

---

## Construction And Validation Of Economics Aptitude Test (Eat) Using Innovative Technique r-Software

**IKOKIDE KEHINDE VICTORIA**

Faculty Of Education

Department Of Guidance And Counseling

Ignatius Ajuru University Of Education

Rumuolumeni, Port Harcourt.

[accesslife100@gmail.com](mailto:accesslife100@gmail.com)

08034327956

**AGBOWU-WALI FAITH NGOZI**

08033030861

**NDUKWU FAITH**

08034123158

**PEACE OLUDI KINGSLEY**

08033424904

---

### Abstract

The study aimed at the validation of Economics Aptitude Test (EAT) using innovative techniques (R software). The study employed an instrumentation and descriptive survey research design. The Economics Aptitude Test (EAT) instrument was made up of nine components, which was used for generation of 150 items. Survey method was used to collect data from 500 senior secondary school three (SS3) students for trial testing. Simple random sampling was used to select public and private secondary schools in Rivers State. Four objectives and four research questions guided the study. Item analyses on the 150-item multiple choice test was ascertained using R software and items with difficulty and discrimination indices of  $0.40 \leq p \leq 0.70$  and  $\leq 0.25$  respectively were considered good and selected. The reliability of the test was established through Kuder Richardson 20, Split-half and Cronbach Alpha, statistics using R, which produced reliability coefficients of 0.93 for both Kuder Richardson 20 and Cronbach alpha and 0.97 for Split-half reliability. The result revealed that 67 items were considered good and selected while, 83 items were considered bad and marked for elimination. The findings showed that the Economics Aptitude Test (EAT) is both valid and reliable. It was recommended that it should always be used as an assessment tool for determining the aptitude of senior secondary school students in Economics and also for career guidance purposes.

**Keywords:** Validation, Construction, Aptitude test, Difficulty index. Discrimination index

---

## Introduction

People need economic knowledge to make well-informed decisions when facing economic questions in their private and public lives (Zhan 2020). However, research from different parts of the world has shown that adults, students and youngsters alike often lack economic knowledge (Weston & Yee, 2017). It is a cause of concern that economic illiteracy seems widespread, as it can limit people's ability to perceive the economic dimensions of the complex problems they encounter in their everyday lives.

Having economic knowledge is important because economic issues affect people in their many different roles, for instance, as citizens, consumers, workers and producers. Many decisions on public and private concerns involve economic perspectives, and it is important that people can apply economic reasoning to different issues (Kane 2020). Furthermore, Rata (2018) writes that a connection exists between the rational knowledge provided by schools and democratic socialisation and that rationally structured knowledge can function as a tool for thinking and as a means of communication. Different kinds of knowledge – in this case, economic knowledge – can therefore serve as tools for effective citizenship and as means of preserving democratic values. However, research shows that people generally know little about economics (Longjohn, et. al., 2019).

Schools are important arenas for acquiring different kinds of knowledge and the vision of a school should not only be to train their students for academic achievement but also to ensure that these students choose right career paths which are inherent to them. To achieve both, tests are the tools to give feedback on what a person has learnt or an instrument to obtain feedback that will determine the presence or absence of a particular trait (Osioke 2022). To this end, test is the assessment of an examinee's ability, performance or achievement in a given task or subject (Asuru&Longjohn, 2008 in Njigwum, 2019). There are three types of tests (Aptitude, Intelligence and Achievement) but for the purpose of this study the aptitude test will be dwelt on. Thus, aptitude is a test that is used to get feedback of a person's level of competency to perform a certain type of task.

Aptitude tests provide valuable benefits for secondary school students and picking the proper aptitude test for secondary school students is of great essence and the school has a great role to play. An aptitude test is a measure of a person's ability to learn or perform required tasks and succeed in a particular environment, vocation or career. Aptitude tests are not a measure of intelligence but are tests that look for an individuals' strengths and weaknesses, giving the person and the evaluator or tester an idea of the persons' abilities. An aptitude test is an exam used to determine an individual's skill or propensity to succeed in a given activity. Aptitude tests assume that individuals have inherent strengths and weaknesses and have a natural inclination toward success or failure in specific areas based on their innate characteristics. Miller and Vanfossen (2018) An aptitude test is designed to assess what a person is capable of doing or to predict, what a person is able to learn or do given the right education and instruction. The goal of an aptitude test is to predict the ability to learn new skills (Steiner,2021).

