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Construction, Validation and Establishment of Reliability of Biology Achievement Test for Senior Secondary Two Students in Akwa Ibom State, Nigeria

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Abstract

The need for constructing, validating and establishing reliability to enhance the standardization of an instrument for measuring educational variables is very important in providing solutions to educational problems. This study is therefore conducted to construct, validate and establish the reliability of Biology Achievement Test for senior secondary two students in Akwa Ibom State, Nigeria. The Instrumentation research design was adopted for the study. The population for this research was 45,844 respondents that comprised of 628 Biology teachers and 45,216 senior secondary II students in Akwa Ibom State and a sample size of 72 respondents comprising of 12 Biology teachers and 60 students was purposively sampled from the population for the study. The Biology Achievement Test (BAT) constructed, which was used in ascertaining it validity and reliability was made up of a 30-item test with three distractors and a correct option. The finding from the study revealed that the Biology Achievement Test had a good content validity and also reliable. The content validity was ascertained with the construction of the Test Blue Print. Also, a dependable reliability coefficient of .77 was obtained from KR-20 formula with indices obtained from item analysis. Since the Biology Achievement Test constructed was valid and reliable, it is strongly recommended that it should be widely used in the determination of the Biology achievement level of Senior Secondary School II students in order to encourage the implementation of appropriate remedies that will enhance student's achievement of Biology.

key words: Achievement Test, Construction, Reliability, Test, Validation**.**

Introduction

Biology is the branch of science concerned with the study of life and living organisms. Biology as a subject enables man to understand the major Biological processes that take place in the environment (Alaska, 2019). Biology is also one of the basic science subjects that are consistently needed for a nation's technological development. To this effect, Wilfred (2021) asserted that proper teaching of Biology facilitates students' enrollment in medicine, pharmacy,

nursing, among others. Biology like other science subjects is a practical oriented discipline which seeks to develop in a learner, scientific enquiry and problem solving skills. The problem of the student's poor performance in Biology in secondary schools in Nigeria in general and Akwa Ibom State in particular may be attributed to some factors like inadequate supply of teaching and learning resources such as chemicals, charts, apparatus, models, local equipments, laboratories, textbooks, libraries, among others (Robert, 2018).

Biology, which is one of the core science subjects in secondary school is observed to be plagued by serious problems of poor academic achievement by the students. The West African Examination Council (WAEC) Chief Examiners' Reports (2018-2021) revealed an alarming poor performance status of students in senior secondary school achievement examination/test in Biology. The poor students' achievement in Biology has been partly attributed to poor measurement of students' achievement in the learning process among others by their Biology teachers. The use of a poor teacher made test by teachers to quantify academic achievement of students in Biology has given wrong interpretations of students' achievement and teachers' teaching quality, as most Biology teachers cannot develop valid and reliable Biology achievement test required for measuring students' achievement in Biology. An achievement test is a test of developed skill or knowledge. The most common type of achievement test is a standardized test developed to measure skills and knowledge learned in a given grade level, usually through planned instructions such as classroom instructions.

Uche (2018) posited that for any test to be successful and measure the constructs it is designed to measure; careful planning must precede its construction. In the opinion of Mendie (2018), the planning should involve a thorough analysis of the objectives of the test and the purpose the test scores are meant to serve. In furtherance, Mendie asserted that the planning stage should also take into consideration the testing conditions, as testing conditions in behavioural research are very important in instrumentation. In adhering to the preliminary test conditions, the preparation of the test should involve making a preliminary draft of the test. Also to ensure that adherence is made, the items in the test must represent the various constructs that make up the trait and behaviour that will be measured with the instrument, as the content validity and reliability of the Biology Achievement test are meant to be established by the instrument.

A test has a content validity when the items in the test are representative of a universe of items which are deemed by test experts to define the relevant content of the course or subject areas. Content validity of a test therefore demands that an observation of the test can be carried out in order to ensure that the major components of the test contents and domain of the course are adequately represented. This is to ensure the validity of the test. Such arrangement gives the testees the free hand to venture rather than restrict him/her as it is the characteristic of test with limited contents. The Test Blue Print or Table of Specification is used in establishing the

content validity of a test as it contains all the requirements for the establishment of content validity. The nature and objectives of the study should also guide the process. Having prepared the test according to plan, the test is then given a trial. One important factor the researcher should consider in trying out a test is the testing condition (Robert, 2018). Finally, the test constructor needs to evaluate, both the quality of the respondents' response and quality of the test itself.

