EVALUATION OF PSYCHOMETRIC PROPERTIES OF STATISTICAL ANXIETY SCALE (SAS) USING CONVERGENT AND DIVERGENT VALIDITIES IN A STUDY OF UNDERGRADUATE STUDENTS OFFERING STATISTICS IN UNIVERSITIES IN CROSS RIVER STATE, NIGERIA

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Abstract

The research study focused on the evaluation of psychometric properties of the statistical anxiety scale (SAS) using convergent and divergent validities in a study of undergraduate students offering statistics in Universities in Cross River State, Nigeria. The study utilized the ex-post facto research design and the population of the study comprised 5436 final-year students of the Universities situated in Cross River State, who were admitted into the 2017/2018 academic session. The sampling technique that was adopted for the study is the stratified sampling technique which is appropriate when the nature or characteristics of the population consist of several distinct sub-groups which need to be represented in the sample. The reason for the stratification is to ensure that a more representative sample is drawn for the study, reflecting attributes such as sex, age and academic discipline. The total sample of the study consisted of 1091 final year students and the data collection was a statistics anxiety questionnaire (SAQ) validated by experts which yielded a reliability coefficient of 'statistics anxiety scale' produced a Cronbach alpha and split-half reliability estimate of 0.78 and 0.89 and the statistical procedure used was the Factor analysis and the Correlation (Pearson Product Moment Coefficient). The findings revealed that the construct validity of the statistical anxiety scale (SAS) using convergent and divergent validities was high also, the scale reliability of the statistical anxiety scale (SAS) was high based on the fact that the instrument was reliable and valid it is therefore recommended for use among undergraduate students.

Keywords: *Psychometric properties, statistical anxiety scale, convergent and divergent validities*

INTRODUCTION

The benefits impact of the statistical anxiety scale to cannot be compromised. This is because anxiety can be a very strong motivating force in decision-making situations, and it can often spark creativity in the individual experiencing it. Berthold (1963) states that "Anxiety is the mother of the drive to know

In the words of Onwuegbuzie and Wilson (2003), statistics anxiety is a term used to describe the nervousness that occurs when an individual is exposed to statistics content or problems and instructional situations, or evaluative contexts that deal with statistics. Thus, individuals with statistical anxiety often develop an unusual negative phobia for statistical computations. In a study on anxiety and problem-solving, Sarason l. (1960) found that an individual who scored high on the anxiety scales manifested greater interference in problem-solving than a peer who scored low, even though both scored the same on an intelligence test. Since statistics are used extensively in a problem-solving environment, this finding illustrates the probable need for the identification of strongly statistics-anxious individuals. The use of statistics as a problem-solving tool by strongly anxious persons could be very significantly hindered.

Two other studies, one by Malmo and Amsel (1948) and another by Welch and Diethelm (1950) illustrated the negative effects of high anxiety in learning situations. Malmo and Arosel found greater "forgetfulness" in highly anxious subjects, and Welch and Diethelm found higher levels of failure in higher anxiety groups in the learning environment. Montague (1953) found that highly anxious subjects performed better on simple learning tasks than did less anxious subjects. However, when faced with more difficult tasks, the situation was reversed. On the difficult tasks, the lower anxiety group showed better performance than the high anxiety group.

In a very bizarre study on problem-solving, Patrick (1934) found some very clear evidence of the effects of anxiety on human problem-solving. Patrick's problem was for an individual to attempt to get out of a room by determining the pattern of locked doors. To raise the anxiety level, subjects were subjected to three different

anxiety-causing situations. One group of subjects was given a continual electric shock, a second group was continuously sprayed with a high-pressure water hose, and a third group was blasted with a loud horn until they got out of the room. From this study, Patrick found that human problem-solving degenerates to an animal level when anxiety is markedly increased. Without anxiety-causing stimuli, humans were quite proficient in solving the problem, but when exposed to very extreme anxiety-causing stimuli, the human subjects became very poor at solving the problem. Their behaviour greatly resembled the behaviour of laboratory rats that were given an identical problem-solving environment but were not exposed to anxiety-causing stimuli.