To psychometrics, an aptitude test is a form of psychometric assessment used to measure an individuals' natural strengths in a given area, it differs from a knowledge

–based test in that it does not require familiarity with a particular subject. Instead, it looks at your inherent skill and ability to apply them in new situations. Aptitude tests are generally used for job placement, college program entry, and to help people to get an idea of where their interests and aptitudes can take them regarding careers.

Salemi and Siegfried 2020 opine that It is pertinent to note that an aptitude test without proper validation will amount to nothing. This is because a test must be relevant for the purpose for which it was constructed, must be free of bias and be able to accurately verify predictive value. Validation refers to the process of collecting validity evidence to evaluate the appropriateness of the interpretations, uses, and decisions based on assessment results (Kane, 2020). The validity of a test can only be established through a process of validation, and this must ideally be done before the results can be used for any particular purpose. In order to carry out such validation, a validation study has to be undertaken, on the basis of which one can arrive at a conclusion as to whether the interpretations and uses of the test result is valid (Obowo, 2018).

Changes and innovation occurs almost every day in our lives and the soft wares that aid statistical calculations and analysis are not left out. The innovative approach of test validation using the R software is one of such. R is a language and environment for statistical computing and graphics. It provides a wide variety of statistical (linear and nonlinear modelling, classical statistical tests, time-series analysis, classification, clustering, ...) and graphical techniques, and is highly extensible. One of R's strengths is the ease with which well-designed publication-quality plots can be produced, including mathematical symbols and formulae where needed. R is available as Free Software under the terms of the Free Software Foundation's GNU General Public License in source code form. It compiles and runs on a wide variety of UNIX platforms and similar systems (including FreeBSD and Linux), Windows and MacOS.

### **Innovative Techniques in Test Validation Using R**

R is a programming language and a free software environment for statistical computing and graphics that you can use to clean, analyze, and graph your data (Weston & Yee, 2017). It is widely used by researchers from diverse discipline to estimate and display results and by teachers of statistics and research methods. It is free, making it an attractive option but does rely on programming code — instead of drop languages can be intimidating but, we use R for research and teaching, and we believe that the benefits far outweigh the time and effort needed to start. One of the most powerful characteristics of R is that it is open code used to run the program and add their own code for free. This means that R will always be able to perform the newest statistical analyses as soon as anyone thinks of them, anyone can write their own R code, which means anyone can add to the huge list of R's tools.

Programmers submit their code to R in the form of 'packages.' Some packages specialize in specific kinds of analyses, while other packages are much broader. For example, the psych' package by William R. Revelle can do anything from descriptive statistics to itemresponse theory to mediation 10,000 packages available. And as soon as a new statistical approach is developed, someone will create a new package or add new tools to an existing package. On the other hand, validation of test deals with determining the psychometric properties (Reliability and Validity) of items as well as the entire test. This is line with the view of Kpolovie (2019), who opined the science of test construct ideals with the process of designing test with satisfactory psychometric properties (validity and reliability). Validity which ensures a test

measure what it purports to measure can be established for an achievement secondly, is empirical validation through item analysis (computing difficulty and discrimination indices of the test). Here, item analysis is empirically used to detect faulty.

Therefore, the innovative approach of test validation which is advanced in this paper, construct a test with high validity and reliability using simple, cheap and easy to apply technique all in one software. As such, the rigor and cost of using multiple statistical software for test validation will be eliminated. For the paper, R software was employed to complete the basic operations for test validation and some of the techniques were recommended by longJohn, Njigwum and Ibeh (2021).

