ANALYSIS OF THINKING LEVELS IN WAEC MATHEMATICS MULTIPLE CHOICE ITEMS IN KATSINA STATE, NIGERIA

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Abstract

This study analyzed levels of thinking required in multiple choice mathematics items WAEC senior secondary school certificate in Katsina State, Nigeria. The study was guided by three (3) objectives, three (3) research questions and three (3) hypotheses. The study adopted survey research design. The population of the study consists of all the three hundred (300) multiple choice WAEC Mathematics test items of 2017-2019 (past Questions) written by senior secondary school three students in Nigeria. The sample of the study consist of three hundred (300) WAEC Mathematics multiple-choice items. Proforma was used to indicate the levels of thinking by WAEC Senior Secondary School Certificate in Multiple Choice Mathematics Items from 2017-2022 in Katsina State, Nigeria. All hypotheses were tested at 0.05 alpha levels of significance. Findings of the study revealed that, 36% of WAEC Mathematics 2017 multiple choice (MC) items required students to think at applying level in 2017, 56% of WAEC Mathematics 2018 MC items required students to think at understanding level, 38% of WAEC Mathematics 2019. In addition, the findings revealed that, there is significant difference in the thinking level required by 2017 and 2018 ($X2= 7.82$; $df = 5$; p-value < 0.05), 2018 and 2019 ($X2= 6.32$; $df = 4$; p-value < 0.05) Therefore, low performance of students in WAEC Senior Secondary School Certificate Examination in Multiple Choice Mathematics Items in Nigeria may be traceable to WAEC's concentrating examination questions on the lower levels of thinking which may affect the students' critical thinking. Based on the findings, it was recommended that; WAEC should review Mathematics multiple-choice items to take care of higher and lower levels of thinking of students to help the high achievers find a challenge and also challenge low achiever to work harder towards success.

Keywords: levels of thinking, multiple choice, mathematics, items

Introduction

In the global pursuit of quality education, one critical component remains constant: assessment. Assessments serve not only as tools to measure student achievement but also as a mechanism to monitor the effectiveness of instructional strategies and curriculum implementation. In particular, standardized examinations like those administered by the West African Examinations Council (WAEC) are essential benchmarks used to evaluate student learning outcomes and determine readiness for higher education or entry into the workforce. Mathematics, being a core subject in the Nigerian education system, holds a central place in these evaluations. However, there is growing concern about the cognitive rigor and pedagogical alignment of these assessments—especially the multiple-choice items which constitute a significant portion of the WAEC examination structure (Osunde, 2019).

Multiple-choice tests are widely favored for their objectivity, efficiency in scoring, and coverage of broad curriculum content within limited time frames. However, one of their common criticisms

lies in their perceived overemphasis on rote learning and memorization. Critics argue that such tests rarely engage students in deeper cognitive processes such as analysis, evaluation, and creation—the higher levels of thinking identified in Bloom's Revised Taxonomy (Anderson & Krathwohl, 2001). This is especially problematic in the context of mathematics, a discipline that naturally lends itself to logical reasoning, analytical thinking, and problem-solving. If the assessment structure fails to challenge these higher-order skills, it may hinder students from acquiring the competencies needed to succeed in complex real-life scenarios (Olutola, 2015).

In recent years, national and international assessments have revealed a persistent trend of underachievement among Nigerian students in mathematics. Studies by educational evaluators (e.g., Ugodulunwa, 2018; Osiesi, 2023) have linked this trend to weak cognitive engagement in classroom assessments and external examinations. WAEC, as a major examination body in West Africa, has a duty to ensure that its items are representative of various levels of cognition. This responsibility is particularly important considering the foundational nature of mathematics and its influence on students' access to science and technology-related fields in higher education.

Moreover, in an era characterized by rapid scientific advancement, global competitiveness, and the push for STEM (Science, Technology, Engineering, and Mathematics) development in Africa, it becomes imperative that educational assessments do not merely test for knowledge recall. Rather, they must serve as platforms to cultivate and evaluate students' higher-order thinking abilities. The current structure and focus of WAEC multiple-choice items must therefore be critically examined to ascertain whether they align with this educational imperative (Zhou, Lin & Chan, 2022).

