A STUDY ON THE PSYCHOMETRIC PROPERTIES OF 2022/2023 OBJECTIVE ITEMS OF MEASUREMENT AND EVALUATION EXAMINATION AMONG NCE II STUDENTS OF FEDERAL COLLEGE OF EDUCATION (TECHNICAL) BICHI, KANO STATE, NIGERIA

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Abstract

The paper determined the psychometric properties of 2022/2023 Measurement and Evaluation among NCE II students of Federal College of Education (Technical) Bichi, Kano State, Nigeria. Three objectives and three research questions was guided by the study. The design used by the study was ex post facto. The population of the study was one thousand five hundred and seventy-three (1573) and a sample size of three hundred and six (306) were selected as subjects through cluster and simple random sampling techniques. The results of the objectives answer sheet for the students who sat for 2022/2023 Measurement and Evaluation in Federal College of Education Technical Bichi were collected and analyzed in order to obtained the p-value , discrimination index and distractor effectiveness through Statistical Package for the social Sciences in accordance with Classical Test Theory perspective (CTT). The study revealed that that the objectives items number 2, 8, 9, 12 and 20 were difficult to the students whereas item 1,3,4,5,6,7,10,11,13,14,15,16,17,18 and 19 were not difficult. The study revealed that the objectives item number 6, 9 and 10 discriminate well among high and low achievers. Similarly, item number 1,2,3,4,5,7,8,11,12,13,14,15,16,17,18,19 and 20 do not discriminate well among high and low achievers. The study finally revealed that option A Item number 8,9 and 20 were not functional distractors. But all other items were effective functional distractors. Similarly, in option B ITEM number 9,10,13 and 17 were functional not distractors. Moreover, in Option C, item number 9 and 16 were not functional distractors. Finally, in option D item number 1,2,34,13,15,16 and 17 were found to have low distractor effectiveness. The paper concluded that Majority of the items do not discriminate between high and low achievers and that finally most of the items are functional distractors. The paper recommended that Item analysis after every semester examination should be conducted for the course and there should be item analysis of other courses such as Psychology, Guidance and counseling.

Keywords: Study, Psychometric, Item, Measurement, Evaluation.

1.0 Introduction

Evaluation of students' performance is necessary to teaching and learning. Evaluation in this context is a systematic process of determining the extent to which learners have achieved the stated instructional objectives. Information generated through evaluation

provides basis for grading, diagnosis, feedback, remediation and guidance. According to Alken (1996), evaluation is the process of ascertain the decisions to be made, selecting related information and collecting, analyzing information in order to report summary of data useful to decision makers in selecting among alternatives.

Anikweze (2012) opined that "the essential qualities normally considered in item analysis are item difficulty/easiness, item discrimination and distractor analysis. Ebel & Frisbie (1991) asserted that the purpose of item analysis is to examine the contribution that each item is making to the test; items that are identified as faulty can be modified or rejected. Ukwuje (2013) in his view sees item analysis as a systematic procedure designed to obtain specific information about each item of a test. -

Steps

1. Administer the test to a large group student (ideally, over about 30).
2. Randomly divide the test questions into two parts. For example, separate even questions from odd questions.
3. Score each half of the test for each student.

Many teacher-made tests are of unknown psychometric properties just like tests that we conducted in semesters and terminal examinations. It is very difficult to know the behavior of items as many could be difficult but undetected. This may pose a serious problem as many items will be repeatedly administered and not knowing that they are difficult so that appropriate measures could be taken to address the situation.

Some items may or may not discriminate well among high and low achievers and this could only be traced if item analysis is conducted. Most teacher-made tests do not conduct such analysis for better quality items.

Similarly, some items or options may not have effective distractor analysis and this may lead to exposing direct answer to the tests-takers. Test is supposed to have a well and effective distractor which will improve the students' level of thinking in answering questions. But we failed to conduct these important analyses that will assist us in constructing qualitative items that will measure the expected learning outcome.

It is in this regard to note that psychometric properties of tests are part of the evaluation that is conducted so as to come up with important information and the behavior of items. Doing this would definitely improve the quality of our test items. It is important to investigate and learn about a test's psychometric properties for two or more reasons. First, the information that could be obtain after ascertaining the psychometric properties of tests would lead to sound test construction and modifications of some items. Professionals and other teachers who develop tests need to evaluate and describe how test function so that it can be built to a specified level of quality.

