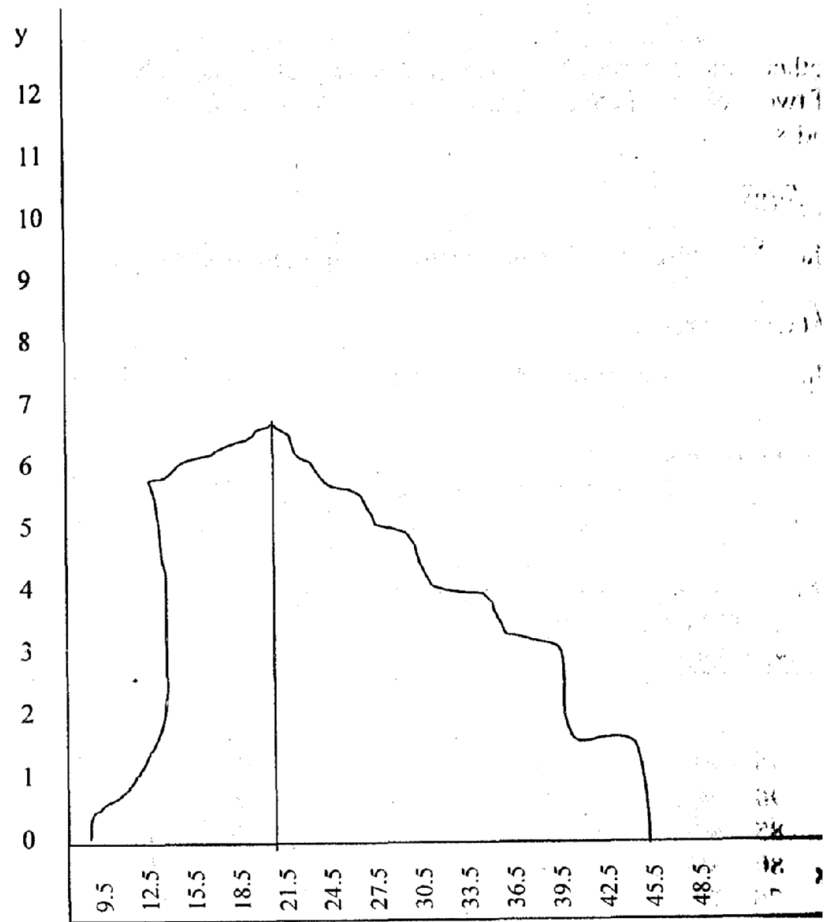
(b) In skewed distribution, the mean is usually pulled towards the side of as symmetry i.e the side lacking most in symmetry.

(c) In a negatively skewed distribution, the mode has the highest value followed by that of the median and the mean has the least value.



The Mode is 41, Mean 36.8, Median 37.7.

(d) In a positively skewed distribution, the mean has the highest value following by that o the median and mode has the least value.



Mean = 21.2, Median = 19.4, Mode = 17.0.

Other Averages:

Geometric Mean: This mean is in psychophysics or kother data concerned with measures of rates of change. The GM of two measures is the square root of their product. The GM of 2 and 8

$= \sqrt{2(8)} \quad = \sqrt{16 = 4}$

The GM of three measure is the cube root of their product GM

$\sqrt[3]{(x_1)(x_2)(x_3)} = x_{=}$

This average is not used when the value of a measure is 0 or has a negative.

The Harmonic Mean:

It is used in averaging rates when the time factor is variable and the act being observed is constant.

$$HM = \frac{1}{1/N/(1/X_1 + 1/X_2 + 1/X_3 + \ldots\ldots\ldots 1/X_N}$$

Assignment:

A

X	F
95 – 99	1
90 – 94	1
85 – 89	2
80 – 84	3
75 – 79	5
70 – 74	6
65 – 69	10
60 – 64	5
55 – 59	4
50 – 54	3
45 – 49	2
40 – 44	1
35 – 39	1
30 – 34	1
	$f = 45$

B

X	F
10	2
9	3
8	5
7	10
6	6
5	3
4	2
	$\sum f = 31$

For distribution A

(a) Calculation the mean using the coded method. Method 2p.4

(b) Calculation the median.

(c) Find the mode.

