UNIT 1 MEASUREMENT

Structure

1.1 INTRODUCTION

The first principle of a scientific study is to describe objectively what a scientist observed, under what circumstances, and to communicate the same as precisely as possible. A scientist reports not only what has been observed, but states the circumstances and the methods used, too. This is a high priority condition because others must be given a chance to verify those observations. In fact, specification of the conditions of observation is the first step in the measurement of a given phenomenon.

Although arguments continue over the nature of measurement, measurement in some form or other has always been there even when social sciences were no more than a branch of speculative philosophy. Quantitative principles from physics and chemistry have given us very precise and accurate measurement in these fields. Biological sciences, of late, have established principles that are nearly at par with those found in physical sciences. Social sciences lag far behind as compared to physical biological sciences. Measurement is the key to all sciences.

After studying this unit you will be able to

- explain the meaning and concepts of measurement in social science research
- describe the levels of measurement that quantify social variables.
- distinguish between various levels of measurement that have been used in the social science research
- describe the importance of measurement.

1.2 MEASUREMENT – MEANING AND CONCEPT

Measurement is an inseparable part of any science, natural or social. Any science aims to obtain a specific and accurate measurement of the events, of the characteristics of the different units of a phenomenon, and, of the inter-relationship between the units. Measurement is assigning numbers to objects or events according to rules (Stevens, 1946.) The purpose is to have information in a form in which variables can be related to each other. In social science research we have to deal with various social and psychological variables. Their measurement is one of the vital stages in the research process. Measurement of social and psychological variables is a complex and demanding task.

Measurement, simply speaking, is the assignment of numerals or other symbols or signs (male, female, occupational categories, for example) to objects or events according to a set of operational rules. Measurement always refers to some property of the object or event and not the object or event by itself. In this measuring process, the observer follows a scheme or procedure by which observed events can be classified into non-overlapping categories unambiguously, and the categories are given labels - numerals or symbols. The basic assumption in measurement theory is that every event or object in a set of events or objects possesses a specific quantity of the property under observation. This quantity of the property can be compared directly against a standard scale (as when we measure the length or mass of a material) or can be evaluated fairly accurately by trained observers (judges or experts assessing the level of performance of a student in a debate or in class examination). Often the measurement operations involve the use of mechanical devices such as thermometer, barometer, measuring tape, or weighing scale. The use of such mechanical devices is the least observer dependent, and, hence, the measurements are fairly precise, accurate, and objective. The thermometer, for example, when applied to a given object, gives a number, the temperature. This is a technical refinement of the precision of a crude judgment into categories such as very hot, hot, warm, cold, etc., that are obtained by the impression of the observer when he touches an object with his finger. In social sciences, too, we make use of a physical (not necessarily mechanical) component or stimulus.

Social science research follows a standardized procedure or mechanism, as is followed in the physical sciences. When a scale is applied on a person, it gives us a number (or symbol) on his attitude, IQ, interest, emotional stability, motivation, and so on. It follows, then, that a measurement operation is always a standardized way of proceeding, which may or may not make use of mechanical devices or stimuli, but which always results in classification of the objects measured into some non-overlapping categories labelled by numerals, or simply by symbols. From the viewpoint of mathematics, measurement operation is a standardized rule that maps each of a set of objects into one, and only one, of a set of several categories or numbers.

The first principle of a scientific study is to describe, objectively, what a scientist observed, under what circumstances and communicate the same as precisely as possible. A scientist reports not only what he has observed, but also states the circumstances and the methods he used for such observations. This is a high priority condition because others must be given a chance to verify those observations. In fact, specification of the conditions of observation is the first stop in the measurement of a given phenomenon.

Although arguments continue over the nature of measurement, measurement of some form or other has always been there even when social sciences were no more than a branch of speculative philosophy. Quantitative principles from physics and chemistry have given us very highly precise and accurate measurement in these fields. Biological sciences, of late, have established principles that are nearly at par with those found in physical sciences while, social sciences lag much behind in this respect.

1.3 IMPORTANCE OF MEASUREMENT

"Measurement consists of identifying the values which may be assumed by some variable, and representing these values by some numerical notation. The numerical notation is systematically and consistently assigned, that is, it is assigned according to some set of rules."