Classical Test Theory

Classical test theory is a body of related psychometric theory which predicts outcomes of psychological testing such as the difficulty of test items or the ability of test items or test takers. (Wikipedia, 2012) Yakasai (2012) added that classical test theory is a theory that is more of interpretation of test scores. The classical test theory emphasized on interpretation of tests with regards to test reliability. Classical test theory can also be regarded as highly synonymous with true score theory

Origin of Classical Test Theory

Classical Test Theory emanates from the beginning of the 20th century where many psychometricans wrote or contributed to the development of classical test theory. For instance, Declerks in 2008, Allen in 2002, Gregory (2001), Hagen in 2007, Lord and Novick in 1968. These psychometricians wrote extensively on classical test theory.

Basic Assumptions of CTT

The assumptions of classical Test Theory are as follows:

1. Each individual has a true score, t, which would be obtained if there were no errors in measurement.

X	=	I	+	E
Observed score		True Score		Error Score ;

2. Each observed score has true component and error component ;
3. Measurement are evenly dispersed around average that is deviation occur equally to both side of true score (Declerk, 2008);
4. Correlation between parallel test scores is equal to the reliability. (Lord &Novick 1968)

In practical terms, one can deduce that Classical Test Theory deals with the relationship between three variables which are

i. X – observed score
ii. T – Time score
iii. E – Error score

Nurliyanto (2015) conducted a study on test analysis of final examination on economics subjects in Grade XII IPS SMA Negeri Banyumas academic difficulty level, discrimination power and pattern of answer distributions. Quantitative descriptive research design was used. A sample size of 112 students' responses was used. His findings indicated that an excellent internal consistency reliability of 0.70 was obtained.

Kumar and Bhattacharya (2016) conducted a study on item analysis of domestic test in English skills of secondary school students. The study deals with the analysis of diagnostic test items constructed by the researcher in English language skills at secondary school level. Analysis involved difficulty index and discrimination index. The study randomly selected 370 students from central board of secondary school and board of high school and intermediate education in Uttra Pradesh India. The results of their findings shows that difficulty index was found to be between 0.25 to 0.80, indicating that some items are very difficult and some are easy.

Adegoke (2014) conducted his research work on the role of item analysis in detecting and improving faulty physics objective test items. Result shows that some items were faulty in that their difficulty indices were very high and some items could not discriminate between high achievers and low achievers.

Badamasi (2018) conducted a study on IRT anlaysis of psychometric properties of the 2015 Kano State Mathematics Senior Secondary Certificate Qualifying Examination in Dala Zone, Kano State. The study found the difficulty, discrimination and guessing indices of multiple choice items of the examination. A sample size of 370 were selected from a population of 14,512. The result shows that 30% of the items were easy, 20% were moderate difficulty and 50% were difficult. Similarly 30% of the items were found to have

high discrimination, 22.5% did not discriminate at all. Finally, 57.5% were desirable with regards to guessing indices while 42.5% were undesirable.

Mustapha (2018) employed 2PLM to analyzed items on Mathematics qualifying examination in Hadejia Zone of Jigawa State across gender, location and school type. A sample size of 357 was selected from the population of 4,230. The study revealed no significant difference in the mean difficulty and discrimination indices of the items across gender.

Abubakar (2018) employed the 2PLM of IRT to analyze the psychometric properties of Mathematics SSCE/NECO across gender, school type and location in Malumfashi Education Zone of Katsina State Nigeria. Survey research design was employed. A sample size of 357 was selected from a population of 4390. The result showed that the mean difficulty and discrimination were found to be invariant across gender, school type and location.

Umar (2020) conducted a study on psychometric properties of the English language qualifying examination in Jigawa State. The study employed expost factor design. A sample size of 500 students responses were selected from a population of 3,733. The data was analyzed via IRT PRO. The results showed that most items have very low difficulty level, majority of the items have also low discrimination indices and as for guessing index 25 items have very low guessing, while 3 items have low guessing index, 16 items have high guessing values; no difference was found across the gender in the mean b, a and c parameter values.

Nworgwu and Agah (2012) applied three parameter logistics model in the calibration of a Mathematics achievement test on 1514 SS III students in Rivers and Cross Rivers State. Forty items of multiple-choice was used , they found that the probability of guessing Ci in the tests correctly range from 0.02-0.50 for all the ability levels using BILOG software .

