

Application of Classical Test Theory Model on 2021 Mathematics Objectives Items of Entrance Examination into Senior Science and Technical Colleges in Kano State, Nigeria

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Abstract

The study applied classical test theory model on 2021 Mathematics objectives items of Entrance Examination in to Senior Sciences and Technical Colleges (EESSTC). The study has Four (4) objectives and Four (4) research questions. The study employed Descriptive survey design. The population of the study consisted a total number of fourteen thousand six hundred and forty seven (14,647) examinees that sat for 2021 Mathematics EESSTC in Kano state. A sample of five hundred (500) were drawn using cluster proportionate to the size sampling technique The item analysis were carried out using Classical Test Theory (CTT) Frame work. The findings from the study revealed EESSTC 2021 Mathematics items 13(43.33%), 16(53.33%) and 1(3.33%) are difficult, moderate and easy items respectively with a mean of 0.34. The discriminating power showed that 9(30%), 9(30%), 8(27%) and 4(13%) are very good, good, acceptable and poor items respectively with a mean of 0.31. It was concluded that 2021 Mathematics items of EESSTC achieved acceptable psychometric indices. It was recommended that services of Tests and Measurement expert should be employed during items development process in order to improve their psychometric properties.

Keywords: Classical Test Theory, Entrance examinations, Senior Sciences and Technical Colleges, Mathematics, Objectives Items.

Introduction

The quality of any instrument is to measure effectively learning outcome from the students. Test items are the most important or basic blocks for building any good instrument for assessment. During items development process it is essential that the characteristics of the item be examined before the test administration. This can be done by applying one of the test quality estimate model which is the classical Test Theory Frame work.

Classical test theory (CTT) is a body of related psychometric theory that predicts outcome of psychological testing such as the difficulty of items or the ability of the test taker, is a theory about test scores that introduce three concepts. 1. Test Scores (often called Observed score) 2. True Score and 3. Error Score. It is assumes that observed score is equal to true score plus some error. Therefore the central model of this theory is that, observed score is composed of the true score and error score denoted as:

$$X=T+E.$$

Where X= Observed score, T= True score and E=Error score. Classical test theory is concerned with relationship between the three variables X. T. E. are used to say something about the quality of the test scores (Abdullahi,2016). The Observed score (X) is simply the score that a students earn and it is familiar to teachers and students. The True score (T) and Error score (E) are unobserved and are confusion to many layman. This is because they are hypothetical concept whose values one cannot know. The True score is usually thought to be the mean score that a person will get if he/she had taken the test for an infinite number of time. The error scores is the estimated error that occur in the measurement. Classical Test Theory is a framework that is used to determine the difficulty level and discrimination power ability of the test item. Item difficulty is a measure of the difficulty level of the items. It is obtained by finding the proportion of examinee that got the items correct. The discrimination index measure the ability of the test items in differentiating between the abilities of the examinee. It is obtained finding the difference in the proportion of high achieving and low achieving examinees, who scored the item correctly using. According to Babatunde (2019) Students' performance in an examination is determined by several factors among which is the factors associated with item characteristics of the examination. (Item difficulty, discrimination).

As investigated by the researcher Entrance Examination in to Senior Science and Technical Colleges which is conducted by Kano state government through Science and Technical schools Board (STSB) in order to screen out students for appropriate placement in to Senior Science and Technical Colleges resulted to low pass rate and it is of unknown psychometric properties as there is no evidence the items passed through standardization process of CTT framework items analysis. The Examination covers sciences and Technical subjects offered at that level including English and Mathematics. Candidates must pass a minimum of an average of 40/45 marks before he/she is qualified to be placed into Senior Sciences or Technical Colleges in Kano State.

Mathematics is very important in the academic life of a student's, a fundamental discipline for science and technological development. Mathematics was accorded high value and was made a compulsory subject in the school system as it opens mind to analytical thinking, logical reasoning and the aptitude for innovative ideas, deep focusing and clarity of thought and precision. This work was based on the Classical Test Theory of measurement, which assumes that each individual has a true score, which would be obtained if there are no errors in measurement.