Thus, the numerals assigned to the variables, indicate different condition of the variables or different values of the variables or different degrees or intensity of a quality possessed by units. From the above it is evident that

i) measurement is a purely descriptive process

ii) measurement implies that the attributes of persons or objects are possessed in varying degrees and the degree of variation can be measured and represented

iii) measurement, in essence, is a numerical process.

Common objects of measurement in sociology are individual's characteristics, interactions, interrelations, consciousness, participation, socialization, motivation, etc. Some of the properties, of the individuals are visible and easily measurable, such as age, income, height, etc. Some characteristics are abstract and it is difficult to measure them.

These days, both in sociology and psychology, the measurement of beliefs and attitudes is common because of the greater emphasis on a democratic form of government which demands an assessment of peoples' attitude and opinion, from time to time. Besides this, public opinion studies are carried on regularly by various public and governmental agencies. Even the commercial organizations measure peoples' opinion and attitude to know the future market of their products. Polling agencies measure people's opinion and attitude to know the people's preferences for particular political parties and candidates. Thus, they want to predict, on the basis of such polling, the possibility of winning for any particular candidate. Attitudinal studies may also help in predicting an individual's future behaviour and their possible reactions towards different developmental programmes. Such studies might also help in making policies and specially in implementing them. For example, the study of beliefs and attitudes of Indian people towards illness and health measures or family size would help in instituting a social and educational programme to mobilize the people towards vaccination or adoption of family planning.

Measurement and quantification of variables, beliefs, attitudes, etc., do help in statistical manipulation of them, in experiment, and in testing specific hypothesis related to them. Thus, ultimately, it helps in the development and advancement of a theory.

1.4 MEASUREMENT POSTULATES

There are three postulates that are basic to measurement. A postulate is an assumption that is an essential prerequisite for carrying out some operations or line of thinking. In this case, it is an assumption about the relations between the objects being measured.

The three postulates that are basic to measurement are as follows.

a) Either (a=b) or (a =/= b) but not both. This postulate says a is either equal to b or not equal to b, but not to both. We must be able to assert, either that one object is the same in a characteristic as another, or, it is not the same. In measurement 'the same' does not necessarily mean complete identity. It can mean 'sufficiently the same' to be classed as members of the same set

   Example: Duration of variety X is greater than variety Y:

   Yield of variety X is greater than variety Y

   Height of a person X is greater than person Y'

b) If (a=b) and (b=c) then (a=c). This postulate says, "If a equals b, and b equals c, then a equals c. If one member, of a universe is the same as another member, and the second member is the same as third member, then the first member is the same as the third member. This postulate enables a, researcher, to establish the quality of set members, on a characteristic by comparing objects.

   Example: As farmers who have T.V. and radio have the same level of mass media exposure as that of the small farmer having T.V. and radio, and, this, in turn, is equal to the marginal farmer having T.V. and radio.

c) If (a>b) and (b>c) then (a>c). The third postulate is of more immediate and practical importance for our purpose. It says "If a is greater than b, and b is greater than c, then a is greater than c. Other symbols or words can be substituted for greater than (>) less than (<), such as, is at a greater distance, that is stronger than, and soon. Most measurement in psychology and education depends on this postulate. It must be possible to assert ordinal-a rank-order statements, such as a has more property than b, b has more of property than c, thus, a has more property than c.

   Example: Yield of variety X is more than variety Y and yield of variety Y is more than variety Z.

   The rate of adoption is higher in innovators than early adopters, than early majority. Innovators> Early -adopters; Early adopter > early majority, then, Innovator > early majority.

In the above section you have studied about the meaning and postulates of measurement. Now, answer the questions given in *Check Your Progress 1.*

Check Your Progress 1

Note: a) Write your answer in about 50 words.

b) Check your answer with possible answers given at the end of the unit

1) What do you mean by measurement?

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2) Briefly narrate different postulates of measurement?

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1.5 KINDS OF MEASUREMENT

The theory of measurement in social sciences really consists of a system of distinct theories each concerned with a distinct level of measurement. A set of data often will satisfy some of the levels, but not others. It is, therefore, necessary to understand the basic nature of data before applying a particular level of measurement. Choice of an appropriate statistical model for analysis is largely dependent on this level of measurement achieved. The higher the level of measurement, the more informed we are about a variable.