Very little of the information necessary to make meaningful use of the statistics can be gathered intuitively. To begin solving statistical problems, there must first be a considerable amount of learning about statistics. Since the science industry is changing so rapidly, and will likely continue to do so, users of statistical software applications must be life-long learners to keep current with the system. Any interference with learning could also interfere with an individual's initiating statistical application, or could force an individual to be "left behind." Since statistics are most often used in a problem-solving environment, any interference with the ability of individuals to solve the problem, which might occur when statistics anxiety is high, could greatly hamper the successful manipulations of figures.

Concept of Instrument Validation

One of the main purposes of this study is to validate a new instrument of statistics anxiety. To do this properly, the concept of validity must first be studied. A valid instrument measures what it purports to measure. In this study, to validate this newly designed instrument, the evidence must be gathered to support the claim that this instrument is measuring statistics anxiety. A discussion on validity can be subdivided into different types: criterion-oriented validity, content validity, and construct validity. Cronbach (1970) makes the following statements about criterion-related validity: Decisions are based on a person's expected future performance as predicted from the test score. If these expectations are confirmed, the test was useful; if what happens later is not consistent with the predictions, the test was worthless or harmful.

In selection or classification, the psychologist wants to improve decisions. He wants to pick workers who turn out more work, students who learn more, and parolees who do not commit crimes. To examine whether predictions are sound, one must make a follow-up study. The psychologist gives the test, makes his predictions, and waits to see what happens. He obtains a record of the outcome (foreman's rating, school grade, or probation officer's report, for example). This record, which we speak of as the criterion, he compares with the prediction. This is a straightforward empirical check on the value of the test -a criterion-oriented or predictive validation (Cronbach, 1970, p. 122).

When one intends to emphasize that no time has elapsed between measures, the study is spoken of as a concurrent validation. The designer of a new test will suggest its validity by comparing it concurrently with an established test (Cronbach, 1970, p. 122). Thus, criterion-oriented validity can be spoken of as two different subtypes of validity, predictive validity and concurrent validity, depending on the timing of the administration of the validated instrument. Criterion-oriented validity is generally measured by correlating the performance of the new measure with the performance of the criterion such as an existing standardized measure. When a test is being used to measure an amount of change due to treatment, a different type of validation is involved. If there is a defined universe of content or behaviors that are to be tested for, then content validity may be required. The test must sample from this entire universe, and not from outside of it if the measure is to be content valid. Unlike criterion-oriented validity, content is not an empirical measure, but must instead be determined through a judgment by the test designer or those using the test (Cronbach, 1970).

The third type of validity is important when a new idea or concept is proposed. Construct validity is the continuing process of adding credence to a new idea or concept. "Construct validity must be investigated whenever no criterion or universe of content is accepted as entirely adequate to define the quality to be measured" (Cronbach & Meehl, 1955, p. 282). All three of these types of validity will be addressed in this study. For example, the results of the statistics anxiety measure will be correlated with other measures to obtain an evaluation of criterion-related validity. The content of each item in the measure will be closely examined, and a judgment of the content validity of each item will be made by the experimenter and other experts in the field. The validation study is one small step in the ongoing process of construct validation. The construct being validated is statistics anxiety. This is not a widely accepted concept, but positive correlations between the paper and pencil measure to be designed will help to demonstrate that a group of statistics anxiety-related feelings and reactions to those feelings exist. These feelings and reactions will be demonstrated as being a construct that can be called statistical anxiety.

Problems with anxiety measure validation studies are that many validation studies have been conducted using various anxiety measures, in surveying several of these studies, a problem noted by Lastovicka (1982) was a failure by some experimenters to determine if all three areas of validity apply to their work (i.e., content validity,

criterion-oriented validity, and construct validity). The most noticeable omission related to content validity: Often validity was expressed only as a correlation coefficient. Content validity can only be established through judgment. It cannot be reported as a correlation coefficient (Cronbach, 1970). Construct validity is often not determined for measures because it is not easily demonstrated. The experimenter must make a special effort to completely validate any new measure.

One instrument that was used in a study as a concurrent measure of anxiety was the State-Trait Anxiety Inventory (STAI) developed by Spielberger (1970). This standardized, self-report, paper and pencil measure indicated both state and trait anxiety levels. In a review in the Eighth Mental Measurements Yearbook, Dreger states that: The STAl is one of the best-standardized anxiety measures if not the best. For instruments of its type: It appears to be deservedly popular, in that their liabilities are nearly as high as one would expect for intelligence scales; it demonstrates expected differences among groups of persons; and its state form generates non-random factor structures when used over time. The only major reservation this reviewer has in recommending the STAI for both researches and applied uses are its openness to faking (Burros, 1978, p. 1095).