### **Process of Validation Using R Software**

1. Create R workshop folder in your system
2. Key in your data using Microsoft Excel
3. Code your data
4. Transfer to SPSS for cleaning n removing outliers
5. Save your file as Csv file
6. Open R studio software
7. Go R environment, select import dataset from SPSS
8. After importing your data on R studio
9. You call the packages like psychometric, Haven and validate n run them
10. Type `item.Exam(filename, y=NULL, discrim=TRUE)`, click run
11. Type `itemdiff<-colmeans(filename, na.rm=TRUE)` Run
13. To view type `viewitemdiff2` Run
14. Give your object a new name before export
15. To export your data, type  
`write.csv(filename=MATOUTPUT.CSV,row.names=FALSE)` Run
16. As R export to Excel, you will see item difficult, discrimination and reliability.
17. Format your data to form you want
18. You decrease the decimal places

### **Aim and Objectives of the study**

The aim of the study was to construct and validate Economic Aptitude Test (EAT) using the R studio. Specifically, the study sought to:

1. Validate of the Economics Aptitude Test using the R software.
2. Determine the difficulty index and discrimination index of each item of the Economics Aptitude Test (EAT) using the R software.
3. Determine the number of items selected after psychometric analysis
4. Find out the reliability of the Economics Aptitude Test (EAT).

### **Research Questions**

The study was guided by the following research questions:

1. What is the validity of Economics Aptitude Test using the R software?
2. What are the difficulty index and discrimination index of each item of the Economics Aptitude Test using the R software?
3. How many of the items of the EAT was selected after psychometric analysis?

#### 4. What is the reliability of Economics Aptitude Test?

##### Method

The design of this study is instrumentation. It involves the construction and validation of Economics Aptitude Test (EAT). It is designed for selecting senior secondary school students who have ability for Economics. The population for this study comprises public Senior Secondary 3(SS3) students in 2022/2023 academic session in Rivers State. From the population, a total of 500 students in SS3 were sampled for the study in Rivers State. The sampling technique adopted for this study is the stratified sampling and simple random sampling technique, The instrument for the research is Economics Aptitude Test (EAT). 150 questions were constructed but fifty (50) questions were eliminated from the generated 150 items after item analysis; that is the difficulty level and item discriminative index. After the item analysis and modification of the items, fifty (50) items were selected for the final test. Each item has four (4) options lettered; A, B, C and D. One out of the four (4) options is correct while the other three are treated as distracters. Validity is one of the most essential psychometric properties of a test. The validity of a test is the extent to which a test measures what it is supposed to measure. a table of specifications was drawn. This shows the various types of aptitude test considered, and the total number of generated test items. The Kuder- Richardson formula 20 (KR20) was used in establishing a measure of internal consistency of the test. The test was administered to 50 students, A reliability index of 0.96 was For method of data analysis, SPSS and MS Excel software were employed for data coding, data cleaning and conversion to file csv. formats for R environment. The scoring of the test was carried out in SPSS, each item that was correctly answered attracted one (1) mark or one (1) point while wrongly answered items attracted zero (0) mark. After the computation from the R environment, Items with difficulty indices ranging from 0.30 to 0.70 were included (good and accepted items) for the final test while others below 0.30 and above 0.70 were discarded (bad and rejected items). The item discrimination index (D) ranged from 0.30 to 0.44 and this formed the bench mark for accepting items regarding discrimination indices for the final test.

##### Results

**Research Question one:**what is the validity of the Economics aptitude test using R software?

**Table 1: Table of specification for Economics Aptitude Test**

Content	88Behavioural objectives						Total 100%
	Know 49%	Comp 24%	App 14%	Analysis 7%	Synthesis 0	Evaluation 6%	
Basic economic tools	3	3	-	++-	-	-	6
Demand and supply	12	12	3	2	-	2	31
Production	6	3	2	1	-	-	13
Basic economic problems of the society	12	4	38	-	-	-	19
Cost concept	3	1	1	1	-	1	7
Utility	9	4	1	1	-	1	16
Population	10	4	5	-	-	-	19
Public finance	2	-	1	1	-	1	5
Specialization and division of labour	10	3	3	2	-	1	19

<b>Total</b>	<b>74</b>	<b>37</b>	<b>21</b>	<b>10</b>	<b>0</b>	<b>8</b>	<b>150</b>
--------------	-----------	-----------	-----------	-----------	----------	----------	------------

As seen on Table 1, the table of specifications clearly reflects the various content areas in Economics that were considered in this study which helped to establish a high content validity for the Economics Aptitude Test. Therefore, the Economics Aptitude Test has a high content validity because there was a wide content coverage.