1.5.1 Nominal or Categorical Scale

Measurement, in its simplest, most primitive, and weakest form exists when we can substitute numbers (without meaning its numeral values) or symbols to real objects. That is, we use these symbols or numbers merely to classify or categorize objects, persons or even characteristics. A scientist, at the simplest level, must think of a classification scheme so that the different recorded events can be fitted into this scheme of classification. We give each category of event or object a name, or a number, or a symbol for convenience of identification. These symbols or numbers then constitute a nominal or classificatory scale. The categories making up the scale must be mutually exclusive (each observation can be put under only one category) and exhaustive (there are sufficient number of categories so that each observation can be put under some category) and unordered. The categories making up a nominal scale are usually called attributes. Thus, for mammals the attribute, sex, has only two categories: male and female. A population can be classified by the occupations they follow, or, by their rural-urban origin; STD dialling code 033 indicates all telephone subscribers in the Calcutta telephone zone; blue, brown, black, etc., are categories of human eye colour.

How does a scientist get to such a classification scheme? The sources are many. A doctor uses the history of a disease and the symptoms a patient shows for diagnosing a disease into this or that category. The physicists classify elementary particles as electrons, protons, and neutrons depending upon whether the particles are charged negatively, positively, or are neutral. The common sources that are tapped for such classification are listed below.

1) Theoretical considerations (as in atomic structure).

2) Observed similarities and differences in appearance/ behaviour of the objects studied (The Periodic Table of Elements was developed from the observation that certain elements tend to give similar chemical reactions).

3) Practical considerations (the attitude of a group of voters is better understood and explained if they are classified by their age, caste, sex, occupation, etc).

Whatever nature the classification scheme may take, it must adhere to the principles that follow.

In a nominal scale, the scaling operation consists of partitioning a given class into a set of mutually exclusive sub classes. The member of any sub class must be equivalent in the characteristic or the attribute being scaled. The only relation used in this scaling is equivalence. *A* sign of equality (=) symbolizes the relationship. In addition, the relationship of equality is reflexive, symmetric, and transitive. By reflexive we mean x = x for all values of x; by symmetry we mean that, if the relationship of equality holds between x and y, it also holds between y and x, i.e., if x = y, then y = x; by transitivity we mean if x = y, and y = z, then x = z.

Such a classification scheme utilizes only a part of the information about the objects or events being classified. We said earlier, we never measure an object or an event. An object may have many distinguishable properties or attributes. The scientist singles out those attributes only that have relevance to the objectives of his study. Therefore, the act of measurement, however simple or elementary, requires some degree of abstraction from the complex of properties possessed by the event or the object. The level of measurement in a nominal scale is so elementary and crude that many scientists would not like to consider it as measurement at all. Nevertheless, such classification into mutually exclusive categories is a necessary condition for all higher levels of measurement.

On a nominal scale, we are able to classify objects or events into non-overlapping categories purely on the basis of some qualitative character of the studied variable.

1.5.2 Ordinal Scale

The ordinal scale enables the researcher to categorize individuals, objects, or survey responses on the basis of a particular characteristic that they have in common. For example, sometimes, the objects in one class of a nominal scale are not merely different from objects in another class on the same scale; they stand in some kind of relationship. Typical relationships among the classes are that the members of one class have more of some property or characteristic than those in other classes. Such a relationship is often designated by the carat (>), which means 'greater than'. The symbol > is used to express all such relations between classes as 'preferred to', 'more than, 'greater than', 'higher than', etc. Conventionally, the number 1 is assigned to the class, which numerically has larger quantity of the property than all other classes. Number 2 is assigned to that class that has less of the property compared to that of the class given the number 1, but more of it than the rest of the classes, and so on. That is, the numbers in such a classification indicate the place of a category or class in an ordered series. In a sprint event, whoever touches the finishing tape first is given the number 1; the person coming second, the number 2, and so on, for other sprinters, no matter if the second sprinter comes 1 second or 0.04 seconds after the first, the third runner taking 4 seconds, or, more than the runner in the second spot. Such numbers, in an ordered series, constitute an ordinal scale.

