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Reliability and Internal Consistency of data: Significance of Calculating Cronbach's Alpha Coefficient in Educational Research

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ABSTRACT:
The purpose and aim of this paper was to determine the Values of the Cronbach's Alpha. This coefficient comes from Lee Joseph Cronbach (April 22, 1916 – October 1, 2001) who was an American educational psychologist made several contributions to psychological testing and measurement. He was known for the Alpha Coefficient and his research on the Generalizability theory, or G theory, which is a statistical framework for conceptualizing, investigating, and designing reliable observations. G theory is used to determine the reliability of measurements under specific conditions and mostly adequate for assessing the reliability of performance assessments. In any quantitative research, after defining the problem, formulating the hypotheses and finding the most appropriate research design, a data collection instrument is needed. Most of the time Questionnaires with Likert scales (Diener et al.,1985) are used to collect data. Once data is collected, before processing the data for any statistical discussion, a test is needed. It is where the Cronbach's Alpha comes into play. The Cronbach's Alpha value gives an indication of the internal consistency and reliability of the data collection process and data collection instrument. Several methods exist in determining the value of Alpha such as by SPSS and Python. In this research, a traditional approach was taken and EXCEL from Microsoft Office was used. The formula provided by Cronbach (1951) was considered and the values of Alpha were calculated on EXCEL. It was observed that the values obtained for this particular set of samples , for this research on Educational Performance was from .72, .73, .81,.82,.62,.64. Streiner (2003:102) provided an indication of the significance of these calculated values and it was deduced that the internal consistency of the data and instrument ranged from Good to Acceptable. Streiner (2003) stated that one of the central tenets of classical test theory is that scales should have a high degree of internal consistency, as provided by Cronbach's alpha numerical values. Cronbach's Alpha as a reliability and Internal Consistency Test was not spared of criticism. Sijtsma (2009) argued that better alternatives to alpha exist but are hardly known, let alone used to assess reliability. Cronbach's alpha is a function of the number of items in a test, the average covariance between pairs of items, and the variance of the total score. The value thus can be increased by increasing the number of items (University of Virginia Library, 2015). Therefore even a poorly reliable data's Alpha value can be improved to acceptable by increasing the number of items and recollection of data set.

KEYWORDS: *Cronbach's Alpha, Internal Consistency, Reliability, Questionnaires , Likert Scale, Excel.*

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I. INTRODUCTION

a) Research Process and Methodology

Setting the scene to this research paper about Cronbach Alpha, requires an explanation of the traditional research process and types of data used. Any type of research , in any field requires a certain level of methodology to be adopted. Methodology implies a strategy to reach the objectives and be consistent with what the research is intended for. As Cuff and Payne (1979) stated that a scientific approach necessarily involves standards and procedures for demonstrating the ''empirical warrant'' of its findings, showing the match or fit between its statements and what is happening or has happened in the world. Hitchcock and Hughes (1995: 23) suggest an eight-stage model of the scientific method. Schwardt (2007:195) defined a research methodology as a theory of how an inquiry should proceed. It involves analysis of the assumptions, principles and procedures in a particular approach to inquiry. According to Schwardt (2007), Creswell and Tashakkori (2007), and Teddlie and Tashakkori (2007), methodologies explicate and define the kinds of problems that are worth investigating; what constitutes a researchable problem; testable hypotheses; how to frame a problem in such a way that it can be investigated using particular designs and procedures; and how to select and develop appropriate means of collecting data. Leedy (1997:195) further argued that research design is a plan for a study, providing the overall