(d) Using the values of the averages as your guide, describe the shape of the distribution

For distribution B

(a) Calculation the mean using the formula

$$\overline{X} = \frac{fx}{N}$$

(b) Find the median.

(c) What is the mode?

UNIT NINE

DATA ANALYSIS

The decision that a researcher will supposedly make is a decision about the truth or falsity of a statistical hypothesis. There are at least two types of hypothesis to be identified and distinguished: scientific hypothesis and statistical hypothesis.

A scientific hypothesis is a suggest solution to a problem. It is an intelligent, informed and educated gues. It is an empirical proposition in the senses that it is testable by experience. Experience is relevant to the question as to whether or not the hypothesis is true.

Statistical hypothesis on the other hand is merely a statement about an unknown parameter. "H: U= 128" is a statistical hypothesis; it is an assertion that the unknown mean of a particular population is 128. Such a statement is either true or false.

The decision "H: U= 128 is false" is an example of the type of decision with which hypothesis testing is concerned. H: P = 0 where P is the correlation coefficient in a bivariate normal distribution is another example of a statistical hypothesis.

H: $\sigma 1^2 = \sigma 2^2$ is a statistical hypothesis stating that the variance of population 1 and 2 are equal.

NULL HYPOTHESIS

A common used method of stating hypothesis is research is known as the null hypothesis of ten symbolized as Ho. This way of phrasing hypothesis postulates that there is no (null) relationship between the variables under analysis. For example, a null hypothesis applied to a test mean differences between two groups of pupils would be: There is no difference between the men performance of the two groups.

Ho: $U_1 = U_2$ (null hypothesis)

H_A : $U_1 \neq U_2$ (alternation hypothesis)

If it is found on the basic of statistical test that there is a significant mean difference, the null hypothesis is rejected. If on the other hand, it is found that whatever mean difference exist may occur frequently because of mere chance, the null hypothesis cannot be rejected. If Ho is not true, the alternative hypothesis (H_A) must be true.

A null hypothesis is a statement that there is no actual relationship between variance and that any observed relationship is only a function of chance.

TYPE I AND TYPE II ERRORS

The investigator will either retain or reject the null hypothesis is true, the investigator is correct if the retains it and in error if he rejects it. The rejection of a true hypothesis is labeled a type I error. The type I error is made when a true hypothesis is rejected. If the null hypothesis is false, the investigator is in error if he retains it and correct if he rejects it. The retention of a false null hypothesis is labeled a type II error.

LEVEL OF SIGNIFICANTS

All scientific conclusions are statements that have a high probability of being correct rather than statement of absolute truth. How unlikely must the null hypothesis be before one rejects it. The consequence of rejecting a true null hypothesis type I error wary with the situation. Therefore, researchers usually weigh the relative consequences of type I error and type II errors and decide before conducting their experience how strong the evidence must be before they will reject the null hypothesis. This predetermined level at which a null hypothesis will be rejected is called the level of significance.

Type I errors would be a voided by always retaining the null hypothesis and type II errors by always rejecting it neither of these two methods are productive.

If the consequences of a type I error would be very serious but a type II error would be of little consequence, the researcher might decide to risk the probability of a type I error only if the estimated probability of the observed relationships being due to mere luck is one chance in a thousand or less. This is called testing the hypothesis at the 0.001 level of significance. In this case the researcher should be careful not to declare that a relationship exists when there is no relationship. But he is accepting a high probability when in fact a relationship does exist.

If a type I error is not a serious one, a researcher may decide to declare that a relationship exists if the probability of an observed relationship is due to mere luck is one chance in 10 or less. This is called testing the hypothesis at the 0.01 level of significance. Here the investigator is taking only moderate precautions against a type I error, yet not taking a great risk of a type II error.

The level of significance is the probability of a type I error that an investigator is willing to risk in rejecting a null hypothesis. If an investigator sets his level of significance at 0.01, it means that he will reject the null hypothesis it the estimated probability of his observed relationship being a chance occurrence is one in a hundred. The most commonly used levels of significance.