Ibrahim (2019) conducted a research on psychometric properties of 2018 Mathematics Basic Education Certificate Examination (BECE) in Funtua Education Zone, Katsina State, Nigeria. His study found out that the item distractors were effective as 176 (97%) of 180 distractors on the 2018 Mathematics BECE functioned properly.

1.2 Statement of the problem

Items of every examination are supposed to have psychometric properties be it teacher-made or standardized tests. There are many psychometric properties of tests. They are conducted in order to improve the qualities of tests items. It is imperative to conduct or find out the behavior of items and in most cases teacher-made tests are of unknown psychometric properties. Measurement and Evaluation (EDU223) is a course that is taken in every second semester in Federal College of Education (Technical) Bichi and of course other colleges of Education in Nigeria. But to the best of my knowledge, the psychometric properties of the tests are not known, as such a study on item analysis of the 2022/2023 objectives test items was conducted and these includes Difficulty level, discrimination index and distractor effectiveness.

1.3 Objectives of the study

The study determined the following objectives

1. The P-value of Measurement and Evaluation EDU223 objectives tests items of the 2022/2023 second semester examination in Federal College of Education Technical Bichi Kano State.
2. The discrimination index of Measurement and Evaluation EDU223 objectives tests items of the 2022/2023 second semester examination in Federal College of Education Technical Bichi Kano State.
3. The distractor effectiveness of Measurement and Evaluation EDU223 objectives tests items of the 2022/2023 second semester examination in Federal College of Education Technical Bichi Kano State.

1.4 Research questions

1. What is the P-value of Measurement and Evaluation EDU223 objectives tests items of the 2022/2023 second semester examination in Federal College of Education Technical Bichi Kano State?
2. What is the discrimination index of Measurement and Evaluation EDU223 objectives tests items of the 2022/2023 second semester examination in Federal College of Education Technical Bichi Kano State?
3. What is the distractor effectiveness of Measurement and Evaluation EDU223 objectives tests items of the 2022/2023 second semester examination in Federal College of Education Technical Bichi Kano State?

1.5 Design of the study

The ex post facto design was employed by the study, since it seeks to analyzed the b-parameter, a-parameter& c- parameter of the 2020 entrance examination in English and Mathematics items will be determine and they are already in existence. This implies that the data that will be use for the study are already presence, since they are performances of students. This further explains that the independent variable has already occurred and in which the researcher starts with the observation of the dependent variables. In ex post facto research, the researcher attempts to determine the cause or reason for existing differences in the behavior or status of a group of individuals (Gay, Mills & Airasian, 2012 p.227)

3.0 Methodology

3.1 Population of the study

The population of the study was all the level 200 students of NCE program who sat for the 2022/2023 second semester examination of Measurement and Evaluation EDU223. They include male and female students and their age range is between 18-25years. They are estimated to be one thousand five hundred and seventy-three (1,573). The population is depicted below.

Table 1. Showing population of NCE II Students who sat for the second semester examination of Measurement and Evaluation Examination EDU223 for the 2022/2023 session in Federal College of Education (Technical) Bichi by school.

S/N	SCHOOL	POPULATION
1	SOSE SCIENCE	380
2	SOSE TECHNICAL	72

3	SOSE BUSINESS	148
4	SOSE VOCATIONAL	66
5	SOSE SPECIAL	41
6	SOSE ATRS AND SOCIAL SCIENCES	157
7	SOSE LANGUAGES	83
8	SECPADE	626
TOTAL		1,573

SOURCE: EXAMINATION UNIT FCE T BICHI

3.2 Sample Size

The sample size of three hundred and six (306) students was used as sample in accordance with research advisors table for determining sample size (2006),. The selection was done proportionately from the sampled schools using the proportion formula below:

$$\frac{\text{Total population of programme}}{\text{Grand total of population}} \times \text{sample size}$$

and the following table was obtained.

The sample size is shown below

Table 2. Showing population sample size of NCE II Students who sat for the second semester examination of Measurement and Evaluation Examination EDU223 for the 2022/2023 session in Federal College of Education (Technical) Bichi by school.