In Katsina State, as in other parts of Nigeria, students face significant challenges in mathematics performance, as reflected in annual WAEC results. These challenges may be attributed, in part, to the structure and cognitive demand of the questions posed in the examinations. If most items test only basic comprehension and memorization, students are neither prepared nor motivated to develop deeper cognitive abilities. This raises an essential research concern: To what extent do WAEC multiple-choice mathematics questions reflect a balanced distribution of cognitive levels as proposed in Bloom's taxonomy (Anderson & Krathwohl, 2001)?

This study thus investigates the levels of thinking required in WAEC mathematics multiple-choice items administered in Katsina State between 2017 and 2022. It seeks to identify trends, variations, and possible gaps in the distribution of items across lower- and higher-order thinking levels. The goal is to provide empirical data that can inform better practices in item development and curriculum alignment, ensuring that assessments contribute meaningfully to educational quality and learner development.

Concept of Assessment

Assessment in education refers to the process of collecting, analyzing, and interpreting information to determine the extent to which learners achieve educational goals. It encompasses a wide range of techniques, including tests, projects, observations, and portfolios, aimed at measuring student performance in cognitive, affective, and psychomotor domains. In standardized testing, especially high-stakes examinations such as those conducted by WAEC, the primary focus has historically been on cognitive outcomes.

Concept of Mathematics

Mathematics is a fundamental core subject that holds a vital and unique role in society and represents a strategic cornerstone in human development. Hom and Gordon (2021) describe mathematics as the foundation of daily life, influencing everything from mobile technology and architecture to engineering, finance, and art. It is the science concerned with the logic of shape, quantity, and arrangement.

Historically, mathematics held a prestigious status, and the term "mathematician" was exclusively attributed to individuals with profound analytical skills capable of solving complex problems. It served as the backbone of philosophical, theoretical, and practical reasoning. However, with the advancement of scientific disciplines and the proliferation of technological applications, the term "mathematician" became more broadly applied, often encompassing individuals with varying levels of proficiency. This democratization has, in some cases, diminished the perception of depth and rigor once associated with the field (Mateausz, 2024).

Statement of the Problem

The persistent failure of students in mathematics examinations, particularly external assessments like NECO, WAEC, and NABTEB, is a significant concern for all stakeholders in education. This failure is particularly alarming given the fundamental importance of mathematics in daily life and its crucial role in accessing post-secondary education in Nigeria, where a credit pass in SSCE mathematics is a mandatory requirement for admission into universities, polytechnics, and colleges of education.

Data from National Bureau of Statistics (NBS) (2019) and chief examiner's report, showed the result of Senior Secondary School Certificate Examination (SSCE) (WAEC) from 2016- 2019 in the thirty-six (36) states plus Abuja, the federal capital territory. It showed that from 2016 to 2019, 52.3% (2016), 56.5% (2017), 33.8% (2018), 64.18% (2019) of candidates had five (5) credits passes including Mathematics in West Africa Senior Secondary Certificate Examination (WASSCE). Though these figures showed that decline in the achievement is most obvious in 2018 (33.8%) and can be said to be at average in 2016, 2017 and 2019. It still showed that 40% to 50% of Senior Secondary School Students repeat classes each year. There are lots of factors that could be contributory to this poor or fluctuating trend in the students' academic performance, ranging from students' learning skills, students' motivation and readiness, parental background, peer influence, teachers' quality, learning resources, poor implementation of the curriculum poor items construction in objectives test and so on University of Nigeria Azor and Ene (2024).

Objectives of the Study

The main objective of this study is to analyzed levels of thinking required in multiple choice mathematics items WAEC senior secondary school certificate in Katsina State, Nigeria. Specifically, the study sought to:

1. find out the levels of thinking required in 2017 WAEC Mathematics multiple choice items in Katsina State, Nigeria;
2. examine the levels of thinking required in2018WAEC SSCE Mathematics multiple choice items in Katsina State, Nigeria;
3. ascertain the levels of thinking required in2019WAEC Mathematics multiple choice items in

Katsina State, Nigeria;

Research Questions

The following questions were asked in the study.

1. At what thinking levels are the 2017 WAEC Mathematics multiple choice items in Katsina State, Nigeria?
2. At what thinking levels are the 2018 WAEC SSCE Mathematics multiple choice items in Katsina State, Nigeria?
3. At what thinking levels are the 2019 WAEC Mathematics multiple choice items in Katsina State, Nigeria?