In statistics, the word "significant" is very important or meaningful. It means less likely to be a function of chance than some predetermined probability. The level of significance is always determined before running an experiment after weighing the seriousness of type I and II errors. If the data derive from the completed experiment indicate that the probability of the null hypothesis being true is less than the pre-determined acceptable probability, the results are declared to be statistically significant. If the probability the greater than the predetermined acceptable probability the results are described as non-significant. i.e. the null hypothesis is retained.

WAYS OF TESTING NULL HYPOTHESIS T- TEST

A series of distribution called t-distributions for testing hypothesis concerning the population mean using small samples have been developed. When the sample is infinite, the t- distribution will be the same as the normal distribution.

As the sample size becomes smaller, the t-distribution becomes increasingly different from z- distribution. The t- curve does not approach the base line as rapidly as the normal curve.

To test a hypothesis regarding the difference between two means using the t- distribution, the procedure is the same as that used in applying the z-distribution. The only difference in using the former is that we need to determine the number of degrees of freedom for the samples.

DEGREES OF FREEDOM

The number of degrees of freedom refers to the number of observation free to vary around a constant parameter. We could use the following formula to find the degrees of freedom.

$$\boxed{Df = N - 1}$$

For a set of numbers with two means, we have two restrictions. Therefore, the formula for finding the degrees of freedom is

$$\boxed{Df = N - 2}$$

The t- test for Independent Samples

A researcher can draw two samples randomly from a population and assign a specific experimental treatment for each group. After being exposed to this treatment, the two groups are compared with respect to certain characteristics in order to find the effects of the treatment. A difference might be observed between the two groups after the observation of this difference might not be statistically significant, attributable to chance. The index used to and the significance of the difference between the means of the two samples in the case is called the t-test for independent are drawn independently from population without any pairing or other relationship between the two groups. Examples of computation of t- value, <u>for two sample means (Independent samples)</u> .

Suppose a researcher is interested in finding out whether stress affects problem solving performance the first randomly selects two groups of about is subjects from among the students in a course for the purpose of his research. The scores on the dependent variable, problem solving performance and the deviation scores (x) and the squared deviation scores (X^2) are shown in the table.

Since the members of the two groups are selected and assigned randomly, the mean performances of the two groups in a problem solving task should not significantly differ prior to treatment. After the treatment, however, the mean performance of the two groups should differ significantly if stress actually is related to problem solving performance.

The data presented below are the performance scores of the members of the two groups one of which worked under stress conditions and the other under relaxed (non- stress) condition.

Group I	(Non- stress)		Group II	(Stress condition)	
X	X1	X^2_1	X_2	X2	X^2_2
18	+4	16	13	+3	9
17	+3	9	12	+2	4
16	+2	4	12	+2	4
16	+2	4	11	+1	1
16	+2	4	11	+1	1
15	+1	1	11	+1	1
15	+1	1	10	0	0
15	+1	1	10	0	0
14	0	0	10	0	0
14	0	0	10	0	0
13	-1	1	9	-1	1
12	-2	4	9	-1	1
11	-3	9	8	-2	4
10	-4	16	7	-3	9
8	-6	36	7	-3	9

$\overline{X}_1 = \frac{X_1}{N_1} = \frac{210}{15} = 14, \; X^2{}_1 = 106$

$\frac{x_2}{N_2} = \frac{150}{15} = 10, \overline{X}_2 = 10$

The table shows that the mean performance score of the subjects in the stress group is 10 and the mean performance of other group (non-stress) is 14. Clearly there is a difference. We can now determine whether the difference could easily occur by chance now or not. To do this we should estimate how much difference between the groups would be expected through chance alone under a true null hypothesis.

First, determine the standard error of the difference between two means $6X - X_2$. The formula for this for independent sample is:

$$\acute{O}X_1 - \overline{X}_2 = \sqrt{\sum \frac{X^2_2 + X^2}{n_1 + n_2 - 2} \left(\frac{1}{n_1} + \frac{1}{n_2}\right)}$$

GROUP I high stress		GROUP II Moderate stress		GROUP III No stress	
X^1	X^2_1	X^2_2	X^2_2	X^3	X^2_3
191	361	22	484	15	225
18	324	20	400	14	196
17	289	19	361	14	19 6
16	256	18	324	13	169
15	225	17	289	13	169
15	225	16	256	12	144
14	196	16	256	12	121
13	169	15	225	11	121
12	144	14	196	11	121
11	121	12	144	10	100
100	2310	169	2935	125	1585
X_1	X^2_1	ΣX_2	ΣX^2_2	ΣX_3	ΣX^2_3
$X_1 = 15$		$X_2 = 16.9$		$X_3 = 12.5$	