In addition to the table of specifications, the researchers also presented the test items to other experienced Economics teachers and Measurement and Evaluation Experts who also established the correctness, adequateness and appropriateness of the items in the constructed test thereby establishing the face validity of the test. The face validity describes the appearance of the test. It refers to how real the items of a test are to test takers; the cosmetics to the format for presenting or reporting the test items, the typing and general outlook of the test.

**Research Question 2:** What are the difficulty index and discrimination index of each item of the Economics Aptitude Test?

The test constructors used the difficulty indices as calculated from the R to select the suitable items that are appropriate to be included in the final test. These items were selected from the initial items generated for the trial testing. Items with index of  $0.40 \leq p \leq 0.70$  were selected for the difficulty level.

**Table 2: Difficulty indices of items of Economics Aptitude Test**

<b>Item</b>	<b>Difficulty</b>	<b>Item</b>	<b>Difficulty</b>	<b>Item</b>	<b>Difficulty</b>
4	0.55	60	0.6	95	0.54
5	0.46	61	0.6	96	0.47
6	0.43	62	0.4	97	0.49
9	0.40	63	0.6	98	0.40
10	0.54	64	0.6	102	0.45
12	0.45	65	0.5	103	0.42
19	0.41	66	0.6	104	0.58
23	0.46	68	0.5	105	0.42
36	0.46	69	0.5	106	0.57
39	0.42	70	0.5	107	0.54
40	0.63	71	0.5	108	0.62
41	0.42	72	0.6	109	0.58
42	0.44	73	0.6	110	0.53
44	0.41	74	0.5	111	0.59
45	0.42	76	0.6	130	0.69
46	0.48	77	0.5	131	0.65
48	0.65	78	0.5	132	0.68
49	0.60	81	0.4	133	0.70
50	0.60	82	0.5	144	0.57
51	0.58	84	0.4	145	0.58
52	0.44	85	0.4	146	0.57
53	0.60	86	0.5	147	0.52

54	0.53	88	0.4	148	0.67
55	0.50	89	0.4	149	0.46
56	0.55	90	0.5	150	0.66
57	0.45	91	0.5		
58	0.57	92	0.4		
59	0.46				

Table 2 shows the difficulty indices of 80 selected items for the various components of the Economics aptitude test. The acceptable indices ranged from  $0.40 \leq p \leq 0.70$ . The indices were established during item analysis which helped to ensure high item validity for each Economics test item using the R software. Items which have indices below 0.40 and indices higher than 0.70 were discarded (see Appendix for good difficulty indices and bad difficulty indices).

**Table 3: Discrimination indices of items in Economics Aptitude Test**

Item	Discrimination	Item	Discrimination	Item	Discrimination	Item	Discrimination
4	0.25	72	0.65	101	0.58	130	0.68
9	0.26	73	0.63	102	0.78	131	0.67
23	0.27	74	0.70	103	0.84	132	0.62
48	0.51	75	0.61	104	0.69	133	0.63
49	0.59	76	0.31	105	0.87	134	0.58
50	0.54	77	0.51	106	0.64	135	0.62
51	0.52	78	0.48	107	0.74	136	0.37
52	0.87	79	0.58	108	0.52	137	0.36
53	0.63	80	0.61	109	0.72	138	0.36
54	0.73	81	0.48	110	0.64	139	0.37
55	0.81	82	0.33	111	0.55	140	0.33
56	0.67	83	0.61	112	0.45	141	0.35
57	0.77	84	0.51	113	0.33	142	0.35
58	0.65	85	0.50	114	0.40	143	0.42
59	0.86	86	0.43	115	0.46	144	0.70
60	0.60	87	0.59	116	0.48	145	0.64
61	0.64	88	0.57	117	0.36	146	0.73
62	0.86	89	0.58	118	0.29	147	0.74
63	0.58	90	0.52	119	0.45	148	0.47
64	0.61	91	0.42	120	0.46	149	0.92
65	0.73	92	0.58	121	0.44	150	0.49
66	0.56	93	0.49	122	0.54		
67	0.90	94	0.57	123	0.58		
68	0.74	95	0.37	124	0.43		
69	0.62	96	0.52	125	0.41		
70	0.79	97	0.42	126	0.29		
71	0.64	98	0.58	127	0.52		
		99	0.64	128	0.56		

Table 3 indicates the discrimination indices of 106 items for the various components or characteristics of Economics aptitude Test. The acceptable indices during item analysis was put at  $r_{pb} \geq 0.25$ . The item indices were accepted and appropriate for the Economics Aptitude Test (EAT).

