CONSTRUCTION AND VALIDATION OF STATISTICS ANXIETY INSTRUMENT FOR STUDENT S OF TERTIARY INSTITUTION IN BENUE STATE, NIGERIA .

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Abstract

The study develops and validats Statistics Anxiety Instrument (SAI) for measuring statistics anxiety of Benue State tertiary institution students. The study is guided with four objectives which translated to four research questions. Survey design is adopted in the choice of schools and the students were selected using proportionate stratified and simple random sampling techniques with the population of eight thousand, one hundred and eighty-two students (8182). Eight hundred and eighteen (818) students are sampled based on 10% of the population theory posited by Nwana. One hundred and two (102) items generated with six domains are subjected to face & content validity before the psychometric properties of the remaining items are established. The second stage of the validation is carried out for the confirmation of the construct validity using Confirmatory factor analyses of MPLUS 7.4 and RMSEA NFI. The internal consistency of the instrument yielded 0.84 and 34 items emerged from the generated 102 items with eight factors against the six factors from the draft. Based on the analysis of the psychometric properties of the instrument, the refined Statistics Anxiety Instrument(RSAI) is recommended for use by Researchers, Psychologists, Guidance Counselors and Measurement experts

Keywords: Construction, instrument, Construct Validity, Reliability and Statistics Anxiety

Introduction

Statistics is found virtually in all human endeavours. Even the oldest woman in the village applies the techniques of statistics the management of her home. In the academic environment, statistics cuts across almost all faculties in tertiary institutions largely due to its relevance in the educational system. Even in the department of humanities where

one probably would have thought that statistics is of no relevance due to the nature of what they learn, it is obvious that statistics has steadily and slowly permeated into these areas with the advent of content analysis.

Statistics is a branch of Mathematics which deals with the collection, classification, analysis and interpretation of numerical data. It deals with quantitative analysis of numerical data so as to make wise decision. Statistics is the study of how to collect, organise, analyse, and interpret numerical information from data. Statistics helps in arriving at replication of such information by other researchers. The study of statistics helps to engage in precise measurement of resources with a view to deriving maximum satisfaction (Ogwuche 2011). Schield (2004) states that statistics are contextual; they depend on what is taken into account. Over the years, statistics have earned a negative reputation and for good reason. This has affected statistical literacy of learners due to what they probably may have heard about statistics. But the place of statistical literacy cannot be overtaken by descriptive words.

Statistics in tertiary institutions evoke the feeling of "anxiety". While anxiety as it pertains to writing is met with encouragement, anxieties that pertain to statistics are met with empathy (Jordan & Haines, 2003). Jordan and Haines state that "While statements like 'I am not good at writing' are typically answered with encouragement reassurance that good writing can be developed through training and practice, and statements like 'I am just not good in Mathematics' are all too often answered with silence and or a sympathetic nod". Such empathy has worked against statistics anxiety, giving rise to the notion that although everyone can learn to write, not everyone can learn statistics, thus resulting in a society in which many people are anxious about statistics. According to Zeidner (2001), Statistics anxiety is a particular form of performance anxiety characterised by extensive worry, intrusive thoughts, mental disorganisation, tension and physiological arousal. Statistics anxiety is defined as the feelings of anxiety encountered when taking a statistics course or doing statistics analyses; that is, gathering, processing, and interpreting' (Cruise, Cash and Bolton, 2005). So many reports abound on statistics anxiety. Mji and Onwuegbuzic (2004) report that 66% to 80% of all graduate students reported unmanageable levels of statistics anxiety. Also, Nwana (2010), views statistics anxiety as characterised by anxiety, fearful behaviour, attitude, expectations, history, self-control, and performance. Similarly, six domains are found that encompassed most of previous constructs of statistical anxiety and attitudes toward statistics. These domains identified by Burton and Russell (2009) are made through analyses of different theories related to statistics anxiety and attitudes toward statistics.