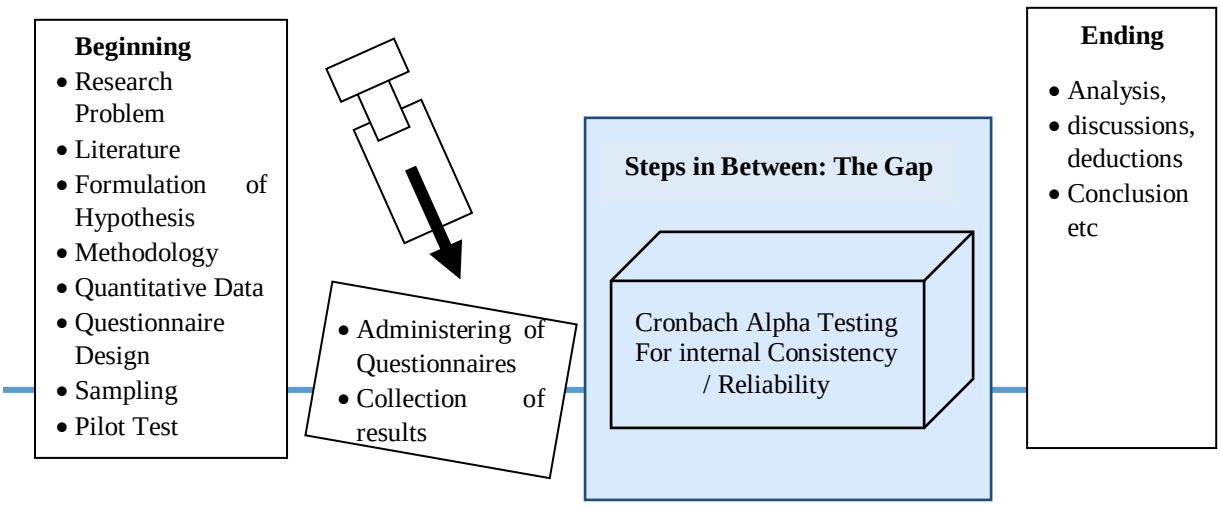
framework for collecting data. MacMillan and Schumacher (2001:166) defined it as a plan for selecting subjects, research sites, and data collection procedures to answer the research question(s). Durrheim (2004:29) described a research design is a strategic framework for action that serves as a bridge between research questions and the execution, or implementation of the research strategy. All this illustrates the importance of a methodology. Depending on the research being conducted, a methodology involves a data collection method. The research can be a Qualitative or Quantitative research. A mixed method is also employed in some research.

b) Qualitative and Quantitative research method

Ahmad et al (2019) described a Qualitative research as one which provides insights and understanding of the problem setting. It is an unstructured, exploratory research method that studies highly complex phenomena that are impossible to elucidate with the quantitative research. Qualitative research is used to gain an in-depth understanding of human behaviour, experience, attitudes, intentions, and motivations, on the basis of observation and interpretation, to find out the way people think and feel. Some common types of qualitative research are Case study, grounded theory, ethnography, historical and phenomenology. On the other hand Quantitative research is a form of research that relies on the methods of natural sciences, which produces numerical data and hard facts (Ahmad et al ,2019) . Quantitative research establishes cause and effect relationship between two variables by using mathematical, computational and statistical methods. Ahmad et al (2019) argued that the research is also known as empirical research as it can be accurately and precisely measured. The data collected by the researcher can be divided into categories or put into rank, or it can be measured in terms of units of measurement. Graphs and tables of raw data can be constructed with the help quantitative research, making it easier for the researcher to analyse the results.

c) The research Gap

Irrespective of the outcome of the end research, after collecting data, in a Quantitative Research, the Reliability of the Questionnaire used and responses obtained needs to be tested. It is where the Cronbach Alpha comes into play, to provide a reference value of whether the Questionnaire responses are Reliable or not, even before nay Statistical deduction are drawn from the research. This paper calculates the Cronbach Alpha, on Excel by Microsoft, of a research conducted on Educational Performance of Students. The value obtained is compared to the norms of Cronbach Alpha of reliability.



II. METHODOLOGY

Saunders and Thornhill (2003) defined research strategy as a general plan of how the researcher will go about answering the research questions and they distinguish between eight types of research strategies, namely: experiments, surveys, case studies, grounded theory, ethnography, action research, cross-sectional studies and exploratory studies. However, Robson (2002), argued that the three mostly used strategies used are: experiments, surveys and case studies because of great benefits associated with using them. Saunders et al. (2003:83) research onion on figure 1, shows the range of choices, paradigms, strategies and steps that needs to be followed by researchers during the research process.

