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AN OVERVIEW OF THE SCALES OF MEASUREMENT IN EDUCATIONAL RESEARCH

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ABSTRACT:

In our daily life measurement plays an important role. If we want to know the height, weight or other physical characteristics of any object, we need to know measurement process. Even if we want to determine the qualities of something, for example, how well someone paints, how well someone plays cricket etc., we need to know measurement. But in such case of qualitative judgment, that means when we have to measure the qualities of some objects, it becomes a complex as well as a critical issue. However, measurement requires assigning numbers with respect to the properties of the objects. But it is quite tough in case of abstract entities like intelligence, motivation to succeed, marital adjustment, anxiety etc. They require poignant attention to measure. So a researcher requires high alertness for measuring abstract qualities. Here lies the requirement of various scales of measurement.

KEYWORDS:

Measurement Scales: The scales perform a major role in conducting research related work in behavioural sciences. At the time of collecting information or evidences from the available sources in educational research, a researcher has to take resort to various scales of measurement. Such scale of measurement is a classification that analyses information within the values assigned to variables. Each scale of measurement has certain characteristics which further determine the appropriateness for the use of certain statistical analyses. There are four scales of measurement which are used in educational research. They function following a unique level of hierarchy. These scales are (from the lowest to the highest order) - Nominal, Ordinal, Interval and Ratio. Nominal and ordinal scales are used for categorical classification. On the other hand, interval and ratio scales are perfect scales for continuous measurement. These four-level scales of measurement were originally developed by American psychologist Stanley Smith Stevens in 1946 in an article, entitled "On the Theory of Scales of Measurement". This article was published in a journal, titled *Science*.

Properties of Measurement Scales: The following properties of measurement are partially or entirely fulfilled by each scale of measurement. The properties are as follows --

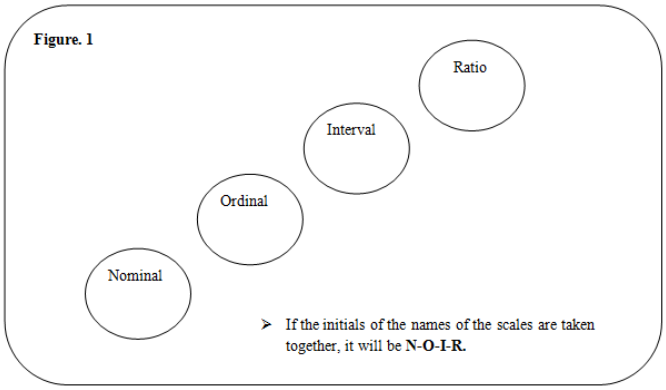
i) **Identity**: Identity refers to the assignment of numbers to the responses provided by the respondents. Each and every value on the measurement scale has a unique identity or meaning.

ii) **Magnitude**: A variable may also possess magnitude along with identification. Magnitude refers to the facts that numbers maintain a specific order.

iii) **Equal Intervals**: Equal interval means the difference between numbers anywhere on the scale is same.

iv) **Absolute or True Zero**: The measurement scale has a true or absolute zero point. Below this zero point no value exists.

Types of Scales in Measurement: The four scales of measurement, as mentioned earlier, are discussed below ----



❖ **Nominal Scale**: The word 'nominal' means 'associated with names'. This is the first and foremost scale of measuring objects, events or behaviour. This scale deals with non-numeric variables or the numbers that do not have any value. So they cannot be added, subtracted, divided or multiplied. They do not even follow any order. This scale of measurement uses symbols (such as numbers or words) for labelling, tagging, categorizing, classifying or identifying people or objects. This scale is often considered the least powerful scale of measurement. It does not indicate any order. It has no arithmetic origin. Nominal scale

has been defined as ---

- According to Johnson & Christensen (2017: 159), a nominal scale is a "*scale of measurement that uses symbols, such as words or numbers, to label, classify, or identify people or objects.*"
- According to K.S. Sidhu (2002: 25), "*The nominal scale represents the lowest level of refinement. Some may even question whether this level of measurement is measurement at all. In this scale the set of objects are distributed among unordered categories on the basis of qualitative differences among the objects.*"
- According to Gravetter & Wallnau (2014: 23), "*A nominal scale consists of a set of categories that have different names. Measurements on a nominal scale label and categorize observations, but do not make any quantitative distinctions between observations.*"