GRAND MEAN = **14.80** = $\overline{X}$

The means for the 3 groups differ from each other and from the overall mean for all 30 subjects. To find whether the differences among these are great enough to be statistically significant, the F- ratio should be computed. This is done step by step as follows:

Step I: Find sum of the squared deviation of each of the individual scores from the ground mean. This index is called total sum of squares and is found by applying the following formula

$$\Sigma X^2t = \Sigma X^2 - \frac{(\Sigma X)^2}{N}$$

Substituting we get: $= X^2t = 6830 \quad \frac{(444)}{30} = 258.8$

Step II: Find the sum of the squared deviation of the group means from ground mean. This index is called the sum of squares between groups and is found using the following formula:

$$\Sigma X^2_b = \frac{(X_1)^2}{n_1} + \frac{\Sigma(X_2)^2}{n_2} + \ldots\ldots\ldots\ldots\ldots\ldots \frac{\Sigma(X)^2}{N}$$

Where:

$\acute{O}\bar{X}_1 - \bar{X}_2$ = the standard error of the difference between two means

n^1 = the number of cases in group I

n^1_2 = the number of cases in group II

X^2_1 = the sum of the squared deviation score in group I

X^2_2 = the sum of the squared deviation score in group II.

The standard error of the difference between two means is sometimes referred to as the error term for the t- test. This would be as follows:

$$\acute{O}\bar{X}_1 - \bar{X}_2 = \sqrt{\frac{106}{15} + \frac{44}{15-2}\left(\frac{1}{15} + \frac{1}{15}\right)}$$

$$= \sqrt{150\left(\frac{(2)}{28}\right)}$$

$$\sqrt{0.714} = 0.84$$

This tells us the difference that would be expected through chance alone if the null hypothesis is true.

Is the observed difference sufficiently greater than the expected value to enable us reject the null hypothesis? To answer this we have to calculate the ratio of the two numbers. This is ratio is called the t-ratio with the following formula:

$$\boxed{t = \frac{\bar{X}1 - X2}{\acute{o}X1 - QX2}}$$

Where:

$X_1 - X_2$ = the observed difference between two means

$OX_1 - OX_2\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$ = the standard error of the difference between two means.

In our example the value $= \frac{14 - 10}{0.84}$

$= 4.76.$

Next calculate the degrees of freedom thus:

$= n_1 + n_2 - 2$
$= 15 + 15 - 2$
$= 30 - 2$
$= 28.$

Note that the observed or calculate t= 4.76 and the table t with the degrees of freedom 28 at the 0.05 level of significance = 2.048.
Therefore, obtained/observed/calculated t>2.048
Then Ho at the 0.01 level, table t = 2.763.

Obtained t> 2.763.

Then Ho is rejected at 0.01 level of significance. It can be concluded that the value of 4.76 was not only significant at the 0.05 level ($P<0.05$) but also significant at the 0.01 level ($P<0.01$). We can therefore conclude that stress does affect problem solving performance.

The t- test for non-independent or correlated samples

In independent sample each member is chosen randomly from the population, and the composition of one group has no bearing on the composition of other group. Sometimes, the researcher may wish to match the subjects of his two groups on some qualities that are important to the purpose of his research or he may wish to compare the means obtained by the same group under two different experimental conditions. In such cases the groups are no longer independent in as much as the composition of one group is related are expected to be correlated in such cases.

Therefore, the t- test for dependent means must be used. Let's consider an example. Suppose we wish to know whether making a statistics course affects the attitudes of VTE 303 students towards research. To investigate this we select a statistics class and obtain attitude measures towards research from the students on the first and last days of class. Let us suppose the following data are collected. Columns 2 and 3 show the scores of each presents the difference between the first and second tests. Columns 4 presents the difference between the first and the second score of each student. The sum of these differences amounts to 30. The mean of these differences = +2, ie 30 (D) divide by N = the number of paired observations or 15. The last column shows the square of the difference.