Hypotheses

The following null hypotheses were formulated for the study:

$H0_1$: There is no significant difference in the thinking level required by 2017 and 2018WAEC Mathematics Multiple Choice Items in Katsina State, Nigeria.

$H0_2$: There is no significant difference in the thinking level required by 2018 and 2019 WAEC Mathematics Multiple Choice Items in Katsina State, Nigeria.

$H0_3$: There is no significant difference in the thinking level required by 2019 and 2020 WAEC Mathematics Multiple Choice Items in Katsina State, Nigeria.

Methodology

The study adopted a descriptive survey research design to analyze the cognitive levels of WAEC mathematics multiple-choice items. This design was chosen due to its effectiveness in providing an objective overview of item characteristics based on systematic observation and classification. The research focused on past WAEC mathematics question papers administered in Katsina State between 2017 and 2022, reflecting a six-year trend in item construction and cognitive engagement.

The population of the study comprised all multiple-choice mathematics questions from the WAEC SSCE examinations for the selected years. These items were obtained through school archives, official WAEC booklets, and examination preparation materials commonly used by teachers and students in the region. A total of 300 items (50 per year) were examined using a complete enumeration method, ensuring that no item was excluded.

Data were collected through a validated coding proforma based on Bloom's Revised Taxonomy. Each item was carefully reviewed and independently classified by two experienced mathematics educators who had been trained in cognitive level identification. Items were categorized into one of six thinking levels: remembering, understanding, applying, analyzing, evaluating, and creating. Where there was disagreement between raters, a third expert was consulted to reach consensus. This inter-rater agreement approach enhanced the reliability of the categorization process.

Descriptive statistics (frequency and percentages) were used to present the distribution of items across cognitive levels. To test the research hypotheses, the Chi-square test of independence was employed to assess whether there were significant differences in the distribution of cognitive levels across selected years. This inferential approach allowed the researcher to determine if any observed variation in thinking levels was due to random chance or underlying patterns in item

construction. The significance level was set at 0.05 for all statistical tests.

Data analysis was carried out using SPSS version 26. The results were interpreted in light of the study objectives and compared with findings from relevant literature to validate consistency and identify gaps. Ethical considerations, such as confidentiality and academic integrity, were strictly adhered to throughout the research process.

Result

Research Question One: At what thinking levels are the 2017 WAEC Mathematics Multiple choice items in Katsina State, Nigeria?

Table 1: Frequency and Percentage of Thinking Levels of 2017 WAEC Mathematics Multiple choice items in Katsina State, Nigeria

Levels of Thinking	Frequency	Percentage
Remembering	6	12%
Understanding	16	32%
Applying	18	36%
Analyzing	3	6%
Evaluating	3	6%
Creating	4	8%
Total	50	100%

Table 2: Order of Thinking Required of 2017 Mathematics Multiple Choice Items in Katsina State, Nigeria

Order of Thinking	Frequency	Percentage (%)
Higher Order	10	20%
Lower Order	40	80%
Total	50	100%