On fearful behaviour domain, Nwana (2010) opines that it comprised items that address fear of asking for help, fear of statistics' teachers, extensive worry, intrusive thoughts, mental disorganisation, tension, and behavioural responses. Aiken (2006) posits that the

attitude domain comprised of items that address attitudes to statistics, perceived worth of statistics, its effect, and psychological arousal. The expectation domain comprised items that address subjective norms, motivation to continue learning, steps in information processing, cognition, social expectations, unrealistically high parental/peer pressures to succeed in Statistics, high expectations of punishment for failure to meet demands in solving statistics problems, unfortunate past experience in understanding statistics course material, and low level of Statistics reasoning ability. The history and self-concept domain comprised of low self-esteem in statistical related courses, history of successful and failed experiences in situations involving Statistics, self-concept, prior educational experience, motivation to learn and instructional situations. Lastly, the performance domain is comprised of self-perception of ability to perform in statistics. Thus, understanding a student's level of anxiety that may be generated through statistics classes may help teachers find ways to reduce the level of anxiety and enhance the learning experienced by their students (Baharun & Porter, 2009). This could be done by seeking the opinions of these students about what causes anxiety in them during their statistics classes.

A well designed instrument could be used to elicit information from the students that teachers could use to make necessary adjustment in their lessons and behavior towards their students. So many instruments have been developed by researchers such as Hassed (2007) for measuring instructor attitude towards concept based teaching of introductory statistics. However, the variable attitude is just one of the indices of anxiety and this calls for better instrument for measuring anxiety. Also, Koh and Zawi (2014) examined statistics' anxiety among postgraduate students in National University of Malaysia using an instrument with domains in anxiety toward class activities, attitude toward class and mathematics, and self-perception. This instrument was found inadequate because it could not capture most of the anxiety domains and this warrants the development and validation of a new instrument. It is against this background that this study aims at construction and validation of an instrument for measuring statistics anxiety among students of tertiary Institutions in Benue state that will capture most of the neglected part of the indices of anxiety.

Statement of the Problem

The ideal learning situation demands that students have confidence in themselves and a positive attitude to learning because attitude controls the cognitive aspect of learning which invariably leads to high performance. In a teaching-learning situation, the teacher should not only be interested in the academic achievement of students but also in their affective and psychomotor development. It is on this note that assessment of students and reporting has to be done on the three domains as reflected in the students' assessment cards. There is much non-cognitive behaviour that is within the affective domain such as good attitudes, values, interests among others. Teachers need valid and reliable tools in evaluating these traits in students and it appears that these instruments are relatively

scarce. The available ones have not really exhausted all the indices of anxiety. Observation shows that a large number of students display a high level of anxiety, and fearful behaviour when it comes to expression of numbers.

Statistics anxiety describes an enduring, habitual type of anxiety. Anxiety and fearful behavior comprise statistics content anxiety, statistics test anxiety, class anxiety, interpretation anxiety, numerical anxiety, and lack of Statistics foundation. Having a Statistics anxiety instrument will help teachers to identify causal factors so as to provide better solutions. Due to the observed magnitude of the rate of failure of students, most especially education students in statistics related courses, some researchers have come up with certain ideas to solve this problem. This, they have achieved by studying/investigating problems like improving students' performance through teaching and assessing certain soft skills, ensuring quality in test development process and many others. Researchers have concentrated on cognitive assessment at the expense of affective and psychomotor assessment. Students are thus certified worthy in learning who lack the character worthy of an educated person. This research therefore seeks to bridge that gap by developing a valid and reliable instrument for measuring student's anxiety in Statistics in Benue State which can be used for affective and psychomotor assessment.

Purpose of the Study

The main purpose of this study is to construct and validate an instrument for measuring statistics anxiety among students of tertiary institutions in Benue State Nigeria. Specifically, this study aims at achieving the following objectives:

i. To determine the factors that underlie the Statistics Anxiety Instrument (SAI) based on the empirical data
ii. To determine the factor that are salient underlying the SAI
iii. To determine the construct validity of the refined SAI
iv. To determine the reliability of the refined SAI

Research Questions

The following research questions were raised in order to guide the study:

1. How many factors underlie the Statistics Anxiety Instrument (SAI) based on the empirical data?
2. How many factors were salient underlying SAI?
3. What is the construct validity of the Refined SAI?
4. How reliable are the refined SAI (RSAI)?