Statement of the Problem

Kano State Government, through the Ministry of Education, conducts Entrance Examination into Senior Science and Technical Colleges. The examination is taken at the third level of junior secondary school for the purpose of placement of students in to Senior Science and Technical Colleges in the state.

However, statistics obtained by the researcher from Science and Technical Schools Board (STSB) showed that only 24%, 22%, and 28% of the students that sat for the examination for the year 2018, 2019 and 2020, respectively passed Mathematics. On investigation by the researcher, the psychometric properties of the examination is unknown as there is no evidence that showed the items of the examination pass through the standardization process of items analysis. This prompts the researcher to apply Classical Test Theory model on 2021 Mathematics objectives item of Entrance examination in to senior secondary school to determine their qualities.

Objectives of the Study

The objectives of the study are to find out:

1. the proportion of difficult, moderate and easy items of 2021 Mathematics items of EESSTC
2. the mean items difficulty index of 2021 Mathematics items of EESSTC
3. the proportion of very good, Good, acceptable and poor discriminating items of 2021
4. Mathematics items of EESSTC
5. the mean item discriminating power of 2021 Mathematics items of EESSTC

Research Questions

The objectives of the study were addressed by the following research questions

1. What is the proportion of difficult, moderate and easy items of 2021 Mathematics items for EESSTC?
2. What is the mean difficulty index of 2021 Mathematics items of EESSTC?
3. What is the proportion of very good, good, acceptable and poor discriminating items of 2021 Mathematics items of EESSTC?
4. What is the mean discriminating power of 2021 Mathematics items for EESSTC?

Methodology

The study employed descriptive survey design. The population of the study consisted of a total number of fourteen thousand six hundred and forty seven (14,647) responses of the test takers that sat for 2021 Mathematics EESSTC in Kano state. A sample of five hundred (500) from the examination were drawn using cluster proportionate to the size sampling technique. Raw scores of 30 Mathematics objectives items constructed, administered and scored by Science and Technical Schools Board (STSB) were formally collected by the researcher. The data were then transform in to binary scores (0&1). Correct answer '1' and wrong answer '0' with aid of excel. The item difficulty and discrimination power ability indices were carried out using Classical Test

Theory (CTT) Frame work with aid of excel. The difficulty and discrimination indices were expressed using simple percentages. The mean difficulty and mean discrimination index were obtained using SPSS.

Results

Research Question 1: What is the proportion of difficult, moderate and easy items of 2021 Mathematics items of EESSTC

Table 1. Summary of the Difficulty levels of 2021 SSTCEE Mathematics items

Item Range	Difficulty	Number of items (%)	Level of Difficulty
≤ 0.30		13 (43.33%)	Difficult
0.31≤70		16(53.33%)	Moderately difficult
> 0.70 Easy		1(3.33%)	Easy
Total		30(100)	

Source: (field survey, 2023)

The results of the difficulty levels for EESSTC 2021 Mathematics items showed that out of 30 items 13(43.33%) are difficult, 16(53.33%) are Moderately difficult and 1(3.33%) is Easy items. This showed that 16(53.33%) of the 30 items are ‘good’ (moderate difficult) while 14 items failed to satisfy the conditions ($0.31 \leq 70$). However, more items were found at moderate acceptable level of difficulty.

Research Question 2: What is the mean items difficulty index of 2021 Mathematics items of EESSTC?

Table 2: Mean Items Difficult Index of 2021 EESSTC 2021 Mathematics items

Exam Type	NO. of items	Mean	Std	Std Error Mean
SSTCEE	30	0.34	.16534	.03019

Source: (field survey, 2023)

The mean difficulty index for EESSTC is 0.34, standard deviation .16534 and standard error mean .03019. This signifies the test items achieved moderate difficult level ($0.31 \leq 70$).

