The Place of Non-Parametric Statistics in the Conduct of Research in the Millennium Age (21st Century).

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ABSTRACT

Considering the indispensable roles which research play as a springboard upon which other developments (social, economics, political, technological, education, governance, and scientific, etc.). The act of concluding credible, valid, and thorough research should not be left to guess-work. Reliable and fundamental approaches needed to be employed in this process needs to be highlighted and elucidated either to the beginners for the basic and rudimentary skills and knowledge or to those aspiring to go deeper in the research. If the knowledge and dexterity of research works should not be jeopardized, unambiguous pre–conditions for choosing appropriate, relevant valid and correct statistical methods for any research work have to be established. It remarks that statistical methods are the only weapons and as such, they may be inadvertently misused even when the assumptions underlying their application are not met.

This paper examines the place of Non – parametric statistical methods in the conduct of Educational Research in the Millennium age (21st century). Suggestions were made on how to improve the system to enhance frontiers of knowledge in this field globally.

(Keywords: non-parametric, research activity, statistics, statistical analysis, research design)

INTRODUCTION

Research as a concept has multifarious and multidimensional meanings to contend with. However, some common register words embracing the definitions are herby harnessed and juxtaposed. In other words, there are as many and varied definitions of research as there are researchers, evaluators, educational practitioners, and administrators. Each of these learned professionals uses peculiar parameters to educate their readers.

Research can be defined as:

- Investigation and experimentation aimed at discovery, interpretation and application of scientific data.
- A systematic investigation designed to develop or contribute to generalizable knowledge.
- Scientific study to find out facts, test models and develop theories about the natural word.
- Research is an active, diligent, and systematic process of inquiry in order to discover, interpret or revise facts events behaviors or theories or to make practical application with the help of such facts, laws, or theories (Olaewe 2006).

The aim behind a research work may perhaps include discovery and development. In social sciences, it appears over ambitious, even daunting, to increase human knowledge in any systematic or universal way as to suggest discovery or anything near it. However, a system of knowledge is built up incrementally, that is why a single research project can hardly lead to discovery. In the sciences and technology, research work is more strictly exact where much more precise statistical tools are employed to be sure of the answers and solutions are valid. Any activity classified as research and experimental

development is characterized by originality, it should have investigation as a primary objective and should have the potential to produce results that are sufficiently general for humanity's stock of knowledge (theoretical and /or practical) to be recognizably increased (Kerlinger 1973).

Activities that support research and therefore meet the definition of research are:

- Provision of professional, technical, administrative or clerical support and/or assistance to staff directly engaged in research and experimental development,
- Management of staff who are either directly engaged in research and experimental development or are providing professional, technical or clerical support or assistance to those staff,
- Activities of students undertaking postgraduate research courses, and
- Supervision of students undertaking postgraduate research courses.

RESEARCH DESIGN AS A CONCEPT

A research design is a blue print of what to carry out in a research work. It specifies the formulation of a strategy which would be used to resolve a particular question. It highlights the collection and recording of the evidence. It depicts the collection and recording of the evidence gathered. Research design itemizes the processing and analysis of those data collected and their eventual interpretation. It explains in detail, the power possessed by the researchers to exercise control on the data and its manipulation (e.g. randomization or statistical control). Statistical methods to be employed in analyzing data and the research instruments to be used are all components of research design.

STATISTICS AND STATISTICAL ANALYSIS

Statistics is the science of collecting, classifying, summarizing, and analyzing data. Statistics is a mathematical science pertaining to collection, analysis, interpretation, and presentation of data. It is applicable to a wide variety of academic disciplines from the physical and social sciences to the humanities as well as to business, government, and industry.

In applying statistics to a scientific, industrial, or social problem, one begins with a population to be studied. This might be a population of people in a country, of crystal grains in a rock or of good manufactured by a particular factory. The population may even consist of a single process observed at various times, data collected about this kind of "population" constitute what is called time series.

For practical reasons, rather that compiling data about the entire population, one may instead study a chosen subset of the population, called a sample, in some kind of experimental setting. The data are then subjected to statistical analysis which serves two related purposes: descriptive and inferences.

Descriptive statistics deals with the description of problem. Can the data be summarized in a useful way, either numerically or graphically, to yield insight about the population in question? Basic examples of numerical description include the mean and standard deviation. Graphical summarization includes veracious kind of charts and graphs. Inferential statistics is used to model patterns in the data accounting for randomness an drawing inferences about the larger population. These inferences may take the form of answers to yes/no questions (hypothesis-testing), estimates of numerical characteristics (estimation), prediction of future observations, description of association (correlation), or modeling of relationship (regression). Other modeling techniques include ANOVA, time series, and data mining.

The use of statistical method is valid only when the system or population under consideration satisfies the basic mathematical assumptions of the method. Misuse of statistical methods can produce subtle but serious errors in description and interpretation.