The only other problem that is pointed out by Dreger concerns the validity of the measure, which he believes may be in question. The other reviewer of the same instrument in the Mental Measurements Yearbook does not have this reservation, however. Katkin states: It appears that the STAI is an excellent choice for the clinical psychologist or personality researcher looking for an easy-to-administer, easy-to-score, reliable, and valid index of either individual differences in proneness to anxiety or individual differences in the transitory experience of anxiety (Burros, 1978, p. 1096). This measure will be used as a concurrent measure of validity with the statistics anxiety index. The reliability of the STAI has been tested in several studies. In a study by Joesting (1977), 105 educational psychology students were tested with the STAI and retested after a 45-minute class. The correlation reported for the A-state measure was .66, while the correlation for the A-trait was .81. This substantiated the claims made by Spielberger that the tests were highly reliable and that the trait measure was more stable over time than the state measure.

The theoretical basis of factor analysis

Factor analysis is a statistical procedure used to describe variability among observed variables called factors. The observed variables are modeled as linear combinations of the factors plus "error" terms. The information gained about the interdependency can be used later to reduce a set of variables in a dataset. Factor analysis originated in psychometrics, and is used in behavioural science, social sciences, marketing, product management, operations search, and other applied sciences that deal with large quantities of data. The statistical procedure estimates how much of the variability is due to a common factor ("commonality"), Cattell (1973).

Exploratory factor analysis (EFA) is used to uncover the underlying structure of a relatively large set of variables. The researcher's a priori assumption is that any indicator may be associated with any factor. This is the most common form of factor analysis. There is no prior theory and one uses factor loadings to intuit the factor structure of the data, MacDonald (1985). Confirmatory factor analysis (CFA) however seeks to determine if the number of factors of the loadings of measures (indicator) variables on them conform to what is expected based on pre-established theory. Indicator variables are selected based on prior theory and factor analysis is used to see if they load as predicted in the expected number of variables. A minimum requirement of confirmatory factor analysis is that one hypothesis beforehand the number of factors in the model, but usually also the research will posit expectations about which variables will load on which factors. The researcher seeks to determine, for instance, if measures created to represent a latent variable belong together.

Statement of the problem

In the research environment, statistics is an all-rounder course for all and sundry due to its potential relevance to students, by providing them with skills to critically assess and understand various functions of the world in a meaningful way. Personal interaction with most students has shown that they lack the construct required (psychometric properties) required to manipulate statistical computations. Therefore, the poor construct in statistics has made most students dabble in statistics without having the needed skills and practice in statistical concepts has made the researcher carry out a study on an evaluation of the psychometric properties of the statistical anxiety scale (SAS) using convergent and divergent validities in a study of undergraduate students offering statistics in Universities in Cross River State, Nigeria.

Purpose of the study

The main purpose of the study was to carry out an evaluation of the psychometric properties of the statistical anxiety scale (SAS) using convergent and divergent validities in a study of undergraduate students offering statistics in Universities in Cross River State, Nigeria. In specific terms, the study hoped to

1. Examine the construct validity of the statistical anxiety scale (SAS)?
2. Ascertain the reliability of the statistical anxiety scale (SAS)?