The ordinal numbers actually state the relative position or the amount of the characteristic relative to others. The rank of a category depends only upon how many categories are ahead of it in respect to the quantity of the characteristic under comparison and not upon how many classes follow it. The differences of the ordinal numbers do not speak about the absolute differences in the amount of the characteristic the objects posses. A secures the first position by aggregating a total of 520 in the examination, B coming second with a total of 515, and C places in the third spot scoring 450. Although the rank differences between A and B, and between B and C are the same, the differences in absolute term of marks obtained in the examination are different. All we can say from an ordinal scale is that A is best in the group, B the second best (only one has a better record than him); and, C is the third best, coming after A and B, and, so on, with other orders. A large variety of measurements in psychology, sociology and other sciences yield only ordinal data. When a measuring instrument produces ordinal numbers, it is called ordinal scaling.

It is not necessary that the classes in an ordinal scale be expressed only by integers. We can as well use the normal sequence of letters of alphabet to indicate ordering. In many examinations grades A, B, C, D, etc are awarded to indicate the order of classes, We can use any symbol in an ordinal scale as long as the numbers or symbols parallel the order in which the objects are arranged in increasing or decreasing order of possession of the characteristic under observation. However, numerals are more frequently used to help undertake certain statistical operations.

The ordinal scale preserves the relationship of equivalence (=) as when two or more persons have the same level of education and income. It incorporates another relation 'greater than' (>). The latter relation is irreflexive, asymmetrical, but transitive. It really does not matter what number or symbols are given to the pair of classes so long we give a higher grade to the class, that is 'greater than' the other. Although we usually give lower numbers for the more preferred grades (1 for the most preferred, 2 for the second most preferred, etc.), we can use higher numbers to denote 'greater' or 'more preferred' so long we remain consistent in allocation of these numbers (we do it in some non-parametric tests). Allotting the lowest number 1 to the highest rank has the advantage that the rank identification of the class or the individual does not change if more lower order classes or individuals possessing less of the characteristic under study are added to the series. Since a person or object's rank is always relative to the ranks of others, the rank of the individual or the object indicated by lower number remains unchanged so long as the number of persons or objects above the individual or the object does not change. Rank 1 given to a student securing 520 marks remains unchanged as long as no one else scores 520, or more. Similarly, rank 2 awarded to the student scoring 499 will remain the same if no one else scores 499, or more. Both ranks are independent of the size of the sample for which ranks are ascertained. This independence of 'rank numbers' will be missing if lower numbers are assigned to lower ranks, higher to higher.

At the ordinal level of measurement, numbers are assigned to objects or events not only to categorize them, but also to indicate a 'greater than' or 'less than' relationship. The scale has no absolute zero point and there are unequal distances between the scale values. Numbers assigned at the ordinal level provide more information than at the nominal level because they also establish an ordering of the objects or events. For example, various television programmes may be categorized according to popularity and assigned rank 1 to most popular and 5 to least popular ones. The programmes can then be ordered according to popularity, but it can not be ascertained how much more popular one programme is over another, since the numbers do not indicate equal distances among the scale values.

Ordinal level measurement allows objects or events to be ordered by degree on the basis of possession of some characteristic that can be abstracted and measured quantitatively.

1.5.3 Interval Scale

When a scale has all the properties of ordinal and ordered metric scale and when we have additional information about how large the distances (intervals) between any two stimuli are, we have achieved a more powerful measurement, stronger than ordinality. In such a device, a measurement has been achieved in the sense of an interval scale.

To understand the distance function it is necessary to assign 'real numbers' to all pairs of elements in the ordered set. That is, the position of an element or object in the scale is specified by a real number so that such numbers constitute points on an arithmetic scale with a common and constant unit of measurement. The ratio of any two intervals indicated by the real numbers, however, is independent of the unit of measurement and there is a lowest end point, the zero point. Thus, the ratio of two intervals 32cm and 40cm, and 1 00cm and 140cm is 1:5, which has no unit. If a constant, say 10cm is added to each of the interval points, i.e., if the new intervals are 42cm - 50cm and 110cm - 150cm respectively, the ratio between the two intervals remains the same.

Interval measurement should be used with due caution, especially when comparing differences between two or more attributes. Comparisons are meaningful when the origin, zero, for both the scales is the same and the units of measurements are identical. Measuring temperature with a thermometer, measuring the time from a selected starting moment, measuring the altitude from mean sea level are all done with interval scales.