Methodology

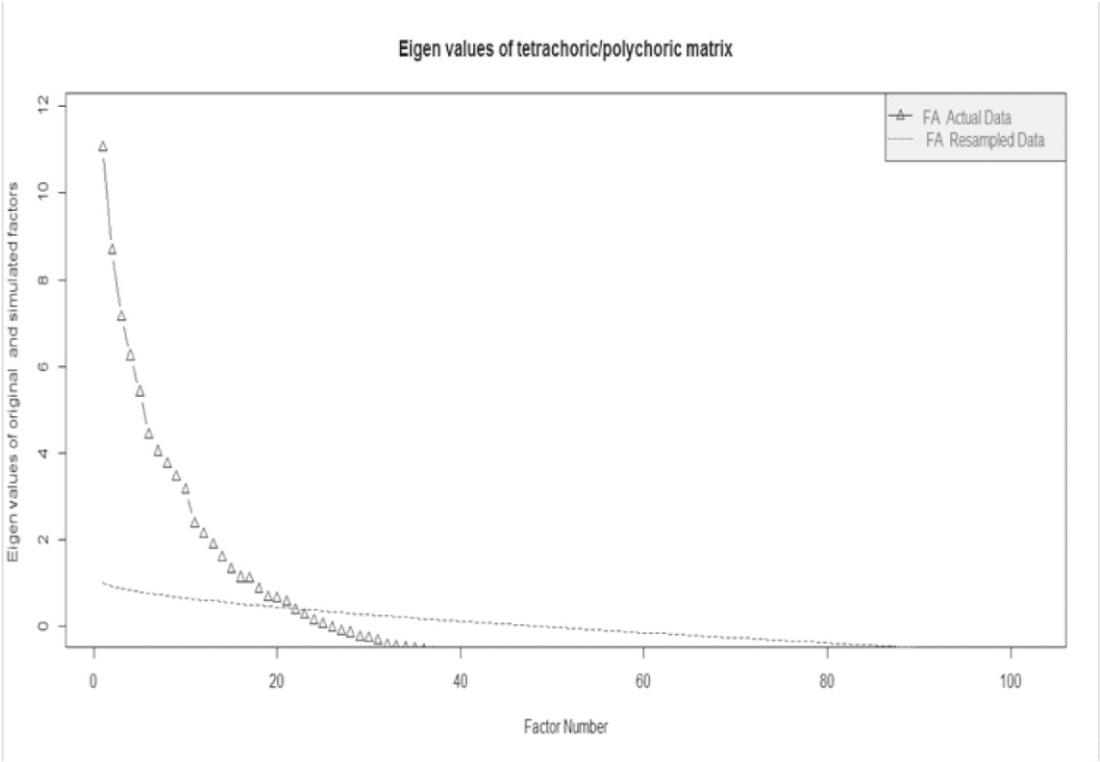
The survey research design was adopted in this study for data collection. This is because of the fact that the research is concerned with finding, describing and interpreting what is already in-existence.The population of the study is Eight thousand one hundred and eightytwo students (8182) (Academic units of the institutions, 2016) from two Universities and Colleges of Education in Benue State. The sample size of eight hundred and eighteen (818) students, was used for the study. This is in agreement with Nwana's (2010) postulation that if the population is a few thousand, a 10% sample size is okay. Therefore, the sample size of 818 represent 10% of the population of 8182 from the four selected tertiary institutions. This sample includes; UAM (105), BSU (113), COE K/ALA (356) AND COE OJU (244). Multi-stage sampling procedure is used which requires several sampling techniques at different stages of sampling the elements of the population. The sampling stages are sampling of school and sampling of research subjects (students) where simple random sampling and proportionate stratified random sampling are used.