**Research Question three:** How many of the items of the EAT was selected after psychometric analysis?

**Table 4: list items selected after psychometric analysis**

Item	Diff	Discrim	Remark	Item	Diff	Discrim	Remark	Item	Diff	Discrim	Remark
9	0.40	0.26	GOOD	68	0.51	0.74	GOOD	97	0.49	0.42	GOOD
23	0.46	0.27	GOOD	69	0.52	0.62	GOOD	98	0.40	0.58	GOOD
48	0.65	0.51	GOOD	70	0.46	0.79	GOOD	102	0.45	0.78	GOOD
49	0.60	0.59	GOOD	71	0.52	0.64	GOOD	103	0.42	0.84	GOOD
50	0.60	0.54	GOOD	72	0.55	0.65	GOOD	104	0.58	0.69	GOOD
51	0.58	0.52	GOOD	73	0.59	0.63	GOOD	105	0.42	0.87	GOOD
52	0.44	0.87	GOOD	74	0.53	0.70	GOOD	106	0.57	0.64	GOOD
53	0.60	0.63	GOOD	76	0.56	0.31	GOOD	107	0.54	0.74	GOOD
54	0.53	0.73	GOOD	77	0.46	0.51	GOOD	108	0.62	0.52	GOOD
55	0.50	0.81	GOOD	78	0.51	0.48	GOOD	109	0.58	0.72	GOOD
56	0.55	0.67	GOOD	81	0.40	0.48	GOOD	110	0.53	0.64	GOOD
57	0.45	0.77	GOOD	82	0.52	0.33	GOOD	111	0.59	0.55	GOOD
58	0.57	0.65	GOOD	84	0.40	0.51	GOOD	130	0.69	0.68	GOOD
59	0.46	0.86	GOOD	85	0.40	0.50	GOOD	131	0.65	0.67	GOOD
60	0.58	0.60	GOOD	86	0.48	0.43	GOOD	132	0.68	0.62	GOOD
61	0.58	0.64	GOOD	88	0.42	0.57	GOOD	133	0.70	0.63	GOOD
62	0.44	0.86	GOOD	89	0.43	0.58	GOOD	144	0.57	0.70	GOOD
63	0.61	0.58	GOOD	90	0.46	0.52	GOOD	145	0.58	0.64	GOOD
64	0.58	0.61	GOOD	91	0.51	0.42	GOOD	146	0.57	0.73	GOOD
65	0.48	0.73	GOOD	92	0.40	0.58	GOOD	147	0.52	0.74	GOOD
66	0.60	0.56	GOOD	95	0.54	0.37	GOOD	148	0.67	0.47	GOOD
67	0.39	0.90		96	0.47	0.52		149	0.46	0.92	
								150	0.66	0.49	

Table 4: shows the list of the items of the EAT selected after psychometric analysis. The tables shows that 67 items selected were good in terms of difficulty and discrimination.

**Research Question Four:** What is the reliability of Economics Aptitude Test using three reliability methods?

To give answer to research question four, the reliability of the EAT was estimated using

Kuder Richardson formula 20, Split half method and Cronbach Alpha method. All the reliability methods utilized single testing or administration; the scores generated were used to compute the reliability coefficient. After computation, the following coefficients were obtained as the measure of internal consistency of the test:

**Table 5: Reliability Coefficients**

Reliability Method	Coefficient
KR20	0.93
Split Half	0.97
Cronbach Alpha	0.93

As seen from Table 4, an estimate of the EAT reliability using three methods were established. Kuder Richardson formula 20 show a .93 reliability, the Split half method shows a .97 reliability and the Cronbach Alpha method shows a .97. This approaches becomes pertinent because the EAT is a multiple choice objective test with expected response of either pass (1) or fail (0). However, the result is significant at .05 level of significance which made the instrument (EAT) very suitable for the study. The reliability coefficients from the three methods confirms that EAT is highly reliable.