- **Examples:** Some of the examples regarding the application of nominal scale are given below ---

i) Assigning numbers to the cricket, football or basketball players in order to identify them. These numbers do not have any quantitative value. They are just used as labels to identify the players.

ii) Room numbers of any hotel, for example, room no. 201 is just a number to identify any specific room in a hotel.

iii) Nominal scale can also be formed with nominal data or variables just as given below:

Questions	*Options to be chosen for response*	*Codes that can be used in support of the response*
1. What is your hair colour?	Black	A
	White	B
	Grey	C
	Other	D
2. What is your gender?	Male	M
	Female	F
	Transgender	T
3. How much satisfied are you with your service?	Very Satisfied	5
	Satisfied	4
	Neutral	3
	Unsatisfied	2
	Very Unsatisfied	1

N.B.: In the first question, letters from the English alphabet are assigned as codes. In the second question initial letters of the options (*M* for Male, *F* for Female and *T* for Transgender) are assigned. In the third question numeric digits are assigned only as labels, not for any quantification or for any arithmetic calculation. So all the codes used in the above examples are just 'labels'.

- **Characteristics of the Nominal Scale**: Some of the notable characteristics of the nominal scale of measurement are as follows ---

i) Researchers use such a low level scale only to classify, tag or label objects, individual etc.

ii) This scale represents non-numeric data.

iii) The nature of the nominal scale is qualitative. It means that in this scale when numbers are used for measurement, they serve the purpose of labels only. Those numbers have nothing to do with arithmetic calculation or quantification. For example, the numbers assigned to the players of a cricket team are only for the purpose of identifying them.

iv) In nominal scale, the numbers assigned to any object do not represent the characteristics of the object or individual. For example, room no 201 of any hotel does not represent any characteristic of the specific room.

❖ **Ordinal Scale:** 'Ordinal scale', as the term suggests, is a scale for determining order with respect to any variable of interest. This is the lowest level of ordered scale. It poses events in order. Data used in ordinal scale are quantitative. They occur in order without representing any difference between them. Ordinal scale is helpful for making ordinal judgement. It determines who owns a higher rank in comparison to the other who possesses a lower rank on a variable of interest. In this scale the measurement that is performed hierarchically represents higher than the nominal scale but lower than the interval and ratio scales. A researcher uses this scale to rank persons, events or phenomena as per their characteristics under observation. Thus through the process of measurement at the ordinal level, the researcher attempts to place

participants from the highest to the lowest order. The categories that constitute an ordinal scale not only have different names (just as found in a nominal scale) but also are organized in a fixed order corresponding to differences of magnitude. Measurement in ordinal scale has no absolute value.

- According to Johnson & Christensen (2017: 159), "*The ordinal scale of measurement is a rank-order scale.*"
- According to K.S. Sidhu (2002: 26), "*When the observations are ordered in such a way that we can call an observation superior to another in respect of the given variable, then it is an example of an ordinal scale. In this scale, each of a set of objects is assigned on the basis of certain rules, to one of a set of ordered categories.*"
- According to Gravetter & Wallnau (2014: 23), "*An ordinal scale consists of a set of categories that are organized in an ordered sequence. Measurements on an ordinal scale rank observations in terms of size or magnitude.*"

- **Examples:** Some of the examples regarding the application of ordinal scale are given below ---

i) The students of class 12 in a school are ranked as 1st, 2nd, 3rd, 4th, 5th……Nth. If Navin scores 98/100 and none scores higher marks than him, then he will be ranked 1st. In this way if Suraj scores 95/100 which is next to that of Navin, then he will be ranked 2nd. Thus the ranking will continue from the highest to the lowest order.