Statistics Anxiety Instrument (SAI) is developed with initial draft of 120 items in sections to reflect the domains and variables which are raised in the research questions and literature review by the researchers. These domains are of six sections of anxiety namely: fearful behaviour, attitude, expectation, history and self-concept and performance was administered to the sampled and later subjected to factorial analysis. The result shows that most of the items did not purely load and the purely loaded items were called *Refined* Statistics Anxiety instrument (RSAI) that has 34 items with 8 factors against the drift with six (6) factor. In the eight (8) sub factors, the respondents are expected to rate each item on four point modified likert scale. This rating is based on the level of anxiety and agreement with the items. The validation of the instrument is carried out twice. The first stage is the establishment of face and content validity with an expert of psychology, while the second stage is the establishment of construct validity, reliability and the confirmatory analysis. The instrument is administered twice to 300 /400 level students in the two universities who offered Research Method and Statistics and NCE II students in COE who offered Measurement and Evaluation by the researcher and four research assistants. The collected data is analysed using Psych package, Chronbach Alpha and Confirmatory Factor Analysis (CFA). CFA is employed to examine the construct validity of the RSAI using MPLUS 7.4. A number of indices are employed to indicate the robustness of fit in CFA. As the Chi square value is sensitive to sample size especially when the sample size is large, the fit indices used in Study 2 are the Root Mean Square Error of Approximation (RMSEA), the Normed Fit Index (NFI) and the Comparative Fit Index (CFI). In general, the criteria for an acceptable data fit include the ratio of chi-square to degree of freedom (df) below three, an RMSEA value below .06 and other fit index values above .95.

Results

Research Question 1: How many factors underlie Statistics Anxiety Instrument (SAI) based on the empirical data?

To assess the number of factors underlying the Statistics Anxiety Instrument, the responses of students to the items of the scale is subjected to parallel analysis. The parallel analysis of the test data is carried out using parallel analysis based on polychoric correlation of test data of Psych package (Revelle, 2017), of R, a language and environment for statistical computing ® core team, 2017). The result is presented in Figure 1



The result presented in Figure 1 shows that eigenvalues of the observed data set, starting from the first are respectively greater than the 95th percentile eigenvalue of the generated data set until the 22ndeigenvalue of the generated data set. From this point, the 95th eigenvalue of the generated data set are respectively greater than the eigenvalue of the observed data set. The result shows that there are 21 factors underlying the SAI.

Research question 2: How many factors underlying the SAI were salient?

Exploratory Factor Analysis (EFA) based on the number of factors found to underlie the test data based on polychoric correlation of the test data is conducted. The analysis is done using Psych package. The result is presented in table 1a as follows:

Table 1a: Exploratory factor analysis result of the responses of undergraduate students to the SAI items

	PA1	Pa2	PA3	PA4	PA5	PA6	PA7	PA8	PA9	PA10	PA11	PA12	PA13	PA14	PA15	PA16	PA17	PA18	PA19	PA20	PA21
V1						0.95															
V2						0.96															
V3						0.93															
V4						0.75															
V5	**0.7**					**0.38**															
V6	0.74																				
.																					
.																					
.																					
V98		**0.39**															**0.34**				**-0.38**
V99																	**0.35**				**-0.37**
V100				-0.6																	
				-																	
V101				0.55																	
V102							≥ 0.32													-0.32	

Table 1a shows the factor loadings having salient loadings (loadings > 0.32) and the related factors resulting from the factor analysis of the SAI data. The table showed that all the items have one of two salient loading on the extracted factors. In addition, the table shows that 36 items (5, 8, 9, 12, 15, 16, 17, 23, 24, 33, 34, 37, 38, 42, 45, 46, 47, 48, 55, 59, 60, 67, 70, 71, 72, 75, 76, 79, 80, 82, 84, 90, 93, 97, 98, and 99) had loading higher than or equal to /0.32/ on two or more factors simultaneously (see bold faced Items and loading on Table 1a). These items were deleted. The remaining items and their respective factors loading are presented in Table 1b.