S/N	SCHOOL	POPULATION
1	SOSE SCIENCE	73
2	SOSE TECHNICAL	14
3	SOSE BUSINESS	28
4	SOSE VOCATIONAL	14
5	SOSE SPECIAL	8
6	SOSE ATRS AND SOCIAL SCIENCES	31
7	SOSE LANGUAGES	16
8	SECPADE	122
TOTAL		306

SOURCE: EXAMINATION UNIT FCE T BICHI

3.3 Sampling Technique

The study employed cluster and simple random sampling techniques to select the sample size. **Simple Random Sampling is** one of the best probability sampling techniques that helps in saving time and resources, is the Simple Random Sampling method. It is a trustworthy method of obtaining information where every single member of a population is chosen randomly, merely by chance and each individual has the exact same probability of being chosen to be a part of a sample. Cluster sampling is a method where the researchers divide the entire population into sections or clusters that represent a population. Clusters are identified and included in a sample on the basis of defining demographic parameters such as age, location, sex etc. which makes it extremely easy for a survey creator to derive

effective inference from the feedback (Cresswell, 2018). The Federal College of Education (Technical)Bichi, is divided into schools as clusters, with other sub clusters within each school known as departments.

3.4 Data Collection Procedure

The researcher only went directly to the Examination Unit in the department of Educational Psychology / Guidance and Counseling of the college to collect the data.. The researcher did not encounter any difficulty in having access to the data and the data includes the followings:

3.5 Data Analysis Techniques

Research question 1-3 was answered on the basis of classical tests theory perspective via SPSS.

4.0 Results/Findings

4.1 Results

Research Question 1. What is the P-value of Measurement and Evaluation EDU223 objectives tests items of the 2022/2023 second semester examination in Federal College of Education Technical Bichi Kano State?

Table 4. Table showing the P-value of Measurement and Evaluation EDU223 objectives tests items of the 2022/2023 second semester examination in Federal College of Education Technical Bichi Kano State.

S/N	*N*	MEAN	STANDARD DEVI
1	306	0.5033	0.50081
2	306	0.2484	0.43277
3	306	0.7516	0.43277
4	306	0.7484	0.43466
5	306	0.5000	0.43466
6	306	0.5000	0.50082
7	306	0.5000	0.48974
8	306	0.3954	0.43466
9	306	0.2516	0.50082
10	306	0.5000	0.50082
11	306	0.7386	0.44014
12	306	0.3824	0.48676
13	306	0.7451	0.43652
14	306	0.2516	0.43466
15	306	0.5000	0.50082
16	306	0.7516	0.43277
17	306	0.2484	0.43277
18	306	0.5033	0.50081
19	306	0.5000	0.50082
20	306	0.3824	0.434

Mean and standard deviation was used to find out the p-value of the Measurement and Evaluation EDU223 examination items in Federal College of Education Technical Bichi. The results show that item number 2, 8, 9, 12 and 20 were difficult to the students whereas all other items were not difficult.

Research Question 2

1. What is the discrimination index of Measurement and Evaluation EDU223 objectives tests items of the 2022/2023 second semester examination in Federal College of Education Technical Bichi Kano State?

Table 5. A table showing the discrimination index of Measurement and Evaluation EDU223 objectives tests items of the 2022/2023 second semester examination in Federal College of Education Technical Bichi Kano State.

S/N	UG	LG	DI
1	**4**	**4**	**0**
2	**1**	**1**	**0**
3	**5**	**5**	**0**
4	**4**	**4**	**0**
5	**4**	**4**	**0**
6	**0**	**5**	**-5**
7	**2**	**2**	**0**
8	**3**	**3**	**0**
9	**6**	**4**	**2**
10	**0**	**5**	**-5**
11	**3**	**3**	**0**
12	**5**	**5**	**0**
13	**1**	**1**	**0**
14	**4**	**4**	**0**
15	**1**	**1**	**0**
16	**3**	**3**	**0**
17	**2**	**2**	**0**
18	**3**	**3**	**0**
19	**5**	**5**	**0**
20	**1**	**1**	**0**

A discrimination index analysis was used for 2022/2023 measurement and Evaluation examination among NCE II students of Federal College of Education Technical Bichi. The results showed that item only item 6, 9 and 10 discriminate among high and low achievers. But all other items do not discriminate between the high and low achievers.