The above procedure needs to be adopted for this study so that a valid and reliable instrument can be constructed to measure students' achievement in Biology with respect to the validity and reliability of the test. Going on the importance of validity and reliability, there is need to develop an instrument that is valid and reliable to take care of major problems of achievement in school subjects mainly on the aspect of measurability due to lack of valid and reliable tests. Therefore, there is need to develop and validate an instrument, which could generally be applied to determine Biology achievement status of students in senior secondary II in Akwa Ibom State. The problem of this study therefore, is to construct a standardized instrument that is valid and reliable for measuring students' achievement in Biology in secondary schools.

Purpose of the Study

The main purpose of the study is to construct, validate and establish the reliability of Biology Achievement Test for Senior Secondary Two Students in Akwa Ibom State, Nigeria. Specifically, the study sought to:

1.) Construct a Biology Achievement Test
2.) Establish content validity of the Biology Achievement Test.
3.) Analyze the items for the Biology Achievement Test (item analysis).
4.) Determine the reliability of Biology Achievement Test.

Research Questions

The following research questions were formulated to guide the study:

1.) How can content validity of the Biology Achievement Test be established?
2.) How can the Biology Achievement Test items be analyzed?
3.) How can reliability of the Biology Achievement Test be determined?

Methodology

An instrumentation research design was adopted for this study. This is because, it is a study aimed at the construction, validation and production of valid and reliable tests for teachers and other educators to use in assessing students' achievement in Biology. A purposive sampling technique was used in selecting 6 secondary schools from the State.to conduct the initial trial testing, simple random sampling technique was used to select 100 S.S.2 students from 6 different secondary schools within the state. Also, the initial pool of 50 items were selected for the first draft of the test. The items were edited with respect to language clarity, relevance and ambiguity. Also, appropriate instructions for the subjects to attempt the test were written.

After scoring the items, Item analysis was done to verify whether each item is good for inclusion in the final version of the test. Item difficulty and item discrimination were examined for each item on the BAT. Based on the item analysis result obtained after scoring of the test, items having difficulty index of below 0.19 and above 0.75 were discarded. Also, items having discrimination index of below 0.19 were discarded while appropriate items are selected for the final draft. The final draft was administered to 60 S.S.2 students and 12 biology teachers drawn from each of the selected schools making a total of 72 participants were used for the final study.

The content validity was established through the agreement among the six teachers on the percentage weights assigned to the objectives in the cognitive domain and content areas of the senior secondary school Biology curriculum respectively, determined through Kendall coefficient of concordance. The test items were therefore drawn in a table of specification which was comprised of 4 content areas of the senior secondary school biology curriculum and 6 cognitive domains of the Bloom's taxonomy. Preparing the table of specification helped the test to obtain high content validity.

Based on the test blueprint, a biology achievement test (BAT) was constructed and served as the instrument for data collection. This instrument was in 3 sections: A, B and C. Section A requested for demographic information of the students such as name of school, school type. Location and sex. Section B requested demographic information of the biology teachers such as: name of school, location, years of experience, sex and area of specialization. Section C contained fifty items with 4 response options comprising one correct answer (key) and three wrong answers (distracters)which the students were asked to respond to within 2 hours. Generally, the questions were well constructed and a P-value or difficulty index of 0.5 for each item was considered after correction for guessing formula was applied. During the item analysis, items with inappropriate distracters were retouched or discarded. Thirty items were eventually selected. The estimate of reliability of the BAT was determined through Kuder_Richardson formula 20 (KR-20) where copies of the final test were administered to a randomly drawn sample of 60 testees. Each either passes an item with (1) or fails with (0). The KR-20 helps to establish the internal consistency of the Biology Achievement Test.