Research Question 3 What is the proportion of very good, good, acceptable and poor discrimination items of 2021 Mathematics items of EESSTC

Table 3: Summary of the discrimination levels of 2021 EESSTC Mathematics items

Item Discrimination Range	Number of items (%)	Level of Discrimination
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0.40 and above	9(30%)	Very Good items
0.30 to 0.39	9(30%)	Good items
0.20 to 0.29	8(27%)	Acceptable items
-1.00 to 0.19	4(13%)	Poor items to be revised eliminated completely
Total	30(100)	

Source: (field survey, 2023)

Based on the discriminating power index criteria set by Bichi (2015) EESSTC 2021 Mathematics items indicated that, 9(30%) of the 30 items have very good discriminating power, 9(30%) are Good 8(27%) are acceptable and 4(13%) are poor items.

Research Question 4: What is the mean discriminating power of 2021 Mathematics items for BECE?

Table 4: Mean items discriminating power of 2021 EESSTC Mathematics items

Exam Type	NO. of items	Mean	Std	Std Error Mean
SSTCEE	30	0.32	.12467	.02276

Source: (field survey, 2023)

From the table4, the mean discriminating power index of 2021 Mathematics items for EESSTC is 0.32, standard deviation.12467, standard error mean .02276. This signifies that the test items are good (≥ 20).

Summary of findings

1. Out of 30 items of EESSTC 2021 Mathematics items 13(43.33%) are difficult, 16(53.33%) are moderately difficult and 1(3.33%) is Easy items.
2. The mean difficulty index of 2021 Mathematics items for EESSTC is 0.34 which signifies that the test items achieved moderate difficult level.
3. EESSTC 2021 Mathematics items indicated that 9(30%) of the 30 items have very good discriminating power, 9(30%) are Good 8(27%) are acceptable and 4(13%) are poor items
4. The mean item discriminating power of 2021 Mathematics items for EESSTC is 0.32 which signifies that the test items are good.

Discussion

The findings on the difficulty level showed that out of the 30 items for 2021 EESSTC ,13(43.33%) are difficult, 16(53.33%) are moderately difficult and 1(3.33%) is Easy items as shown by table 1. This signifies that 16(53.33%) of the items achieve acceptable difficulty level (moderate difficult $0.31 \leq 70$). This result agree with submissions of John et al. (2020), Juliate (2018), Ado, and Sa'ad (2020), Bichi (2015), Anigbo (2015) and Ugodulunwa and Barko (2015), Moyinoluwa (2015).

The result of the mean difficulty index of 2021 Mathematics items of EESSTC in Table 2 showed 0.34 which signifies that averagely the test items are difficult. This finding disagree with submission of Deborah et al,(2021). When the purpose of the test is to discriminate among those who take the test, it should have average item difficulty of approximately 0.50. (Abdullahi,2016). The result of this study contradicted with this statement. Since the purpose EESSTC is to measure the achievement of students and discriminate between those who take it for proper placement into Senior Secondary Schools, the items on the test should be in agreement with this submission.

Based on the discriminating power criteria, the findings of this study showed that 9(30%) of the 30 items have very good discrimination, 9(30%) are Good 8(27%) are acceptable and 4(13%) are poor items for EESSTC 2021 Mathematics items as shown by table 3. This signifies that 26(87%) of the items satisfied the condition (≥ 20) while, 4(13%) items failed to satisfy the condition. The finding agree with findings of John et al. (2020), Juliate (2018), Ado, and Sa'ad (2020), Bichi (2015), Anigbo (2015), Ugodulunwa and Barko (2015), Moyinoluwa (2015), Orluwene et al.(2017).The mean discriminating power of EESSTC 2021 Mathematics items in table 4 showed a value 0.32. This result agree with Deborah et al.(2021)

Conclusion

The study applied classical test theory model on 2021 Mathematics objectives items of Entrance Examination in to Senior Science and Technical Colleges in Kano State Nigeria. It was concluded that the items of the examination achieved acceptable difficulty levels and discriminating power abilities. The poor pass rate recorded in this examination is not attributed to the items characteristics(difficulty and discrimination power ability) other factors

associated with measuring instrument such as validity and reliability of the 2021 Mathematics examination need to be investigated.