Research Question 3. What is the distractor effectiveness of Measurement and Evaluation EDU223 objectives tests items of the 2022/2023 second semester examination in Federal College of Education Technical Bichi Kano State?

Table 6. A table showing the distractor effectiveness of Measurement and Evaluation EDU223 objectives tests items of the 2022/2023 second semester examination in Federal College of Education Technical Bichi Kano State.

Q	*N*	A	B	C	D
1	**306**	**49.67**	**43.46**	**4.90**	**1.96**
2	**306**	**25.49**	**32.68**	**39.22**	**2.61**
3	**306**	**29.08**	**32.68**	**1.96**	**36.27**
4	**306**	**24.18**	**25.49**	**46.08**	**4.25**
5	**306**	**22.55**	**26.47**	**43.79**	**7.19**
6	**306**	**16.67**	**17.97**	**19.93**	**52.29**
7	**306**	**6.21**	**13.07**	**14.71**	**66.01**
8	**306**	**1.63**	**3.27**	**82.03**	**13.07**
9	**306**	**0.00**	**0.00**	**2.61**	**97.39**
10	**306**	**2.61**	**4.58**	**10.13**	**82.68**
11	**306**	**48.37**	**30.39**	**24.51**	**23.86**
12	**306**	**43.46**	**32.03**	**13.07**	**11.44**
13	**306**	**6.86**	**0.65**	**91.83**	**0.65**
14	**306**	**63.07**	**14.71**	**13.40**	**8.82**
15	**306**	**32.03**	**28.43**	**36.27**	**3.27**
16	**306**	**93.79**	**3.27**	**0.98**	**1.96**
17	**306**	**6.86**	**4.25**	**86.93**	**1.96**
18	**306**	**7.19**	**12.75**	**66.67**	**13.40**
19	**306**	**5.56**	**14.05**	**16.01**	**64.38**
20	**306**	**0.98**	**20.26**	**57.52**	**21.24**

A Distractor Effectiveness analysis was conducted for the 2022/2023 Second Semester Measurement and Evaluation Examination among NCE II students of Federal College of Education Technical Bichi. The results showed that in option A Item number 8,9 and 20 were not effective in distracting students answers. But all other items were effective. Similarly, in option B ITEM 9,10,13 and 17 did not distract students in selecting the options or answers. Moreover, in Option C, item number 9 and 16 were not effective in distracting students in selecting the answer. Finally, in option D item number 1,2,34,13,15,16 and 17 were found to have low distractor effectiveness.

4.2 Findings

1. The study revealed that that the objectives items for the 2022/2023 Second Semester Measurement and Evaluation Examination among NCE II students of Federal College of Education Technical Bichi. number 2, 8, 9, 12 and 20 were difficult to the students whereas item 1,3,4,5,6,7,10,11,13,14,15,16,17,18 and 19 were not difficult.
2. The study revealed that the objectives item number 6, 9 and 10 discriminate well among high and low achievers for the 2022/2023 Second Semester Measurement and Evaluation Examination among NCE II students of Federal College of Education Technical Bichi. Similarly, item number 1,2,3,4,5,7,8,11,12,13,14,15,16,17,18,19 and 20 do not discriminate among high and low achievers.

3. The study finally revealed that option A Item number 8,9 and 20 were not functional distractors. But all other items were effective functional distractors. Similarly, in option B ITEM number 9,10,13 and 17 were functional not distractors. Moreover, in Option C, item number 9 and 16 were not functional distractors. Finally, in option D item number 1,2,34,13,15,16 and 17 were found to have low distractor effectiveness.

5.0 Discussions

The study revealed that that the objectives items for the 2022/2023 Second Semester Measurement and Evaluation Examination among NCE II students of Federal College of Education Technical Bichi. number 2, 8, 9, 12 and 20 were difficult to the students whereas item 1,3,4,5,6,7,10,11,13,14,15,16,17,18 and 19 were not difficult. This is in line with findings of Kumar and Bhattacharya (2016) who conducted a study on item analysis of domestic test in English skills of secondary school students in India. The results of their findings shows that difficulty index was found to be between 0.25 to 0.80, indicating that some items are very difficult and some are easy.