## **Discussion**

The discussion of this study is based on the main findings after answering the research questions. The instrument was validated. Validity is one of the pertinent psychometric properties of an instrument. It refers to the extent to which an instrument measures what it is purported to measure. In establishing the content validity of the instrument, two approaches were adopted. First the use of table of specification was employed. This approach is similar to Osadebe (2018), Irighweferhe (2008) and Longjohn, et. al., (2021). The second approach adopted was the use of experts' judgement. The items were presented to experienced Economics teachers and measurement and evaluation experts. This provided for the correctness, adequateness and appropriateness of the test.

The Bloom taxonomy was used in the construction of the Economics Aptitude Test (EAT). This approach is similar to longJohn, et. al., (2021) who also used it in the preparation of the table of specification. The difficulty indices and discriminating indices were computed. In terms of difficulty indices, experts in measurement and evaluation such as Obowu-Adutchay (2014) reported that an ideal item should have facility index of 0.4 but in real life situation it will range from 0.30 to 0.70. All items in the instrument are within the range of 0.40 and 0.70 making them very appropriate, suitable and effective. This is similar to Akpoguma (2008) and Osiobe (2012).

The discriminating indices that measure the extent items discriminate between the bright and dull students were also computed. Discriminating index of an item varies from 0.00 to 0.01. Negative indices are abnormal because they penalised more of the bright students than the dull students; hence they were rejected. Nworgu (2003) agreed that an ideal item should possess discriminating indices of +1 but realistically it should range from + 0.03 to 1.00. Asuru (2015) also opined that all items with negative values should be rejected. In order to include only high-quality items, the researcher used a realistic range of discriminating indices from 0.25 to 0.97 to select the items included in the instrument. This is similar to Akpoguma (2008) and Osiobe (2012).

To establish the reliability of the Economics Aptitude Test, Three reliability methods were employed to ascertain the consistency of the reliability of the test and all three methods revealed a very high reliability of the test. This is line with Oloya (2005) and Onoyumolo (2005), who used split half method and Osadebe (2018).Furthermore, Irighweferhe (2008) agreed that reliability coefficient of 0.69 is high and adequate. Akazue (2009) in his study, reported reliability coefficient of 0.75 which he judged to be significant for a test. This study has found out that the new instrument (EAT) has a highreliability of 0.93-0.97 (from the different method) which is almost in the same level with the above reported ones. The instrument yielded very high internal consistency of scores.

## Conclusion

The Economics Aptitude Test developed by the researchers is a test with high psychometric properties. As such, the test could be used for the selection of secondary school students who have the desire to study Economics in their university level as well as an assessment tool for the evaluation of learning outcomes. The items of the test are suitable and appropriate in terms of difficulty and discrimination indices. 67 items were selected while 83 items were discarded.

## Recommendations

Based on the findings of the study, the following recommendations were made,

1. EAT can be used as a valid test for measuring students' proficiency in Economics in public senior secondary schools in Port Harcourt metropolis.
2. Teachers and researchers should be trained to explore R software to develop and validate their tests and:
3. Educators and experts should provide resources on the use of advanced techniques for validation of test.

## References

- Akaezue, N. N. (2019). Construction and Validation of Physics Aptitude Test for Senior Secondary School Student in Delta State. Unpublished M.Ed. Project, Delta State University, Abraka, Delta State.
- Akponguma, J. (2018). Construction and Validation of Mathematics Achievement Test for Senior Secondary School Students in Delta State. Unpublished M.Ed. Project Delta State University, Abraka
- Asuru, V. A. (2015). Measurement and evaluation in education and psychology(2<sup>nd</sup> ed.). Pearl Publishers International Ltd.
- Erner, C., M., Goedde-Menke, M. & Oberste, H. (2016). Financial Literacy of High School Students: Evidence from Germany. *Journal of Economic Education*, 47,(2), 95–101
- Irighweferhe, S. U. (2018). Construction, Validation and Standardization of Mathematics Achievement Test for Senior Sate Secondary School Student in Delta State of Nigeria. An Unpublished M.Ed project, Delta State University Abraka, Abraka, Delta State.
- Jappelli, T. (2019). Economic Literacy: An International Comparison. *The Economic Journal*, 120 (548), 429–431.
- Kane, M. T. (2016). Validation. In: Brennan R.L, Educational measurement. 4th ed. Praeger; 17–25
- Kaplan, R.M.&SaccuzzoD.P.(2020) Psychological Testing, Principles, Applications and Issues. Sixth Ed. Cengage Learning, Pvt Ltd.
- Kpolovie, P. J. (2019). Advanced research methods.Springfield Publishers Ltd.