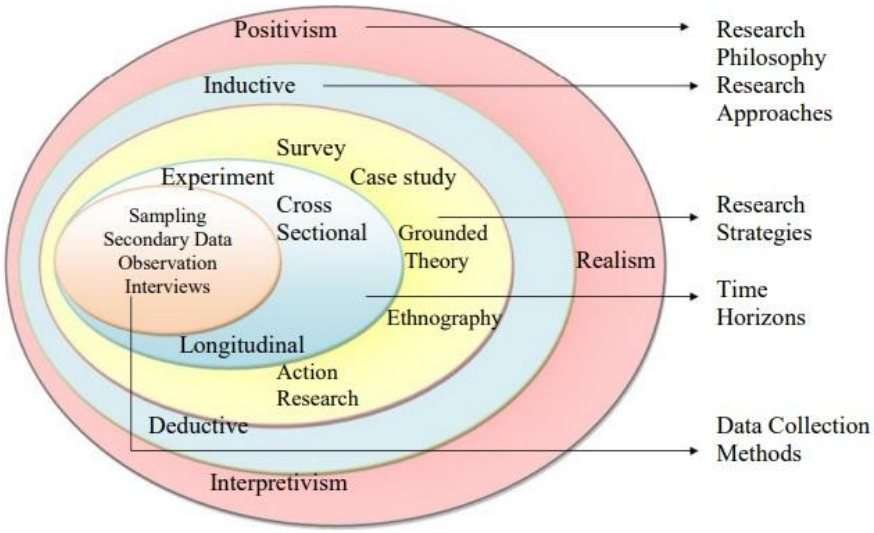


Figure 1 Showing Research Onion. (Source Saunders et al.,2003:83)

For this current paper , the study was on the Academic performance of students at SC level. The 7-point Likert scale of Diener et al., (1985) was used in the administered questionnaires. All Ethical Standards were obeyed to while collecting data, thus some limitations in sample size and freshness. Yamane (1967:886) formula was used to get the sample size and the pilot testing was according to the thumb rule proposed by Whitehead et al. ,(2016) , Machin et al. (2018) and Julious (2005).

Several Sample of study were collected. After data was collected , the values for a particular Sample population, were tabulated in EXCEL by Microsoft , accordingly with 27 variables on the first row and 400 sample on the first column.
The Value of the Cronbach Alpha was Calculated.

III. DISCUSSION

At this stage no deduction, explanation is made with the collected data. The aim is to measure the Internal consistency of the Instrument.

Cronbach's alpha , represented by the Greek letter α is used to examine the internal consistency or reliability of summated rating scales (Cronbach, 1951). Cronbach"s alpha is the most common estimate of internal consistency of items in a scale (Cronbach, 1951; Cronbach & Shavelson, 2004). Alpha measures the extent to which item responses (answers to survey questions) correlate with each other. Alpha α estimates the proportion of variance that is systematic or consistent in a set of survey responses.

Cronbach (1951) Equation is as follows;

$$\alpha = \frac{K}{K-1}\left[1 - \frac{\sum S^2 y}{S^2 x}\right]$$

Where;

α $is\ the\ Cronbach's\ Alpha$
K $is\ the\ number\ of\ test\ items$
$\sum S^2 y$ $is\ the\ sum\ of\ the\ item\ variance$
$S^2 x$ $is\ the\ variance\ of\ total\ score$

For the research paper, On EXCEL by Microsoft, the value is calculated.

	A	B	C
1	**Description**	**EXCEL Functions Applied**	**Values**
2	**Number of Test Items** K		27
3	**Sum of the Item Variance** $\sum S^2y$	=VAR.P(:) =SUM(:)	1.464050264
4	**Variance of Total Score** S^2x	=SUM(:) =VAR.P(:)	4.79
5			
6	**Alpha** α	Cronbach's Equation (C2 / (C2-1)*(1 - (C3/C4))	0.721058639

Table 1 Showing EXCEL table from Microsoft Office in Calculation of Alpha Value

IV. FINDINGS

The value of Cronbach's Alpha was obtained to be .72 to (2 d.p.)
Streiner (2003) provides a table of values to explain the significance of the Calculated value of Alpha, in relation to Internal consistency and reliability.