In interval scale has all the properties of a nominal scale (equivalence relation), an ordinal scale (greater then or transitivity relation) and an ordered metric scale (transitively relation in respect to distance between classes). In addition, this scale is able to specify the ratio of any two intervals. It is, therefore, to be regarded as more powerful measurement compared to the three others already discussed.

Interval scale puts objects or events into a continuum with such units that measure intervals of equal distance. The starting point zero of the scale is arbitrarily chosen.

1.5.4 Ratio Scale

Ratio scale provides the most powerful measurement for it satisfies not only all the characteristics of an interval scale, but has also an additional and vital characteristic - that it has an invariant or absolute zero. This invariant zero point introduces a new dimension in mathematical operations. Not only is the ratio of intervals of two classes independent of origin and unit of measurement, the numbers associated with scale points can be expressed as ratios independent of the unit of measurement. In an interval scale (the origin is arbitrary) we could not say that a score of 60 obtained by A is twice as large as the score of 30 obtained by B, for the simple reason that the zero point was chosen arbitrarily. If 5 is added to each score, the translated score of A will now read as 65 and is not twice as large as B's translated score 35, although the differences between the two sets of scores (60 - 30 and 65 - 35) remain the same. This shows that if we have an absolute zero in a scale, the scale values can no longer be translated, but can only be multiplied (or, divided) by a scalar. In the example cited in connection with measure of authority, *we* could not possibly associate a 'zero authority' with any regular staff member of a university.

Ratio scale is most commonly encountered in physical sciences. The weights of two objects whether measured in pounds or kilograms always yields the same ratio. The same is true of the length of two objects, or time taken by two individuals to complete a specific job.

A measurement will be said to be in ratio scale if it is possible to operationally attain the four relations: (i) equivalence (ii) greater than (iii) known ratio of any two intervals, and (iv) known ratio of any two real numbers associated with any two points on the scale.

Ratio scale places objects or events on a continuum, which has a rigidly defined starting point (real zero), such that the variable quantities (real numbers) can be expressed in terms of ratio of another number.

Table 1.1 : Examples of Questions in Each of the Five Basic Scale

S.No.	ScaleType	Examples
1.	Nominal Scale	Do you like the quality of health care services provided by your health centre Yes-1 No-2
2.	Ordinal Scale	If you are asked to rate the quality of health care services provided by the primary health care centre, how will you rank it? Excellent-1 Very Good -2 Good-3 Average-4 Poor-5
3.	Interval Scale	In the past twelve months, how many times have you gone for check up to the primary health centre? <5 times – 1 6-10 times – 2 11-15 times – 3 >16 times – 4
4.	Ratio Scale	In the past twelve months, how much of money have you spent on health care? Amount of money spent......

1.6 ADMISSIBLE STATISTICAL TESTS FOR MEASUREMENT

The application of various statistical tests for different categories f measurement scales are discussed below.

Statistical Tests for Nominal scale: since the symbols or labels attached to any category are arbitrary and can be interchanged without altering essential information contained in the scale, the only kind of descriptive statistics that can be used are those, which would not be affected or altered by such interchange. They are crude mode, proportion and frequency. The nominal scale data, however, can be used for testing of hypothesis relating to distribution of events among the classes. Chi-square test, Contingency Coefficient, and certain other tests based on binomial expansion can be used for the purpose.

Statistical Tests for Ordinal scale: median is the most appropriate measure of central tendency of the scores that are in an ordinal scale. Obviously, quartile deviation is the measure of dispersion for such data. There are a number of non-parametric tests to test a hypothesis with scores in an ordinal scale - runs test, sign test, median test, Mann Whitney U- test, etc. These tests are often referred to as 'order statistics' or 'ranking statistics'. Interrelations can be computed from rankings of two sets of observations on the same group of individuals. Spearman's Rank Difference, or Kendall Rank Correlation coefficients are appropriate for such situations.