Construction of Final Draft of the Biology Achievement Test

Steps adopted by researchers in the construction of the Biology Achievement Test (BAT)

Step One: Specification of the Purpose of Testing

The first issue to settle in the test construction was the specification of purpose of the testing. The purpose of testing for this study was to measure senior secondary II students' mastery of Biology concepts and rank them in terms of their achievement in the Subject. However, it should be noted that the purpose of this test was built from the contents in senior secondary II Biology scheme of work which was based on the instructional objectives of the study.

Step Two: Specification of Item Type

The second step of the instrument development process was specification of appropriate items for the test based on level of difficulty. For example, Bloom identified six educational objectives to be observed while planning an instructional evaluation of cognitive domain. These educational objectives include Knowledge, comprehension, application, analysis, synthesis and evaluation. The six objectives form a hierarchy of mental skills from the lowest and easiest level of Knowledge to the highest and most difficult level of evaluation. When constructing an achievement test, therefore, some of the items should test each of these six groups. The first two can be classified as having low cognitive objectives, while the last four are classified as having higher cognitive objectives.

Step Three: Item Development and Selection

After constructing the test blue print, the items were written based on the specifications in the test blueprint. Item development involves translating the contents into test items that will stimulate the testees and elicit the type of behaviour specified in the instructional objective. To achieve this, more than the required number of items was written to take care of item mortality.

Step four: Specification of Instructions

Objectivity is mostly desired in testing and it calls for every clear, simple, specific and direct wording of items. Two sets of instructions are required: one for the testees and one for the test administrators. The instructions for the testees was on how to answer the items in the Biology Achievement Test (BAT). The instructions included:

i) The time limits
ii) The method of recording answers
iii) The marks awarded for each correct answer

Instruction for the test administrators on how to administer the BAT were:

i) The duration for the test
ii) Arrangement of testing rooms
iii) Distribution and collection of test materials
iii) Procedures for recording the answers
iv) How to handle malpractice cases.

Step Five: Assembling the Test

The BAT (See Appendix I) was assembled by putting the items and instructions together and producing the test in a form that will go around to all the testees. The production was neat and

eligible for the testees and it was devoid of poor printing, wrong spellings, omitted parts, among others.

Step Six: Administering the final draft of the BAT

In administering the BAT, the guiding principle was that all students were given equal opportunity to demonstrate their achievement of the learning outcomes being measured. The test administrator provided comfortable physical and psychological environment for the testees and also controlled factors that could interfere with the proper administration of the BAT. The test instructions were also read to testees before the commencement of the test. A total of 60 students were used for the final draft of the BAT.

Step Seven: Appraising the Test (Item Analysis)

Item analysis is an analysis of response made by the students to the teacher-made test. It is a statistical procedure for which appropriate items are selected and poor items rejected. Item analysis was done to verify whether each item is good for inclusion in the final version of the test. In analyzing the items, Item difficulty and item discrimination were examined for each item on the BAT. By Using the following formula:

Item discrimination (d-value) =

$$\frac{\text{No of bright students who got the item right- No of dull students who got the item right}}{\text{No of students in each group}}$$

The discrimination values were obtained. A total of 10 items with d-values within the range 0.20-0.29 needed minor modifications, 10 items had d-values of below 0.19 and were discarded, while 30 items were of excellent qualities and had d-values ranging from 0.31-0.81 and were selected for the revised draft. Therefore, the revised draft of the BAT had 30 items. Each item has four options lettered A-D. Out of the four options, one was correct while the other three were present as distracters.

Step Eight: Second try- out of Biology Achievement test and item analysis

The revised draft of the BAT was again administered to another group of 60 S.S. 2 students offering biology. Table 1 and 2 shows the table of specification and item analysis respectively of the second draft of the biology achievement test.

Results

Research Questions 1: How can content validity of the Biology Achievement Test be established?