The purpose of statistical analysis also include the ability to present data precisely and intelligently, ability and to understand and interpret modern day literature in education, pure, and social sciences as well as ability to empower researchers with the scientific method. Statistics makes a comparison between present and past data possible. It is also useful for making projection and extrapolation. Certain important

correlation and association of attributes can be found with the help of statistics. It explain the facts by revealing quantitative uniformities and relation between facts an lastly, it enables one to form a probable inference by calculation of chances and estimation of probabilities, it describes facts precisely through convenient presentation of facts and data. It leads to economy and degree of flexibility, it approach is quantitative and hence, definite and reliable (Ghosh 2006).

THE NON-PARAMETRIC STATISTICS

In making inferences about population based on the behavior of samples and in testing hypothesis, there are number of different methods or tests of significance, (alpha level) which can be applied in research studies. Different tests are appropriate for different sets of data. Factors such as the scale of measurement (Normal, ordinal interval and ratio) unit represented by the data, method of subject selection, the number of groups and the number of independent variables determined which test of significance should be selected for a given research design. Non-parametric statistical methods are applicable to researchers that seek to make inferences about a population parameter without rigid mathematical assumptions about the shape or distribution of the population being sampled. As a result, these techniques have been referred to as " distribution free" procedure. However, it is misleading to think of non-parametric statistical method as though they could be legitimately conducted without considering population data.

Though never requiring population normality, in some instances non-parametric statistical test do involve limited assumptions regarding the nature of population distributions. It is certainly true, however, that the assumptions associated with non-parametric statistical test are much weaker than those demanded by many parametric statistical methods.

Researches generally agree that when the researchers are working with data, which seriously violate the parametric assumptions required by appropriate parameter suitable alternatives.

Non-parametric statistics techniques are appropriate and they are very useful for analyzing the data that are of nominal and ordinal scales. When variables of interest are for instance, anomie, social differentiation, prestige, social control, or alienation, they are often measured by crude scales, and researchers can not assume ratio or even interval level data. When this occurs the estimation and comparative test procedure of parametric statistics are of little use, hence, the need for non-parametric statistics.

The Need for Non-Parametric Statistics

Apart from the fact that these tests are used because certain assumptions cannot be made about the population involved, researchers can use these statistical tests because:

(i) They are easier to learn and apply.
(ii) The mathematical derivation is more readily understand.
(iii) They can be applied to data of classificatory nature that are common in behavioral research (Nominal or ordinal scale).
(iv) They handle ranked data better.
(v) The computations of these statistical tests are relatively simple.

The above conditions notwithstanding, parametric tests possess the advantage of being fairly robust with respect to violation of assumption having more power-efficiency (the power of a test relative to the sample size of which permits one to compare the power of two different statistical tests. The power of a statistical test is the probability that the test will correctly reject the Null hypothesis is false and sometimes providing more information about a phenomenon (i.e. interaction in the analysis of variance).

Some Notable Non-Parametric Statistical Tests:

(a) Chi-Square (X^2) - The Chi-Square (X^2) test is a measure of the relationship, association or independence. It was introduced by Karl Pearson in 1900), the Chi-Square test is probably the best known and the most important of all non-parametric methods. It involves a measure of reliability by comparing observed frequency distribution with theoretical or expected distribution. Conditions for its application include:

(i) The sample observations are independent of each other.

(ii) Sample data are drawn at random from the population.
(iii) Sample data are expressed in original units.
(iv) The sample should contain at least 50 observations.
(v) There should be no less than five observations in any one all.
(vi) Not more that 20% of the expected frequency should be less than five.

Chi-Square statistics can be one sample case or two and more sample cases. Mathematically speaking, Chi-Square statistics can be expressed as

$$X^2 = \frac{(O_1-E_1)}{E_1} + \frac{(O_2-E_2)^2}{E_2} + \cdots + \frac{(O_n-E_n)^2}{E_n}$$

where :

$$E = \frac{Row\ Total\ X\ Column\ Total}{Ground\ Total}$$

(b) Wilcoxon Matched-Paris Signed Ranks Test - The Wilcoxon matched-pair signed ranks test is used to assess the significance of difference between two samples consisting of matched pairs of subjects, such matched pairs of subject would include two measure taken on the same subject as in a pre and post comparison of individuals. Wilcoxon is the non-parametric counterpart of the t-test for correlated data. The null hypothesis tested is that there is no difference between the two population from which the matched. Comparisons are drawn. The applications of this method are as follows:

Step 1: The absolute differences between each pair of observation are found, eliminating pairs with an absolute difference of zero.

Step 2: the obtained absolute differences are ranked, assigning the rank of 1 to the smallest difference. Tied values of the absolute difference are given the same rank by averaging the ranks associated with tied position.