For applying tests to measurements on an ordinal scale, we make an assumption that the observations are drawn from a distribution, which is essentially continuous. Such assumptions are also made for all parametric tests. A continuous variate is one that is not restricted to having only isolated values. Given a certain limit (interval between two classes), we can have any number of values inserted in between. With an increase in the number of observations, more and more of these values are likely to be represented. It will suffice, at this point, to remind the readers that very often the crudeness of our measuring devices obscures the underlying continuity that may exist. The classification of respondents with respect to an attitude statement into categories strongly agree, agree, neutral, disagree, strongly disagree essentially presumes the presence of a continuum. If a variate is truly continuous and if the instrument for measuring the property in question is sensitive enough, then the probability of obtaining a tied observation is extremely small.

Statistical Tests for Interval Scale: the interval scale preserves both the ordering of objects and the relative differences between them, even though the numbers associated with the position of the object may be changed, following a regular system. A set of observations will be scalable by interval scale if the data permits a linear transformation, That is, if the equation $y = a + bx$, where a and b are two positive constants, satisfies a set of real numbers, the numbers are said to be in an interval scale.

All the common parametric tests - arithmetic mean, median, standard deviation, product-moment correlation, etc., are applicable to data that follow an interval scale. Parametric tests for statistical significance like Z, t, F are also applicable to data in interval scale.

Statistical Tests for Ratio scale: since the values in a ratio scale are real numbers with a true zero (no upper limit) and only the unit of measurement is arbitrary, the ratios between two numbers and intervals preserve all the information contained in the scale even if these true numbers are multiplied by a true positive constant. Any statistical test, parametric or non-parametric, is usable when a ratio scale is used, such statistical tools as geometric mean and coefficient of variation, which require knowledge of true scores, can be used with observations that are in ratio scale.

Table 1.2: Analysis Method in Various Scales

Scale	Basic Operation	Measure of Central Tendency	Other Appropriate Statistics
Nominal	Puts objects into classes, i.e., male/ female, marital status, occupation	Mode	Chi-square
Ordinal	Determination of greater or less, i.e., preference, level of education achieved	Median	Rank Order Correlation, Man Whitney U-test
Interval	Determination of equality of intervals or differences, i.e., temperature	Arithmetic Mean	Correlation Coefficient
Ratio	Determination of equality of ratios, i.e., weight, income, number of visits	Geometric Mean, Harmonic Mean	Coefficient of Variation

Source: John boyce, Marketing Research, Mc Graw Hill, Australia, 2005.

1.7 CRITERIA FOR JUDGING THE MEASURING INSTRUMENTS

A measurement, too, must satisfy certain criteria. The most important criteria to be used in evaluating a measurement tool are described below.

i) **Unidimensionality:** this means the scale should measure one characteristic at a time, e.g., the ruler should measure length, not temperature.

ii) **Linearity:** this means that a scale should follow the straight-line model. Some scoring system should be devised, preferably one based on inter-changeable units. In a ruler an inch is an inch whether it lies at one end of the ruler or at the other, but in altitude scales such interchangeability cannot be ensured. In such cases, ranking is preferable.

iii) **Validity:** this refers to the ability of a scale to measure what it is supposed to measure.

iv) **Reliability:** this is an attribute of consistency. A scale should give consistent results.

v) **Accuracy and Precision:** a tool should give an accurate and precise measure of what we want to measure.

vi) **Simplicity:** a scale should be as simple as possible; an elaborate, complicated, and over - refined scale may become unduly cumbersome, costly or even useless.

vii) **Practicability:** this is concerned with wide range of factors like cost effectiveness, convenience and interpretability. Some trade off is usually needed between an 'ideal' tool and, that which the budget can afford. The benefit to be derived should be commensurate with the cost incurred.

The tool should be easily administrable; it should contain proper instructions; it should be easily understandable and conveniently arranged for easy completion. In order to enable others to interpret the results of a test, there is need for such aids as a statement of its function, its construction procedure and guides for interpreting the result.