	Cronbach's Alpha	Internal Consistency/ Reliability Test
1	$\alpha \geq 0.9$	Excellent (High -Stakes testing)
2	$0.7 \leq \alpha$ 0.9	Good (low Stakes testing)
3	$0.6 \leq \alpha < 0.7$	Acceptable
4	$0.5 \leq \alpha < 0.6$	Poor
5	$\alpha < 0.5$	Unacceptable

Table 2 Showing Internal consistency value and significance. (Source Streiner, 2003:102)

$\alpha = .72$ falls into the range of $0.7 \leq \alpha$ 0.9 and the internal consistency is good and passes the Reliability Test. (Streiner, 2003:102)

$$\alpha = \frac{K}{K-1}\left[1 - \frac{\sum S^2y}{S^2x}\right] = Good\ ,Reliable\ Instrument\ of\ data\ collection$$

For other samples of data also the value of Cronbach's Alpha was calculated using the same method.

No.	Sample		Calculated Value of Cronbach's Alpha	Internal Consistency/ Reliability Test
	Affected performance/ Before Covid 19			
1	A	Boys	.72	Good
2		Girls	.73	Good
	Affecting performance/ During Covid 19			
3	B	Boys	.81	Good
4		Girls	.82	Good
	C	Educators		
5		Men	.62	Acceptable
6		Women	.64	Acceptable

Conclusive values of Alpha were obtained for all samples.

Cronbach Alpha measures the extent to which item responses (answers to survey questions) correlate with each other. Alpha α estimates the proportion of variance that is systematic or consistent in a set of survey responses. Statisticians have debated what constitutes an acceptable size for Cronbach‟s alpha (Nunnally & Bernstein, 1994; DeVellis, 2003). Vaske (2008) also suggested that an alpha of .65 to .80 is often considered an "adequate" scale in human dimensions research . Ritter (2010) stated that a negative estimate of value can occur when the items are not positively correlated among themselves. In this situation, one or more variables may need to be recoded so all items are coded in the same conceptual direction. A negative correlation, however, can also occur when respondents‟ answer inconsistently (Thompson, 2003). Several Scholars (Cortina, 1993; Green, Lissitz, & Mulaik, 1977; Ritter, 2010; Schmidt, Le, & Iles, 2003; Schmitt, 1996; Sijtsma, 2009), have highlighted the limitations and misuses of alpha in applied research. For example, the number of items in the scale, item intercorrelations, and dimensionality affects α.

V. CONCLUSION

There has been an ongoing debate of the degree of desired consistency of an instrument. Some scholars argued that a high level of alpha is fundamentally undesirable. Kline (1986:118) argued that "high internal consistency can be antithetical to high validity and that the importance of internal-consistency reliability has been exaggerated." Boyle (1991, p. 291) criticized researchers' obsession with a high level of alpha, stating that "it may often be more appropriate to regard estimates such as the alpha coefficients as indicators of item redundancy and narrowness of a scale."Clark and Watson (1995) noted that the issue of internal consistency reliability assessment is complicated by the fact that "there are no longer any clear standards regarding what level is considered acceptable" for Cronbach's alpha (p. 315); past criteria have ranged from .80 or .90 alpha coefficients, and now it has been reduced down to .60 or .70 alphas.

Once the values of Alpha are at least acceptable , the researcher can proceed to further statistical test and deduction.

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DEDICATION

While confined two weeks at home to recover from a Head Surgical Operation, I worked on this research paper and finished it.

I, Mr Yudhistir S.M.F. Jugessur dedicate this Research paper to my mother, who during these difficult times of solitude, has always been by my side and my only support. ' Doing far more, with far less'

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