GROUP I high stress		GROUP II Moderate stress		GROUP III No stress	
X^1	X^2_1	X^2_2	X^2_2	X^3	X^2_3
191	361	22	484	15	225
18	324	20	400	14	196
17	289	19	361	14	19 6
16	256	18	324	13	169
15	225	17	289	13	169
15	225	16	256	12	144
14	196	16	256	12	121
13	169	15	225	11	121
12	144	14	196	11	121
11	121	12	144	10	100
100 X_1 $X_1 = 15$	2310 X^2_1	169 ΣX_2 $X_2 = 16.9$	2935 ΣX^2_2	125 ΣX_3 $X_3 = 12.5$	1585 ΣX^2_3

GRAND MEAN = **14.80** = $\overline{\mathbf{X}}$

The means for the 3 groups differ from each other and from the overall mean for all 30 subjects. To find whether the differences among these are great enough to be statistically significant, the F- ratio should be computed. This is done step by step as follows:

Step I: Find sum of the squared deviation of each of the individual scores from the ground mean. This index is called total sum of squares and is found by applying the following formula

$$\Sigma X^2 t = \Sigma X^2 - \frac{(\Sigma X)^2}{N}$$

Substituting we get: $= X^2 t = 6830 \quad \frac{(444)}{30} = 258.8$

Step II: Find the sum of the squared deviation of the group means from ground mean. This index is called the sum of squares between groups and is found using the following formula:

$$\Sigma X^2_b = \frac{(X_1)^2}{n_1} + \frac{\Sigma(X_2)^2}{n_2} + \ldots\ldots\ldots\ldots\ldots\ldots \frac{\Sigma(X)^2}{N}$$

Step III: Find the sum of the squared deviations of each individual score from it group mean. This index is called the sum of the squares within groups and is found using the following formula:

$$\Sigma X^2_w = X^2_1 - \frac{(\Sigma X_1)^2}{N_1} + X^2_2 - \frac{(\Sigma X_3)^2}{n_2}$$

$$\Sigma X^2_w = 2310 - \frac{(150)^2}{10} + 2935 - (169)^2 + 1585 - (125)^2 = 161.40$$

Step IV: Summarize the analysis of variance in a table.

Summary of the Analysis of variance of the 3 groups.

Source of Variance	SS	Df	Ms	F
Between groups	97.40	2	48.70	3.14
Within groups	161.40	2	5.98	
Total	25.8	29		

df = (G-1) (between groups)
where G = number of groups = (3-1) =2
df within groups = (n1 – 1) + (n2 –1) + (n3 – 1)
= (10 – 1) + (10 –1)
= 9 + 9 + 9
= 27

Step V: Find the between group mean square and within groups means square = SS/2 = 97.4/2 =48.70

Msw = 161.4/27 5.978
Step VI: Calculate the F-ratio using the following formula:
F = Msb/Msw = 48.70/5.98 = 8.14

We then consult the F-table to determine whether the F-ratio obtained is significant. If the calculated F-ratio= the table F-ratio, the hypothesis is rejected. With 2 and 27 degrees of freedom, table F- ratio is 3.35 at the 0.05 level and 5.49 at the 0.01 level. The two values are each less than the calculated F-ratio.

Therefore, the null hypothesis is rejected at both levels. There the F-ratio is significant at both levels.

Note: A significant F-ratio does not necessarily mean that all groups differ significantly from all other groups. It only indicates that there is significant but does not say which group differs from one another. For instance, in the above problem, it might be that group 1 is significantly different from group 3 but not group 2. In such a case, statistical tests known as Dun can multiple Range Test or schefee's Multiple Range Test are applied to determine where differences between groups lie.

The Chi-square Test of Significances

Sometimes it is necessary to find the significances of difference among the proportions of subjects, objects, events and so forth; that fall into different categories". A statistical test used in such cases is called the chi- square (X^2) test.