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Table 1: Table of Specification for Biology Achievement Test (BAT) for final draft

Content Percentage	Knowledge 30%	Comprehension 20%	Application 20%	Analysis 10%	Synthesis 10%	Evaluation 10%	Total 100%
Classification of Plants 20%	2	1	1	1	1	0	6
Digestive System 30%	3	2	2	1	0	1	9
Transport System 30%	3	2	2	1	1	0	9
Respiratory System 20%	2	1	1	0	1	1	6
Total 100%	10	6	6	3	3	2	30

The Table of specification as shown in Table 1 clearly reflects the various content areas in Biology that currently make up the Biology Syllabus for senior secondary II students. It shows that there is a good distribution of the BAT items which is as a result of the agreement among the six teachers on the percentage weight assigned to the objectives in the cognitive domain and content areas of the S.S.S Biology curriculum. The degree of agreement was significantly high and in line with Kendell coefficient of concordance. An index of 0.82 for cognitive levels and 0.79 for content areas was obtained. The result showed that all the objectives and content areas were well covered. These are enough evidences to show that the BAT has a high content validity.

Research Question 2: How can the Biology Achievement Test items be analyzed?

Table 2: Item analysis for the Biology Achievement Test

Items	Upper 27%	Lower 27%	Difference	D-Value	Middle	Total	P-Value
1 A		5	8	.50	18	32	.53
*B	16	8					
C		2					
D		1					
2 A		3					

B		3					
C		3					
* D	16	7	9	.56	22	45	.75
3 A	2	1					
B		1					
C	2	2					
* D	12	7	5	.31	18	37	.62
4. A	1	3					
B	2	4					
*C	12	7	5	.31	18	37	.62
D	1						
5. A	1	4	9	.56	20	37	.62
*B	13	4					
C		3					
D	2	5					
6. A		6					
B		4					
*C	15	4	11	.69	18	37	.62
D	1	2					
7. A		7					
B		2					
*C	16	5	11	.69	22	43	.72
D		2					
8*A	13	8	5	.31	13	34	.57
B	2	2					
C	1	4					
D		2					
9 A	2	5					
*B	13	3	10	.63	9	25	.42
C		3					
D	1	2					
10 A	4	3					
*B	12	5	7	.44	18	35	.58
C		3					
D		2					
11 A	3	5	8	.50	17	31	.52
*B	11	3					
C	1	4					
D	1	4					
12 A		1					
*B		14	11	.69	16	31	.52
C		1					
D							
13 A		4					

B	2	6					
C		5					
*D	14	2	12	.75	14	30	.50
14 A		2					
B		2					
*C	15	7	8	.50	17	39	.65
D	1	4					
15 *A	14	5	9	.56	18	37	.62
B	2	1					
C		4					
D		6					
16 A	2	4					
B	2	4					
* C	11	4	7	.44	8	23	.38
D	1	4					
17*A	15	9	6	.38	24	48	.80
B		1					
C	1	5					
D		1					
18 A		5					
B		4					
*C	15	2	13	.81	14	31	52
D	1	5					
19*A	15	3	12	.75	9	27	.45
B		5					
C		4					
D	1	3					
20 A		3					
B		3					
*C	15	4	11	.69	16	35	.58
D	1	4					
21 A		2					
*B	11	4	7	.44	8	23	.38
C	1	5					
D	4	4					
22*A	12	2	10	.63	10	24	.40
B	2	6					
C	2	6					
D		2					
23 A	1	5					
*B	15	7	8	.50	21	43	.72
C		1					
D		3					
24 A	5	7					

B	1	1					
*C	10	4	6	.38	11	25	.42
D		4					
25 A		6					
*B	12	2	10	.63	18	32	.53
C	3	3					
D		2					
26 A	1	1					
B	2	3					
*C	11	4	7	.43	15	30	.50
D	2	7					
27*A	14	4	10	.63	10	28	.47
B		3					
C	3	3					
D	2	2					
28 A	1	2					
B	1	3					
C		4					
*D	14	7	7	.44	13	34	.57
29*A	14	3	11	.68	9	26	.43
B	1	3					
C	4	3					
D	1	3					
30*A	13	6	7	.44	16	35	.58
B	1	3					
C	2	4					
D		3					

Key: *The correct options are asterisked.*

The item analysis in Table 2 above carried out reveals the number and proportion of students in high ability and low ability groups who failed and passed each item on the BAT. It also shows the item difficulty and discrimination indices of the items on the BAT. The item difficulty and discrimination indices indicate that all the items were appropriate for inclusion in the final copy of the BAT. These indices were obtained from the item analysis.

In order to establish the reliability coefficient of the BAT, the indices for kuder-Richardson formula 20 was derived and used to estimate the reliability of the BAT

Research Question 3: How can reliability of the Biology Achievement Test be determined?