Research questions

1. What is the construct validity of the statistical anxiety scale (SAS)?

2. What is the reliability of the statistical anxiety scale (SAS)?

Method and Procedure

The study utilised the ex-post facto research design which studies phenomena after they have occurred. Kerlinger (1986), as cited by Isangedighi, Joshua, Asim and Ekuri (2004), defines it as a systematic empirical inquiry in which the scientist does not have direct control of independent variables because their manifestations have already occurred or because they are inherently not manipulable**.** The research area of this study was the Cross River State of Nigeria. Cross River State is in the tropical region. The State lies between latitudes 5^0 32^1 and 4^0 27^1 North of the Equator and longitudes 7^0 50^1 and 9^0 28^1 East of the Greenwich meridian. The capital of the State is Calabar and it has eighteen Local Government Areas. The major river in the state is Cross River from which the name of the State is derived, the river covers an area of 39,000 square kilometers. The Atlantic Coastline is 129 kilometers with a coastal area of 10,000 kilometers. In the northern part of the state exists the famous Obudu Plateau (popularly known as Obudu Cattle Ranch) with an altitude of 1,575.76 meters above sea level. This plateau enjoys a temperate climate like other temperate3 regions of the world. The State has a land area of about 23,074,425 sq kilometers. The State is bounded in the North by Benue State, in the Southwest by Akwa Ibom State, West by Abia and Ebonyi States, in the East by the Republic of Cameroon and in the South by the Atlantic Ocean. The state has a population of 2,892,988 with 1,471,967 males and 1,421,021 females in the 2006 National Census conducted in Nigeria (FRN, 2009).

The state is in the South-South Geographical Political Zone of the country. Major towns in the state include Calabar, Ugep, Ikom, Ogoja and Obudu (CRSTrade Fair Brochure, 1998). The state has three major ethnic groups, which include Efik (Southern), Ejagham (Central) and Bekwarra (Northern), with many minority ethnic groups. The state is rich in natural features, which offer a great deal of tourist attractions. They include the Obudu Cattle Ranch, Agbokim Water Falls and Kwa Falls near Oban, Mary Slessor Tomb, Spectacular Nkarasi Monoliths, National Parks, the Drill Ranch, and the Old Residency Museum among others. The state also has two Universities situated in it: University of Calabar and Cross River University of Technology with campuses in Calabar, Obubra and Ogoja. The state has a Federal College of Education, Obudu, the State College of Education, Akampka; College of Health Technology and the School of Nursing in Calabar. It also has 234 secondary schools and 1,016 primary schools. The people of the state are mostly subsistent farmers with yams, cassava, plantain and cocoyam as the major staple food crops. Others are farming, hunting, fishing, arts and crafts, and trading. This research area was chosen because of its proximity and familiarity with the researcher. Moreover, the high population density and the students' population density were considered adequate for the study. Furthermore, the two Universities have a high concentration of students in various disciplines which facilitate the availability of all categories of students from such discipline giving the area a full representativeness for effective generalization. The population of the study comprised 5436 final year students of the Universities situated in Cross River State, who were admitted into 2017/2018 academic session. The sampling technique that was adopted for the study is the stratified sampling technique which is appropriate when the nature or characteristics of the population consist of several distinct sub-groups which need to be represented in the sample. The reason for the stratification is to ensure that a more representative sample is drawn for the study, reflecting attributes such as sex, age and academic discipline. The total sample of the study consisted of 1091 final year students and the data collection was a statistics anxiety questionnaire (SAQ) validated by experts which yielded a reliability coefficient of 'statistics anxiety scale' produced a Cronbach alpha and split-half reliability estimate of 0.78 and 0.89 and the statistical procedure used was the Factor analysis and the Correlation (Pearson Product Moment Coefficient).

Presentation of results

Research question one

What is the construct validity of the statistical anxiety scale (SAS)? To answer this research question, data collected were subject to factor analysis and the result is presented in Table 1.

TABLE 1
FACTOR 3 Computational self-concept in statistics

S/N	Item No	Item Description	Factor loading	Communality Coefficient
1	27	I have confidence in interpreting statistical results	0.551	0.709
2	30	I am very fast at interpreting statistical results	0.535	0.591
3	28	I rely perfectly well on my innate ability in statistics	0.517	0.679
4	55	Statistics class is my best moment	0.509	0.461
5	61	I can handle statistical concepts very well	0.475	0.541
6	68	Computation formulas in statistics are at my fingertips	0.401	0.799
7	29	I am patient in sorting computational formulas	0.469	0.559
8	65	I view myself as below-average in computing data	0.425	0.643
9	63	I have self-confidence in computing data	0.442	0.534