In the chi-square test, two sets of frequencies are compared observed frequencies and expected frequencies. Observed frequencies are the actual frequencies obtained by observation. Expected frequencies are theoretical frequencies which are used for comparison. The chi-square measure the value of discrepancy between expected and obtained frequencies. The formula for computing $X^2 = \frac{\sum(fo - fe)^2}{fe}$

Where:

X^2 = value of chi-square
fo = observed frequency in each cell
fe = expected frequency in each cell

Let's consider a situation where we want to test a hypothesis that a proportion of adults to adolescent students in the department of vocational Education, UNN is different from that of adults to adolescents in the entire Faculty of Education, UNN. Suppose we know that 30% of the total enrolment in the faculty of Education at the University of Nigeria are adults and that 400 students are enrolled in the Department of Vocational Education. The expected frequencies will be as follows:

Adults 120)
) 400
Adolescents 280)

Suppose the observed frequencies are found to be

Adults 190)
) 400
Adolescents 210)

We can now determine whether the difference between the expected and observed frequencies is statistically significant. To do this we apply the chi- square formula thus:

$$X^2 = \frac{\Sigma(fo - fe)^2}{Fe}$$

Substituting we have

$$X^2 = \frac{(190\text{-}120)}{120} + \frac{(120 - 280)^2}{280}$$
$$= 40.83 + 17.5$$
$$= 58.33$$

We then proceed to calculate the degrees of freedom which is the number of observation (n) minus one that is n-1.

For this problem this is given as df = k-1 where k is the number of categories used for the classification. The df therefore = 2 –1 =1. The chi-square table value at the 0.05 level of significance is 3.841 and at the 0.01 level it is 6.635.

Employing the decision rule thus:
If the calculated X^2 value = the table X^2, reject Ho; which can be stated as follows :

Ho: $fo = fe$
Ho: $fo \neq fe$

The Ho is rejected since the calculated X^2 (58.33) is greater than the table X^2, of 3.841 and 6.635 at the 0.05 and 0.01 levels of probability respectively.

We can now conclude that there is a significant difference in the proportion of adults to adolescent students in the Department of Vocational Education and that of adults to adolescent students in the entire faculty of education at the University of Nigeria Nsukka.

One Way Chi- square Test

Let us consider the following hypothesis survey results taken from a random sample of 100 students in the Department of Education Each student was asked to indicate on a questionnaire who influenced his/her choice of college major. They responded as follows:

Formulas for the Product Moment Coefficient

The formula for the calculation of product moment correlation is as follows:

$$r_{xy} = \frac{\Sigma xy}{ns_x \, s_y}$$

where:

rxy = Correlation coefficient between X and Y

xy = Sum of cross products of deviation scores for X and Y.

s_x, s_y = Standard deviation of x and y scores then n = Number of paired observation.

The basic formula can be manipulated algebraically to result in the following raw score correlation formula.

$$R_{xy} = \frac{\Sigma XY = \frac{(\Sigma X)\ (\Sigma Y)}{N}}{\sqrt{\Sigma x^2 - \frac{(\Sigma X)^2}{n}\ Y^2 - \frac{(\Sigma Y)^2}{n}}}$$

Assume the following scores by 10 students in VTE 303 and VTE 304.

Subject	Test I X	Test II Y	X^2	Y^2	XY
1	8	3	64	9	24
2	2	1	4	1	2
3	8	6	64	36	48
4	5	3	25	9	15
5	15	14	225	196	210
6	11	12	121	144	132
7	13	9	169	81	117
8	6	4	36	16	24
9	4	4	16	16	16
10	6	5	36	25	30
	78	61	760	533	618

Applying the formula we get

$$r = \frac{618 - \frac{(78)(16)}{10}}{\sqrt{\left(670 - \frac{(78)^2}{10}\right)\left(533 - \frac{(61)^2}{10}\right)}}$$

$$= \frac{142.2}{\sqrt{24392.44}}$$

$$r = 0.91$$

A correlation of 0.9 is an index of a strong relationship between two variables.

df = (N - 2) where N = number of paired observations. By entering the table of correlation coefficient with df 8, the r of 0.91 is significance at the 0.01 level and 0.05 level. This is because the calculated r of 0.01 is greater than the table values of 0.765 and 0.632 at the 0.01 and 0.05 levels respectively.