- Kubiszyn, T. & Borich, G. (2021). *Educational Testing and Measurement: Classroom Application and Practice*. Hobokon: John Wiley & Sons.
- LongJohn, I. T., Njigwum, A. S. & Ijeh, C. P. (2021). Validation of Basic Science Achievement Test Using R Software. *International Journal of Innovative Research & Development*, 10(9), 77-87
- Miller, S. L., & VanFossen, P.J. (2018). Recent Research on the Teaching and Learning of Pre-Collegiate Economics. In *Handbook of Research in Social Studies Education*, edited by L. Levstick & C. Tyson, 283–289. Routledge.
- Njigwum, A. S. (2019). Predicting Senior School Certificate Examination Performance in Mathematics and English Language from the Junior School Certificate Examination Performance in Obio/Akpor Local Government Area. Unpublished MEd Thesis, Ignatius Ajuru University of Education.
- Nworgu, B.G. (2018). *Educational Measurement and Evaluation, Theory and Practices*. University Trust Publishers.
- Obowu-Adutchay, V. (2018). Test development. In Obagah, M.O.N & Inko-Tariah, D. C. (Eds). *Educational measurement and evaluation*. Rodi Printing and Publishing Company. 87-107
- Osadebe, P.U. (2021). Construction and Standardization of an Economics achievement test for senior secondary school students. Unpublished Doctoral thesis, University of Port Harcourt.
- Osadebe, P. U. & Nwabueze P. C. (2018) Construction and Validation of Physics Aptitude Test as an Assessment Tool for Senior Secondary School Students. *International Journal of Assessment Tools in Education*, 5(3), 461–473.
- Osiobe, G.A. (2022). Construction and Standardization of Geography Objective Test for Senior Secondary Schools in Delta State. Unpublished Ph.D thesis, Delta State University Abraka.
- Rata, E. (2018). Connecting Knowledge to Democracy. In *Knowledge, Curriculum and Equity: Social Realist Perspectives*, 19-32 B. Barrett, U. Hoadley, and J. Morgan.
- Raza, M. A, & Shah, F. A. (2017), Impact of Favourite Subject Towards the Scientific Aptitude of the Students at Elementary Level. *Pakistan Journal of Social Sciences (PJSS)*, 31(1), 135- 143. 17.
- Reeves, J.F.(2020). Aptitude Assessment. [Http://www.theworksuite.com/id15.ht](http://www.theworksuite.com/id15.ht)
- Salemi, M.K. & Siegfried, J. J. (2020). Promoting Economic Literacy in the Introductory Economics Course, Use It or Lose It: Teaching Literacy in the Economics Principles Course. *American Economic Association Papers and Proceedings* 92 (2), 463–472
- Steiner, P. (2021). The Sociology of Economic Knowledge. *European Journal of Social Theory* 4 (4), 443–458.
- Ukwuije, R.P.I. & Opara, M. I. (2021). *Test and measurement for teachers*(3rd ed.). Chadik Printing Press. 129-130.

- Walstad, W. B, & Watts, M.(2019). Perspectives on Economics in the School Curriculum: Coursework, Content, and Research. *Journal of Economic Education*, 46 (3), 324–339.
- Weston, S. J, & Yee, D. (2017). Why you should become an R user? A brief introduction to R. *APS observer*, 30-32
- Zhao, Y.Y. (2020). Motivation in Education. *International Journal of Engineering Education*, 22, 1281–1286.