Eigen Value % of variance 10.351

Table 1 shows factor analysis of the statistical anxiety scale, the screened scale was made up of 68 items. All the items were first subjected to factor analysis using Statistical Package for Social Science (SPSS) version 19, and 35 items were retained. Initially, 22 factors were extracted which converged at 25 interactions. The rotation was done using varimax orthogonal rotation. However, the suitability of the data was assessed using Kaiser-Olkin (1974) criteria. The criterion was that if the obtained Kaiser Meyer Olkin (KMO) value is greater the .50, then, the data was suitable for factorability. In this study, the KMO value of 0.849 was obtained. This implies that the data was suitable for factor analysis. More so, the commonalities of the items were assessed to ensure that all items loaded beyond .40. According to Tabanach and Fidel (2011); and Child (2009), any item whose commonality is below .04, such is not a good item and should be deleted. Based on this, 33 items loading below .04 were deleted and another analysis was performed by the application of confirmatory factor analysis with the remaining 35 items. From the result, the Eigenvalue was set at 2, and 3 factors were extracted using Varimax orthogonal rotation. The three-factor with Eigenvalues equal to or greater than 2 is 16.75, 12.516, and 10.418. From the result, factor 1 accounted for 16.75% total variance followed by factor 2 with 12.516% and factor 3 with 10a.418%. However, the total cumulative percentage of total variance explained by the extracted factors is 69.87%. The first factor is Statistics interpretation anxiety with 17 items loading on it. The Eigenvalue percentage is 17.814% which implies that the variance in the factor can be explained by the 17.91% contribution of each item etc. Table 9 reports the intercorrelations of factors of the statistical anxiety subscale. From the result, factor 1 and factor 2 have a high strong relationship with a value of (r = 516. P>.05), factor 1 and factor 3 correlate highly (r = .558. p>.05) and factor 2 and factor 3 (r = .472, p>.05).

Research question two

What is the reliability of the statistical anxiety scale (SAS)?

To answer this question, Cronbach alpha and split-half reliability estimates were applied and the result is presented in Tables 2 and 3.

Tables 2 and 3
Cronbach split-half reliability estimates
A Cronbach

S	N	X	SD	Cronbach Coefficient
Factor 1	17	48.47	8.42	.796
Factor 2	9	22.06	6.596	.792
Factor 3	9	25.06	9.156	.904
Overall	35	94.59	20.184	.910

Table 3: Split Half

	N	Odd Even	X	SD	Split Half
Factor 1		9	26.85	5.333	.616

	8	21.62	4.561	
Factor 2	5	12.29	3.625	.751
	4	11.86	3.747	
Factor 3	4	13.54	5.157	.872
	5	10.52	2.566	
Overall	35	95.35	21.242	.892

TABLE 3

Convergent and Discriminant validity indices of the statistics anxiety scale

Correlations	Types of Validity	Indices
Statistics anxiety scores with the attitude toward statistics scores	Convergent	0.84
statistics anxiety scores with Becks depression scale scores	Discriminant	- 0.852

correlation is significant at 0.01 level (2-tailed)

The result showed that the Cronbach alpha reliability coefficient ranged from .796 - .904 for three subscales with an overall of .910, while the split-half reliability of Table 10b ranged from .616 - .872 with an overall of .892. The subscales of SAS indicated a good and high-reliability index as the .910 in the SAS as found in the Cronbach and split-half for the three subscales with an overall of .892 is an indicator that when the items converge, they are measuring the same construct.

Discussion of findings

The discussion is presented according to the findings of the study.

The reliability of the statistics anxiety scale

The 35 items were subjected to factor analysis, three factors were extracted which were labeled as Statistics Interpretation Anxiety (SIA), Perceived Worth of Statistics (PWS) and Computation Self Concept in Statistics (CSCS) as against those of Cash, Cruise and Bolton (1985). Whose six factors of statistics anxiety rating scale names are: interpretation anxiety, fear of asking for help, computational self-concept, fear of statistics teachers, perceived worth of statistics and test and class anxiety. The findings of the present study are in contrast with the earlier study conducted by Cash et al (1985) which could be a result of the difference in the subject used as a sample for the study and also the level of development technologies and exposure in most of this area where this instrument was developed and tested, differ significantly with the area the present study is situated hence the differences in the factors extracted. The differences could also be a result of the work having stayed for an expanded period whereas the present study is recent.