Table 1b: Factor loading and respective factors of SAI Items

Item	**PA1**	PA2	PA3	PA4	**PA5**	PA6	PA7	PA8	PA9	PA10	**PA11**	**PA12**	PA13	**PA14**	**PA15**	PA16	**PA17**	PA18	PA19	**PA20**	**PA21**
V1						0.95															
V2						0.96															
V3						0.93															
V4						0.75															
V6	**0.74**																				
V7	**0.85**																				
V96																0.78					
V100				-0.6																	
V101				-0.55																	
V102																				**-0.32**	

Table 1b showed that 9 of the 21 extracted factors have less than three items loading saliently on them (see bold face factors on Table1b). These 9 factors include: PA1, PA5, PA11, PA12, PA14, PA15, PA17, PA20 and PA21. These 9 factors and the items loading on them were deleted. The resulting factors are presented in Table 2

Table 2: Refined SAI Factor loading and respective factors

Item	PA2	PA3	PA4	PA6	PA7	PA8	PA9	PA10	PA13	PA16	PA18	PA19
V1				0.95								
V2				0.96								
V3				0.93								
V4				0.75								
.												
.												
.												
V96										0.78		
V100			-0.6									
V101			-0.55									

Table 2 showsthat the Refined SAI has **12** factors underlying it. Factor1 has 4 items (items 51, 52, 53 and 54), factor**2** has 4 items (86, 87, 88 and 89), factor**3** has 5 items (10, 11, 68, 100 and 101); factor **4** has 4 items (1, 2, 3, and 4); factor **5** has 3 items (56, 57, and 58), factor **6** has 3 items (61, 62 and 69); factor **7** has 5 items (13, 14, 25, 26, and 27); factor **8** has 5 items (18, 19, 20, 21, and 22); factor **9** has 5 items (28, 29, 30, 31, and 32); factor **10** has 3 items (94, 95 and 96); factor **11** has 4 items (35, 39, 40, and 41) and factor **12** has 6 items (63, 64, 65, 66, 81 and 83).

Research question 3: What is the construct validity of the Refined SAI?

The redefined SAI was administered to another group of sample other than the sample to which the pools of items of SAI were first administered. The collected data was analysed using Confirmatory Factor Analysis (CFA). The result is presented in figure 2