Let's consider another example below

Subject	**Measure I X**	**Measure II Y**	**X^2**	**Y^2**	**XY**
1	6	2	36	4	12
2	10	1	100	1	10
3	3	8	9	64	24
4	14	1	196	1	14
5	2	9	4	81	18
	35	21	345	151	78

$$R = \frac{78 - \frac{(35)(21)}{5}}{\sqrt{\left(345 - \frac{(35)^2}{5}\right)\left(151 - \frac{(21)^2}{5}\right)}}$$

$$= \frac{78 - 147}{\sqrt{(345 - 245)\ (151\ -\ 88.2)}}$$

$$= \frac{-69}{\sqrt{(100)\quad (62.8)}}$$

$$= -0.87$$

The table value with of 3 is not significant beyond the 0.05 level. Lack of significance is due to extremely small sample.

REGRESSION

An educator may wish to make prediction for one student at a time. For example, a high school counselor is frequently concerned with the likelihood of a particular students' academic success in the secondary school. As we know that a particular relationship exist between intellectual ability and academic performance, it is possible to particularize this relationship in order to make a prediction of success or failure of an individual student. A statistical technique which allows one to make prediction regarding a person's performance on one variable given his performance on another variable is called regression. The prediction model is restricted to linear relationships and the statistical technique can be explicitly referred to as linear regression.

In making prediction regarding an individual's theoretical score on one measure from his score on an initial measure, we usually refer to the variable from which we are making the prediction as the independent variable or predictor variable.

Mc- Nemar test.

McNemar test is type of Chi-square statistical test for significance of change for dependent samples involving animal data shinkle, D E al (1988) noted that NcNemmar test is a X^2 test used for testing significance in two sample case, when the samples are dependent and involving nominal data. This test may be used in pretest – posttest designs in which the same sample of subjects is categorized. Before and after some inferrencing treatment. For instance, suppose a random sample of 110 were asked two different times whether or n problem in learning of mathematics is as a result of pedagogy.

The responses are tabulated below according to tho answered Yes and those who answered No. The cells marked A are for those respondents who indicated a change in respons pretest to posttest while the cells marked B and C must b indicating no change in response from protest.

	Yes	No
No	30A	40B
Yes	25C	15D

Let us consider the data above in the context of the st testing hypothesis.

Step 1. State the Hypothesis:

Note we are only interested in the cells of the contingenc that reflect a change of opinion about whether pedagogy is the c poor performance in mathematics. So it is called A and D that are interest.

In our null hypothesis our expectation in the population there will be equal number of changes in both directions. The e: frequency in cell A will be equal to the expected frequency in cel be equal to the expected frequency in cell D. We test this for OX Ho. No significant difference in the changes.

Step 2. Criterion for Rejecting Ho.

The test statistic for the example above is X^2 (Chi- However, this X^2 is reduced only to be applied to A and D. S expected frequencies for these two cells are hypothesized to be e expected value for both cells is (A + D)/2.

Therefore the X^2 formula is reduced in the following manner.

$$X^2 = (0 - E)2/F$$

$$= \left(A - \frac{1 + D}{2}\right)^2 \quad + \quad \left(D - \frac{A +}{2}\right.$$

$$\frac{\overline{A + D}}{2} \qquad \frac{\overline{A + D}}{2}$$

$$= \quad (7.5)^2 \quad = \quad (-7.5)^2 \quad = \quad 112.5$$

Note that since there are only two cells under consideration, the expected frequency for one of the cells is determined, Thus, the degree of freedom, associated with this X^2 test. The critical value for I degree of freedom at O = 0.05 is 3.84); $X^2_{cv} = 3.841$

Step 3: Compute: The test-statistic.

Using formula (1) the calculation of the X^2 value for the our table above is

$$X^2 = \frac{(30 - 15)^2}{30 + 15}$$

$$= \frac{15^2}{45} = \frac{225}{45}$$

$$X^2 = 5.$$

Step 4. Interpretation of Result and Conclusion:

Since X^2 computed value (5.00) exceeds the critical value (X^2 3.841), the null hypothesis is rejected and we conclude therefore there is significant difference in the change of people's opinion on mathematics pedagogy and students' performance..

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In this book, Dr Ozofor introduces students of education and social sciences to basic statistics and statistical concepts. He exposes the students to data analysis, time-series analysis and some elements of index numbers.

- Dr. J. O. Okpo

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