Table 3: Computation of indices for Kuder-Richardson formula 20 (K-R20)

Item	Number who Pass	Number who Fail	Proportion who Pass (P)	Proportion who Fail (Q)	PQ
1.	42	18	0.70	0.30	0.21
2.	45	15	0.75	0.25	0.19
3.	37	23	0.62	0.38	0.24
4.	37	23	0.62	0.38	0.25
5.	37	23	0.62	0.38	0.23
6.	37	23	0.62	0.38	0.23
7.	37	23	0.62	0.38	0.23
8.	34	26	0.57	0.43	0.25
9.	25	35	0.42	0.58	0.15
10.	35	15	0.58	0.25	0.19
11.	31	29	0.52	0.48	0.25
12.	31	29	0.52	0.48	0.25
13.	30	30	0.50	0.50	0.25
14.	39	21	0.65	0.35	0.23
15.	37	23	0.62	0.38	0.24
16.	23	37	0.38	0.45	0.12
17.	45	15	0.75	0.25	0.19
18.	31	29	0.51	0.48	0.24
19.	27	33	0.45	0.55	0.25
20.	35	15	0.58	0.25	0.15
21.	23	37	0.38	0.62	0.23
22.	24	36	0.40	0.60	0.24
23.	43	17	0.72	0.28	0.20
24.	25	35	0.41	0.58	0.23
25.	32	28	0.53	0.47	0.25
26.	30	30	0.50	0.50	0.25
27.	28	32	0.47	0.53	0.25
28.	34	26	0.57	0.43	0.25
29.	26	34	0.43	0.57	0.25
30.	35	25	0.58	0.42	0.24

Reliability Coefficient of the BAT

$$KR_{20} = \frac{N}{N-1}\left[\frac{SD2-\sum PQ}{SD2}\right]$$

Where:

N = Number of cases in the study

P= Proportion of individuals who passed each item

Q= Proportion of individuals who failed each item

∑PQ = Summation of PQ

SD^2 = Variance of the total scores on the test

$$\frac{30}{} \text{ X } 1 - \frac{5.6}{}$$

29 22.7

= 1.02 (1-0.25)

= 1.03 (0.75)

= 0.77

The reliability index of the Biology Achievement Test was estimated to be 0.77 using Kuder-Richardson formula 20 (KR-20). This shows that the Biology Achievement Test developed is highly reliable. According to Benson (2021), a positive coefficient of over 0.7 is considered to be of good reliability, and the higher the coefficient the more reliable the instrument.

Conclusion

This study developed a standardized Biology Achievement Test which is valid and reliable for senior secondary school II students in Akwa Ibom State. In the development and validation of the Biology Achievement Test, the internal consistency reliability coefficient and content validity were appropriate, indicating that the Biology Achievement Test was reliable and valid. With the persistent poor performances of students in Biology associated with use of poor instrument constructed in measuring the Biology achievement level of senior secondary school II students in Akwa Ibom State,

Recommendations

1. there is therefore a need to develop and validate a comprehensive measure of Biology achievement of these students with a superior quality scale such as the Biology Achievement Test for senior secondary school II students.
2. Since BAT has a high content validity and also of good reliability index , and it is recommended for use by teachers and other educationists in assessing the senior secondary two students' achievement in both internal and external examinations in Biology.

References

Alaska, H. U. (2019). *Why the teaching of Biology is important in secondary schools*. Enugu: Uche Press.

Benson, S. (2021). *When an instrument is said to be valid and reliable*. Enugu: Willy Press.

Mendie, A. T. (2018). Using a valid and reliable instrument in measuring academic constructs. *Measurement in Education*, 17 (2), 107-113.

Robert, F. O. (2018). Students' academic performance in core science subjects. *Research in Education*, 19(2), 67-89.

Uche, S. P. (2018). Establishing validity of a research instrument. *Research and Methodology*, 18(3), 56-72.

Wilfred, S. (2021). Science of life and living organism. *Journal of Biological Sciences*, 14 (2), 65-72

Robert, T. Y. (2018). *How to establish reliability and validity of an instrument*? Lagos: Sango Press.