ii) If Rohan's position in the class is 5th and Sujoy's position in the class is 25th, it does not mean that Sujoy's position is 5 times as poor as that of Rohan. Neither does it mean that Rohan's position is 5 times as good as that of Sujoy. The reason is that ordinal scales only permit the ranking of items from highest to lowest.

iii) Likert scale is a variant of the ordinal scale because in this scale arithmetic operations cannot be conducted. An example of the five-point Likert scale is given below:

Numbering ⇨	**5**	**4**	**3**	**2**	**1**
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Social Networking sites have negative impacts on the school going students.					

iv) For measuring the socio-economic class of members of a population, the following ordinal scale may be used:

Various Socio-economic Classes	**Rank-order**
Upper Class	5 or A
Upper-middle Class	4 or B
Middle Class	3 or C
Lower-middle Class	2 or D
Lower Class	1 or E

v) Examples of ordinal data or measuring data using ordinal scale can often be found in survey questionnaires:

Survey Question	**Options to be chosen**	**Rank-order**
How much are you satisfied with the service provided by the state government?	Fully Satisfied	5
	Satisfied	4
	Neutral	3
	Dissatisfied	2
	Fully Dissatisfied	1

Since ordinal data are quantitative data, as mentioned earlier, they naturally occur in the above table without making any difference between them. They appear as ranks.

- **Characteristics of the Ordinal Scale**: Some of the notable characteristics of the ordinal scale of measurement are as follows ---

i) Ordinal scales contain all the features of a nominal scale because it includes classification or labelling as well as an order corresponding to differences of magnitude with respect to any variable of interest.

ii) This scale has no true zero point or a pre-determined starting point. So statistical calculations (i.e., mean and SD) based on an ordinal scale are essentially absurd or meaningless.

iii) The ordinal scale provides more information than the nominal scale. This scale not only assigns labels to objects or individuals but also determines order with respect to any variable of interest, i.e. things can be ranked and ordered.

❖ **Interval Scale**: Hierarchically an interval scale is the third level of measurement. It is a quantitative measurement scale. This scale occupies a better position than the nominal and ordinal scales but remains one step back from the highest level of measurement that is the ratio scale. The interval scale contains all the features of nominal and ordinal scales because it offers 'labels' (as offered by a nominal scale) and 'order' (as offered by an ordinal scale). In addition to these features, an interval scale consists of a series of equal intervals or equal distances between the numbers on the scale. Clearly speaking, in an interval scale the difference or interval between any two adjacent numbers is equal to the difference or interval between another pair of adjacent numbers. An interval scale contains an arbitrary zero. But this type of scale cannot determine an absolute zero or the unique origin. The main limitation of the interval scale is the absence of a true zero. Consequently, it does not have the capacity to measure the complete absence of a characteristic. So, a value of zero in this scale does not indicate a total absence of the variable being measured.

- According to Johnson & Christensen (2017: 160), an interval scale is a "*scale of measurement that has equal intervals of distances between adjacent numbers.*"
- According to K.S. Sidhu (2002: 27), "*The interval scale also involves quantification, but with an added refinement, viz., the differences between consecutive points on the scale are equal over the entire scale*."
- According to Gravetter & Wallnau (2014: 24), "*An interval scale consists of ordered categories that are all intervals of exactly the same size. Equal differences between numbers on the scale reflect equal differences in magnitude. However, the zero point on an interval scale is arbitrary and does not indicate a zero amount of the variable being measured*."

▪ **Examples:** Some of the examples regarding the use of an interval scale are as follows ---

i) Examples of interval scales are the Celsius temperature scale and the Fahrenheit temperature scale. On these scales all points are equally distant from one another. The zero point, as mentioned earlier, on an interval scale is arbitrary. A difference in temperature between 0 and 10 degrees on a Fahrenheit scale is the same as the difference between 50 and 60 degrees. The zero point on the Celsius scale is the point at which water freezes at sea level. This point does not refer to a complete absence of heat, as referred to by the absolute zero point. The absence of heat is approximately –273 degree Celsius, not the zero point on either a Celsius or a Fahrenheit temperature scale.

ii) An increase in temperature from 10° to 20° involves the same increase in temperature as an increase from 70° to 80°. But it cannot be confirmed that the temperature of 80° is twice as warm as the temperature of 40°. The reason behind this is that both numbers are dependent on the fact that the zero on the scale is set arbitrarily at the temperature of the freezing point of water. The ratio of the two temperatures 10° and 70° does not mean anything because zero is an arbitrary point.

iii) Various psychological tests of personality, attitude, achievement and adjustment are the most common examples of studies for which interval scales are used.