The present study is in agreement with Chew et al., (2018) who studied three factors of statistical anxiety, the agreement of the findings could be a result of the attitude put up by the students in the area the instrument was developed and administered and also the number of respondents the instrument was administered to. The reliability coefficients of SAS were reported using Cronbach Alpha reliability and split-half reliability. These techniques enhance the determination of the internal consistency of the items. The coefficient for the Cronbach Alpha internal consistency reliability was .796 to .904 for the subscale and .910 for the overall SAS for split-half reliability the coefficient ranged from 616 to .872 with an overall coefficient of .892. The overall SAS and the subscales recorded high and satisfactory reliability coefficients relative to the recommendation of Kaplan and Saccuzzo (2005), Clark and Watson (1995) and Nunnally (1978), whose assertion was that if the reliability coefficient in the entire items is about .80 and above, there is no need to add items (Nunnaly, 1978), reliability coefficient from .70 to .80 are considered excellent (Kaplan & Saccuzzo, 2005).

The reliability coefficient of this study compares favourably with the reliability coefficient of other works reviewed such as Mikolojczak et al. (2006), r = 59 and r = .90 etc. Thus, the high-reliability coefficient of the overall SAS is an indication that the instrument is reliable and can be used in Cross River State, Nigeria. The construct validity of coefficients of SAS was obtained through the intercorrelation of subscales scores with the entire scale score, there was a high convergence validity of the subscale with the overall SAS scores showing a satisfactory validity coefficient as shown in Table 1. The coefficients ranged from .610 - .827 significant at 0.05 alpha level, showing that the obtained factors were measuring the construct under study.

The Cronbach alpha obtained in the present study is also in agreement with those of Munoz and Mato (2007) who also obtained a reliability index of .812 for the three factors extracted in their study by examining the

psychometric properties of the scale among students in Singapore and Australia. The similarities recorded in the obtained Cronbach alpha reliability index could be a result of the use of undergraduate students who may be having similar characteristics irrespective of their location.

Conclusion

Based on the findings, it was concluded that the construct validity of the statistical anxiety scale (SAS) using convergent and divergent validities were high and also, the scale reliability of the statistical anxiety scale (SAS) was high. Based on the findings, the majority of the students scored high on the statistics anxiety scale, it is therefore recommended that the curriculum planners should introduce statistics as a foundation course to all categories of students to avert the anxiety encountered later on in their course of study.

Recommendations

1. Based on the findings of the study the instrument was reliable and valid it is therefore recommended for use among undergraduate students.
2. It is also recommended that more credit load be added to statistics as a course to increase the value attached to statistics since statistics are applied in our every day to day activities irrespective of the discipline.

Contribution of the Study to Knowledge Gap

The study's purpose was to develop and standardize a statistics anxiety scale for use among undergraduate students in Cross River State, Nigeria. The outcome will be of great significance to researchers in measurement and evaluation who are often saddled with the responsibility of developing and validating instruments. This is because this study could bridge the gap or solve the problem of a shortage of valid and reliable instruments for testing and identifying students' anxiety over statistics. This study is, therefore, significant because its outcome will help to produce a valid and reliable scale of statistics anxiety for evaluating undergraduate students' anxiety in statistics. The study will be of great value to researchers by helping them utilize an already valuable scale measuring their construct of interest.

Statistics lecturers may use Statistics Anxiety Scale SAS as a comprehensive tool in carrying out effective assessment of students by identifying individuals suffering from statistics anxiety and also gaining a better understanding of the factors or dimensions that contribute to such anxiety thereby providing a remediation mechanism to ameliorate the problem of anxiety over statistics among undergraduate students.

The study may serve as a pointer to curriculum developers of the role statistics plays not just in academics but also in the professional and private lives of every individual in every sphere of life, which will also give a better understanding of the various functions of the world in a meaningful way since statistical knowledge prevent the public from questioning theory thus theory not well understood could be interpreted as facts. The study may be of immense benefit to students by helping them develop a strong positive self-concept towards the interpretation of data when it comes to statistics and also rejecting information that provokes anxiety by identifying the different dimensions of anxiety which pose a problem to them and also mapping out strategies to overcoming such problem as a way forward.

The outcome of this study is hoped to be useful to both undergraduate and graduate students of measurement who may wish to carry out studies in areas related to this study by either adopting or adapting the instrument. In addition to the above importance of the study, it would add to the body of knowledge already existing in this area which will in turn serve as bases for reference material for researchers in the field of measurement and evaluation, research and statistics for those who may be interested in this line of investigation.

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