The study revealed that the objectives item number 6, 9 and 10 discriminate well among high and low achievers for the 2022/2023 Second Semester Measurement and Evaluation Examination among NCE II students of Federal College of Education Technical Bichi. Similarly, item number 1,2,3,4,5,7,8,11,12,13,14,15,16,17,18,19 and 20 do not discriminate among high and low achievers. This is also in tune with the findings of Adegoke (2014) who conducted his research work on the role of item analysis in detecting and improving faulty physics objective test items. Result shows that some items were faulty in that their difficulty indices were very high and some items could not discriminate between high achievers and low achievers.

The study finally revealed that option A Item number 8,9 and 20 were not functional distractors. But all other items were effective functional distractors. Similarly, in option B ITEM number 9,10,13 and 17 were functional not distractors. Moreover, in Option C, item number 9 and 16 were not functional distractors. Finally, in option D item number 1,2,34,13,15,16 and 17 were found to have low distractor effectiveness. This is not in line with the work of Ibrahim (2019) who conducted a research on psychometric properties of 2018 Mathematics Basic Education Certificate Examination (BECE) in Funtua Education Zone, Katsina State, Nigeria. His study found out that the item distractors were effective as 176 (97%) of 180 distractors on the 2018 Mathematics BECE functioned properly.

6.0 Conclusion

Most of the items of 2022/2023 Measurement and Evaluation in Federal College of education Technical Bichi were not difficult. Majority of the items do not discriminate between high and low achievers and that finally most of the items are functional distractors.

7.0 Recommendations

1. Item analysis after every semester examination should be conducted. This will give room to identify questions that are difficult so that measures could be taken to address questions that are difficult or does not discriminate well among high and low achievers or options that are not functional distractors.

2. There should be item analysis of other courses such as Psychology, Guidance and counseling. This will also assist in understanding the behavior of items visa viz Difficulty, discrimination indices and distractor effectiveness
3. Content validity or reliability of the courses offered in the department and of course other departments in the College should be conducted. This will further unveil the psychometric properties of the teacher-made test that are of unknown to be established.

References

Anikweze, C.M. (2013). Measurement and evaluation for teacher education. 3rd edition. Emigel: Snaan Press (Nig) Ltd.

Badamasi, N.T. (2018). An IRT Analysis of psychometric properties of the 2015 Kano State Mathematics Senior Secondary Certificate Qualifying Examination in Dala Education Zone. An Unpublished Med dissertation, Bayero University, Kano.

Creswell, J.W. (2008). Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research. Upper Saddle River, NJ: Pearson Education, Inc. "Data Collection Methods". uwec.edu.

Creswell, J.W. (2012). Educational research: Planning, conducting, and evaluating quantitative and qualitative research. Upper Saddle River, NJ: Prentice Hall

Creswell, John W. (2014). Research design : qualitative, quantitative, and mixed methods and approaches (4th ed.). Thousand Oaks: Sage. ISBN 978-1-4522-2609-5.

Ebel, R.L. (1979). Essentials of Educational Measurement. New Jersey: Prentice hall inc.

Gay, L.R., Mills,G.E,&Airasian P.W.,(2012) Educational research: competencies for analysis and Application New Jersey: Pearson Education Inc.

Ibrahim M.A. (2019) Assessment of psychometric properties of 2018 Mathematics Basic Education Certificate Examination (BECE) in Funtua Education Zone, Katsina State, Nigeria. Unpublished Masters Thesis of the Department of Education, Bayero University, Kano.

Iwuji R.P.I (1989) Measurement & Evaluation for School. Key Publishers Limited 41 Limca Road Onitsha.

Lord, N. (1968). Classical tests theory. Retrieved from www.wikipedia, the free encyclopedia.

Mustapha, S.H. (2018). Analyses of psychometric properties of the 2014 Jigawa State qualifying Mathematics examination in Hadejia education zone (unpublished Masters Thesis, Bayero Univeristy, Kano).

Nurliyanto, D.(2015). Tests item analysis of the final examination on Economics subject in Grade X11 IPS SMA Negeri Banyamus. Unpublished undergraduate project. Yogyakarta state university.

Nworgwu, B.G. and Agah J.J (2012). Application of three parameter logistic model in the calibration of Mathematics Achievement Test. Journal of Educational Assessment in Africa 29(7)162-172

Umar, D. (2020). Psychometric properties of the 2020 English Language Qualifying Examination in Jigawa State. Unpublished Masters Dissertation of the Department of Education, Bayero University, Kano.