Step 3; the absolute differences are assigned the signs (positive or negative) that they ought to have had if the difference found were not absolute.

Step 4: the sum of the positive or plus difference and that of the negative or minus difference are found. If the sum of the positive equals that of negative differences. It means the null hypothesis is true. But if there is a difference let the smaller sum be true. Mathematically expressed:

$$Z = \frac{\frac{n(n-1)}{T-4}}{\sqrt{\frac{n(n+1)(2n+1)}{24}}}$$

(c) Sign Test - The sign test is based on the difference between two pairs of observations without regard to magnitude. It gets its name from the fact that plus and minus signs are its raw data. The only necessary assumption for this test is that the variable being studied has a continuous distribution.It there is a pair of observation X_1 and X_2 , the difference $(X_1 - X_2)$ will either be a plus or a minus, or zero, ignoring pairs for which $X_1 = X_2$, the sum of the pairs of observations for which $X_1 \neq X_2$ constitute the sample, n. the null hypothesis is that there will be equal number of pluses and minuses, since zero difference are ignored the probability of a minus equals 0.5. Symbolically expressed, sign test is written as :

$$Z = \frac{(P+0.5) - \frac{1}{2}(n)}{\frac{1}{2}\sqrt{n}}$$

P=0.5 is used when P is less than 1/2(n) and P=-0.5 is used when P is greater than ½(n).

(d) Mann-Whitney U-Test - When the difference between two independent or unmatched group is to be assessed, the Mann-Whitney U. test represents a powerful alternative to the parametric t-test for uncorrelated samples. The U-test needs data which can be ranked with small samples U-test can be calculated in an extremely brief manner. The statistician which this test is based, that is U is interpreted for statistical significance in one of the three different ways depending upon the size of its sample involved. U test can be computed with very small sample, moderately large sample, moderately large sample and fairly large sample when $n_2 \leq 6$, use the above quoted formula when n_2 is between 9

and 20, the Mann-Whitney U suitable will no longer be suitable for use , instead critical values of U for a one-tailed test or two tailed test is used. When n_2 is greater then 20, a special formula has been developed for interpreting the probability of U by a z-value and the normal curve. Mathematically expressed as:

$$Z \frac{U - \frac{n_1 n_2}{2}}{\frac{\sqrt{n_1 n_2 (n_1 + n_2 + 1)}}{\sqrt{12}}}$$

(e) Friedman Two-Way Analysis of Variance - The Friedman two-way analysis of variance by ranks is designed to test the null hypothesis that several matched samples have been drawn from the same population. The matched samples may be the same group of subjects who have been exposed to several conditions or they may be set of individuals who have been matched on relevant variables condition. In either situation, the condition represents the independent variable while the criterion data, which must be amendable is ranking represent the dependence variable. Statistically expressed as:

$$X^2 = \frac{(12 \sum R_j)^2 - 3N(K+1)}{NK(K-1)}$$

N is number of rows
K is the number of columns
$(R_j)^2$ = Direct one to first square then sum of all column rank total.

(f) Kruskal-Walls H-test (Independent Sample) - f)The Kruskal-Wall is somewhat an extension of Mann-Whitney U test in the same way as the one-way analysis of variance F-test is to the test. The H-test provides an alternative (to the one way (ANOVA) of finding the significance of the difference between more than two means. However, it makes use of ranks instead of raw scores when the null hypothesis is true, and $n_1 \geq 5$ for all j, the H statistics is defined by :

$H = \frac{12 \sum R^2}{n_1} - 3(n+1)$ where

R_j = the rank sum associated with jth sample

n_1 = the number of observation comprising the jth sample:

$n = n_1 + n_2 + \cdots n_k$ =

total number of observations over all samples

SUMMARY

This paper examines the place of non-parametric statistical methods in the conduct of research in the Millennium Age (21st Century). In the process the following components were discussed or highlighted:

- Concepts of research in perspective were examined considered and elaborated.
- Activities supporting research process were itemized and analyzed.
- Research design as the prime determinant of research process, instrumentation and data collection procedure was considered.
- Statistics and statistical analysis was conceptually defined.
- Branches of statistics were considered and their related characteristics discussed.
- The use of statistics as the panacea to the correct collection and interpretation of data was extensively discussed.
- The non-parametric statistics as a concept and broad heading of this article was pin pointed with related examples.
- The need for non-parametric statistical methods and its attendant attributes and characteristics were itemized and discussed.
- Notable non-parametric statistics and their attributes were analyzed, their formulae and symbols was highlighted.

Research as a cornerstone for all-around development should be left to competent, professionally trained and certificated practitioners, so that the require skills and knowledge needed to sustain the system worldwide can be uninterruptedly enhanced. Governments at all levels and various

stakeholders should all embrace research and research activities so as to continuously promote "frontiers of knowledge" in all fields of human endeavors as panacea for growth and development for human and material resources.

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