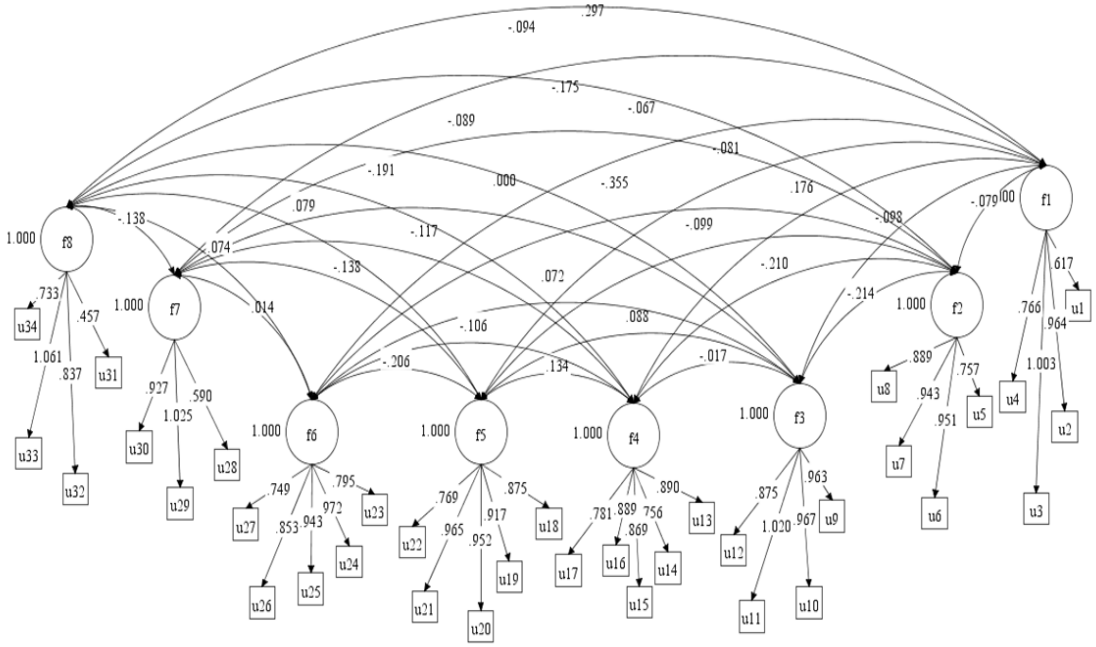


Figure 2: Confirmatory factor analysis of the 8-Factor model SAI

Figure 2 presents the consistency of the 8-factor model SAI under CFA. The result shows that the 8-factor model obtained at the stage1 of the scale development was consistent with the empirical data at stage 2

Also, the developed SAI has construct validity.

Research question 4: How reliable are the refined SAI (RSAI)?

Cronbach Alpha coefficients is used to estimate the reliability estimates of the sub-components of the RSAI. The result is presented in table 3

Table 3: Reliability Estimates of the RSAI Subscales

S/N	Cronbach Alpha coefficient
Factor1	0.87
Factor2	0.92
Factor4	0.91
Factor7	0.89
Factor8	0.93
Factor9	0.84
Factor10	0.91
Factor11	0.84

The result shows that the minimum reliability estimate recorded by the subscales of the SAI is 0.84. This result reveals that the SAI is reliable as the subscales show reliability estimates greater than 0.7 which is the minimum reliability a scale must possess to be regarded reliable.

Discussion of Findings

The discussion of findings is based on the four research questions postulated.

The results of the research questions are in conformity with Ezeugwu (2006)who believes that factor analysis result will yield information about the number of traits that are needed for explaining test performance. The result shows that there are 21 factors underlying the SAI. The factor loadings having salient loadings (loadings > 0.32) and the related factors resulting from the factor analysis of the SAI data.

The result shows that all the items have one or two salient loading on the extracted factors. However, 36 items (5, 8, 9, 12, 15, 16, 17, 23, 24, 33, 34, 37, 38, 42, 45, 46, 47, 48, 55, 59, 60, 67, 70, 71, 72, 75, 76, 79, 80, 82, 84, 90, 93, 97, 98, and 99) had loading higher than or equal to 0.32 on two or more factors simultaneously. All these items are deleted. 9 of the 21 extracted factors have less than three items loading saliently on them. These 9 factors include: PA1, PA5, PA11, PA12, PA14, PA15, PA17, PA20 and PA21. These 9 factors and the items loading on them are deleted.

The Refined SAI has 12 factors underlying it. The result of the constructed and validated instrument is consistent with the works of Kanda and Mawaka (2015),Nwaba (2014) and Madu (2014),Koh and Zawi (2014) who followed the same steps in developing and standardising statistics anxiety instrument for post graduate students in six domains of anxiety. This research confirms their findings as the present study only differs in establishing anxiety based on gender. Also, the scale measures consistently the same

construct in the two samples on which the scale was administered which is in agreement with the study of Ugodulunwa and Mustapha (2015), who developed and validated an instrument for the measurement of Employability Soft Skills for Education Students in Nigeria.

In addition, the minimum reliability estimate recorded by the subscales of the RSAI is 0.84. This result reveals that the RSAI is reliable as the subscales show reliability estimates greater than 0.7 which is the minimum reliability a scale must possess to be regarded reliable. This is in line with the work of Madu (2014) who conducted a study on development and validation of a survey Achievement test in Agricultural Science for Senior Secondary Schools in Plateau State and had a reliability coefficient greater than 0.8

Conclusion/Recommendation

Based on the result of the analysis of the developed and validated SAI, it is concluded that valid and reliable instrument to measure any behavioural construct relating to human behavior is needed. It is recommended that the constructed SAI should be used by statisticians, researchers and measurement experts. The items of the SAI constructed should serve as template to develop other affective instruments in statistics anxiety. This is based on the fact that SAI has high psychometric properties in terms of construct validity and reliability. Future researchers should adopt the use of instrumentation procedure when constructing instrument.

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