▪ **Characteristics of the Interval Scale:** Some of the notable characteristics of the interval scale of measurement are as follows ---

i) An interval scale, unlike the nominal and ordinal scales which are considered qualitative measurement scales, is a quantitative measurement scale. So this scale can quantify the differences between values.

ii) This scale has all the characteristics of a nominal and an ordinal scale. It helps to conduct various statistical and mathematical operations like addition, subtraction, multiplication and division along with calculating the mean and median of variables, standard deviation, correlation etc.

iii) An interval scale does not have absolute zero point. It contains an arbitrary zero. For the absence of a true zero this scale does not have the capacity to measure the complete absence of a characteristic.

❖ **Ratio Scale:** Ratio scale is considered the highest scale of measurement. It includes all the characteristics of other scales, which means the features of nominal (i.e. labels), ordinal (i.e. rank order) and interval scales (equal interval between points) are clubbed in it. Simultaneously, it has an absolute zero which means it has a meaningful or non-arbitrary zero point. Clearly speaking, the value 0 is assigned to a particular location on the scale simply for the convenience or reference. In particular, a value of zero in a ratio scale refers to a complete absence of the variable being measured. This scale, like an interval scale, represents quantitative measurements. In a ratio scale the ratios of number represent ratios of magnitude. Ratio scales help to measure the exact amounts of variables like height, weight, distance etc. Besides, most of the statistical techniques can be utilized with ratio scales. In addition to these, geometric and harmonic means can also be used as measures of central tendency in this scale.

- According to Johnson & Christensen (2017:161), a ratio scale is a "*scale of measurement that has a true zero point.*"
- According to K.S. Sidhu (2002: 27), "*The ratio scales represent the most refined level of measurement as they have a defined zero point and uniform units of measurement.*"
- According to Gravetter & Wallnau (2014: 24), "*A*

ratio scale is an interval scale with the additional feature of an absolute zero point. With a ratio scale, ratios of numbers do reflect ratios of magnitude."

- **Examples:** Some of the examples regarding the use of ratio scales are as follows ---

i) Since ratio scales have absolute or true zero point, measurement can be started from 0. This makes it possible to compare measurement in terms of ratios. For example, a barrel of oil with a quantity of 20 litres (20 more than 0) has twice as much oil as a barrel with 10 litres (10 more than 0) has. It should also be noted that a completely empty barrel has 0 litres. A ratio scale thus helps to measure the direction and size of difference between two measurements, which can be denoted in terms of ratio.

ii) In the field of education, the ratio scale is occasionally used. For instance, to know the number of test items a student has correctly attempted or the amount of time taken to complete an assignment, ratio scales are used.

- **Characteristics of the Ratio Scale:** Some of the notable characteristics of the ratio scale of measurement are as follows ---

i) It is the highest level of measurement scale containing all the features of the nominal, ordinal and interval scales. This scale has labels, orders and equal interval between points.

ii) It has an absolute zero point. So Ratio scales do not have negative number. For example, weight is a ratio data. It is not possible to have negative weight. If an object's weight is 0, then the object has no existence.

iii) Ratio scales permit all types of statistical analysis. In this scale addition, subtraction, multiplication and division of variables can systematically be done. Besides, other statistical analyses like mean, median, mode, coefficients of variation etc. may also be calculated. All manipulations that one can perform with real numbers can also be performed with ratio scale values.

iv) Physical measurements like height, weight, distance, age, area etc. can also be measured on this scale.

CONCLUSION: In this way relevant information can be obtained for conducting research related studies in the field of education through the proceeding from the least precise type of scale (i.e. the nominal scale) to the most precise type of scale (i.e. the ratio scale).

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