1.8 SOURCES OF ERRORS IN MEASUREMENT

Measurement should be precise and unambiguous in an ideal research study. This objective, however, is often not met with in entirety. As such, the researcher must be aware about the sources of error in measurement. The following are the possible sources of error in measurement.

a) **Respondent:** at times the respondent may be reluctant to express strong negative feelings, or, it is just possible that he may have very little knowledge but may not admit his ignorance. All this reluctance is likely to result in an interview of guesses. Transient factors like fatigue, boredom, anxiety, etc., may limit the ability of the respondent to respond accurately and fully.

b) **Situation:** situational factors may also come in the way of correct measurement. Any condition which places a strain on interviews can have serious effects on the interviewer- respondent rapport. For instance, if someone else is present, he can distort responses by joining in or merely by being present. If the respondent feels that anonymity is not assured, he may be reluctant to express certain feelings.

c) **Measurer:** the interviewer can distort responses by rewording or reordering questions. His behaviour, style and looks may encourage or discourage certain replies from respondents. Careless mechanical processing may distort the findings. Errors may also creep in because of incorrect coding, faulty tabulation and /or statistical calculations, particularly in the data analysis stage.

d) **Instrument:** error may arise because of the defective measuring instrument. The use of complex words, beyond the comprehension of the respondent, ambiguous meanings, poor printing, inadequate space for replies, response choice omissions, etc., are a few things that make the measuring instrument defective, and may result in measurement errors. Another type of instrument deficiency is the poor sampling of the universe of items of concern.

The researcher must know that correct measurement depends on successfully meeting all of the problems listed above. He must, to the extent possible, try to eliminate, neutralize, or, otherwise deal with all the possible sources of error so that the final results may not be contaminated.

In the above sections, you read about various kinds of measurement and statistical tests to be used in measurement. Now answer the questions given in *Check Your Progress 2.*

Check Your Progress2

Note: a) Write your answer in about 50 words.

b) Check your answer with possible answers given at the end of the unit

1) What is interval scale?

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2) Write three important criteria for judging the measuring instruments.

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1.9 LET US SUM UP

In this unit, we discussed the meaning, concept, postulates and levels of measurement. Measurement is an undetachable part of any science, natural, or social. Any science aims to obtain a specific and accurate measurement of the events, of the characteristics of the different units of a phenomenon and of the inter-relationship between the units. Measurement is assigning numbers to objects or events according to rules (Stevens, 1946).

The theory of measurement in social sciences really consists of a system of distinct theories each concerned with a distinct level of measurement. A set of data often will satisfy some of the levels, but not others. It is, therefore, necessary to understand the basic nature of data before applying a particular level of measurement. The choice of an appropriate statistical model for analysis is largely dependent on this level of measurement achieved.

Sometimes discrimination is made between scales on the basis of power of measurement. The scales like nominal, ordinal, and ordered metric scales are less powerful because they do not make use of all the information contained in the data. As such, such measurements are referred to as scales by many of its users. The more powerful measurements like interval and ratio scales, on the other hand, make full use of all information contained in a set of observations, and, therefore, are labelled as measurements; whereas, the former scales refer mostly to qualitative aspects of measurement, the latter ones deal with quantitative measurements.

1.10 KEYWORDS

Measurement : the process of assigning symbols/numbers to dimensions of phenomena in order to characterize the status of a phenomena as precisely as possible.

Scale : a device to measure something. Scaling technique is used in ordering a series of items along some sort of continuum. In short, they are methods of turning a series of qualitative facts into a quantitative series.

Validity : refers to the ability of a scale to measure what it is supposed to measure.

Reliability : an attribute of consistency. A scale should give consistent results.

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1.12 CHECK YOUR PROGRESS – POSSIBLE ANSWERS

Check Your Progress 1

1) Measurement consists of identifying the values which may be assumed by some variable, and representing these values by some numerical notation.

The numerical notation is systematically and consistently assigned, that is, it is assigned according to some set of rules.

2) The three postulates basic to measurement can be written as:

   a) Either (a=b) or (a =/= b), but not both. We must be able to assert either that one object is the same in a characteristic as another, or it is not the same.

   b) If (a=b) and (b=c) then (a=c). This postulate enables a researcher to establish the quality of set members, on a characteristic by comparing objects

   c) If (a>b) and (b>c) then (a>c). Most measurement in psychology and education depends on this postulate.

Check Your Progress 2

1) When a scale has all the properties of ordinal and ordered metric scale, and, when we have additional information about how large the distances (intervals) between any two stimuli are, we have achieved a more powerful measurement, stronger than ordinality. In such a device, a measurement has been achieved in the sense of an interval scale.

2) The most important criteria to be used in evaluating a measurement tool are unidimensionality, reliability and validity.