Recommendations

1. Items that satisfied the criteria for both difficulty and discrimination index should be retained for future use by the items developers of EESSTC. Those items that failed to satisfy the condition of items selection should be revised. It is more economical to revise the items than eliminating them completely.
2. Services of tests and measurement expert should be employed by Science and Technical Schools Board (STSB) during items development process in order to improve the psychometric properties Mathematics items for the incoming years,

Reference

- Abdullahi,A.(2016). Classical Item Analysis of 2014 Post-unified tertiary matriculation Examination of Bayero University, Kano, Nigeria. [Unpublished PhD. Theses]. Bayero University Kano, Nigeria
- Ado, M.I and Sa'ad, N. (2020). Assessing psychometric properties of 2018 Mathematics Basic Education Certificate Examination (BECE) Multiple Choice Items in Funtua Education Zone Katsina State Nigeria. *FUDMA Journal of Educational Foundation (FUJEF) Vol.3. No.1* 30-42. Retrieved on 29/12/2021.
- Anigbo L. C (2015) Item Analysis of National Examination Council Senior School Certificate Examination Economics Objective Tests. *International Journal of Innovative Education Research.3 (4):23-30*, www.seahipaj.org ISSN: 2354-2942. Retrieved on 7/11/2021
- Babatunde, G.O (2019) Calibration of Osun State 2016 Multiple Choice Mathematics of Basic Education Certificate Examination Items Using Item Response Theory[Unpublished M.ed Theses]. Owolowo University Ile-Ife Nigeria.
- Bichi, A.A. (2015). Item Analysis using a Derived Science Achievement Test Data. *International Journal of Science and Research (IJSR) VO.4 Issue 5*. Pp1655-1661.Retrieved /08/2019

- Deborah,A.C. Temitope,B. & Peter,A.O.(2021). Comparism of item difficulty and discrimination of pre and post university entrance examinations in Nigeria. *The Universal Academic Research Journal3 (1)*.1-9.Retrieved on 12/04/2023
- John, S, Monica, E.A. and Galle, A.S(2020). Analysis of the Psychometric Properties of English Language West African Senior Schools Certificate Examination in Borno State, Nigeria. *World Journal of Innovative Research (WJIR) Vol 9, issue-6*. PP 1-7.Retrieved on 05/12/2020.
- Juliate,O.O. (2018) Psychometric Properties Analysis of Basic Education Certificate Examination Multiple Cchioce Test Items of 2013, 2014 and 2015 in Anambara State. *Nigeria. Journal of Languages and Linguistics and literary Studies (Jolis)*[Http://WWW.jolls. Com.ng](http://WWW.jolls.com.ng). ISSN2636-7149-6300. PP 153-160.On 13/11/2021
- Moyinoluwa, T.D. (2015). Analysing the psychometric properties of Mathematics in public Examination in Nigeria..*Research on Humanities and social science.Vol.5 No.7*. Pp 24-30 Retrieved on 01/09/2019.
- Orluwene, W.G, Bosede, N.J, and Kinanee, j. (2017). A comparative Study of item Characteristics of 2014-2016 Mathematics Objectives Tests in Junior Secondary School Certificate Examination Questions in Rivers State. *International Journal of Mathematics Trends and Technology (IJMTT) – Volume 52*. PP 544-550. Retrieved on 11/12/2020.
- Ugodulunwa, C.A. & Barko L. (2015). Analysis of Psychometric properties of Business Studies Secondary Certificate Examination in Plateau State, Nigeria. *Online International interdisciplinary Research journal*. Vol.(4) pp165-171.