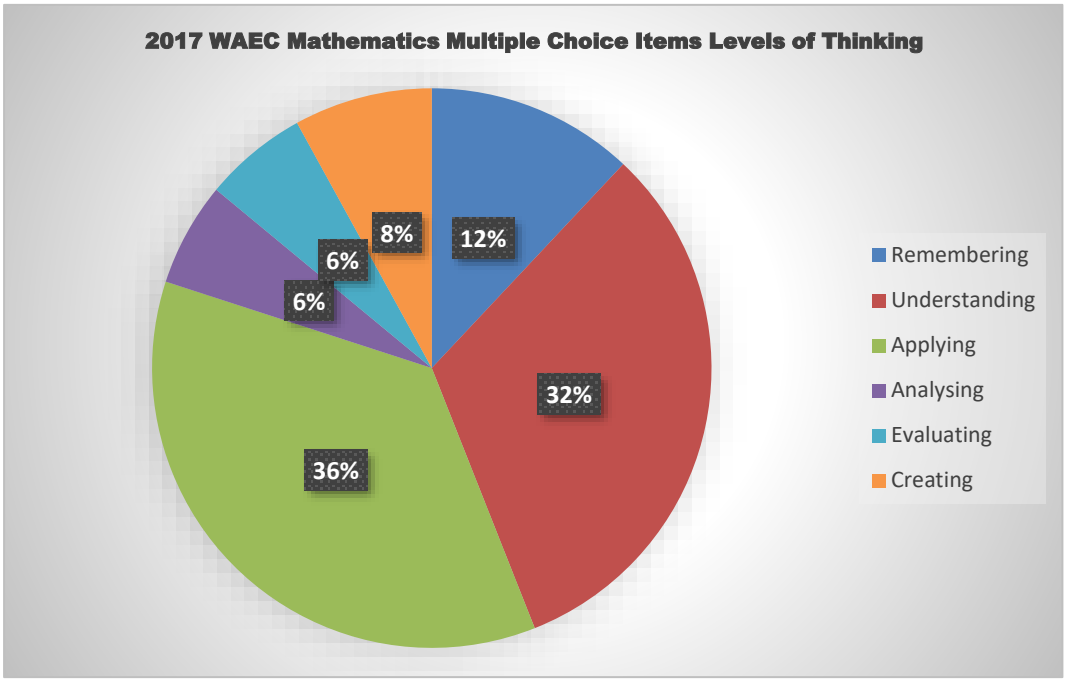

Figure 1: Pie Chart showing Thinking Levels of 2017 WAEC Mathematics Multiple choice items in Katsina State, Nigeria

Table 1, 2 and Figure 1 reveal the frequency and percentage of thinking levels required in WAEC2017Mathematics Multiple choice items, 6 (12%) of the items required students to think at remembering level, 16 (32%) required students to think at understanding level, 18 (36%) required students to think at applying level, 3 (6%) required students to independently think at analyzing and evaluating level and 4 (8%) required students to think at creating level. It implies that more items (36%) required students to think at applying level.

Research Question Two: At what thinking levels are the 2018WAECMathematics Multiple choice items in Katsina State, Nigeria?

Table 3: Frequency and Percentage of Thinking Levels of 2018 WAEC Mathematics Multiple choice items in Katsina State, Nigeria

Levels of Thinking	Frequency	Percentage
Remembering	4	8%
Understanding	28	56%
Applying	-	-
Analyzing	13	26%
Evaluating	2	4%
Creating	3	6%
Total	50	100%

Table 4: Order of Thinking Required of 2018 Mathematics Multiple Choice Items in Katsina State, Nigeria

Order of Thinking	Frequency	Percentage (%)
Higher Order	5	10%
Lower Order	45	90%
Total	50	100%

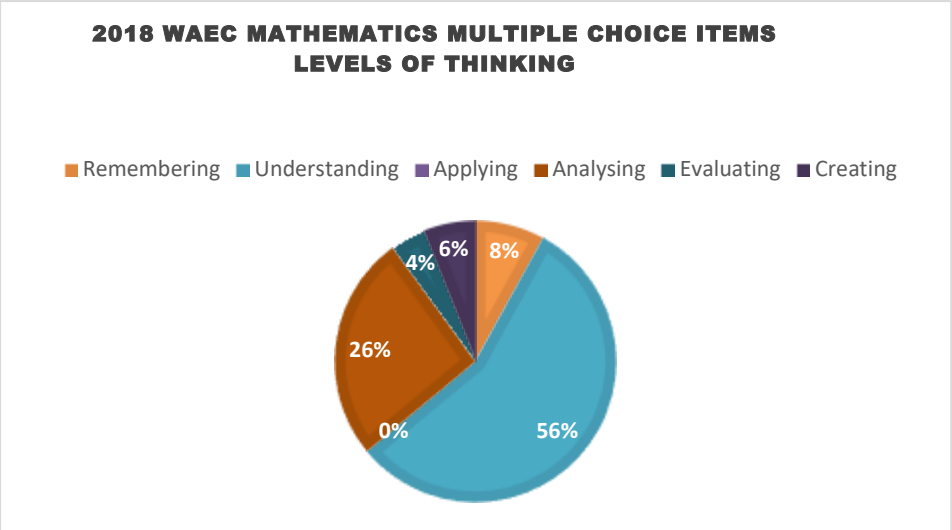

Figure 2: Pie Chart showing Thinking Levels of 2018WAEC Mathematics Multiple choice items in Katsina State, Nigeria.

Table 3,4 and Figure 2 reveal the frequency and percentage of thinking levels required in 2018WAECMathematics Multiple choice items, 4 (8%) of the items required students to think at remembering level, 28 (56%) required students to think at understanding level, none 0 (0%) of the items required students to think at applying level, 13 (26%) required students to think at analyzing level, 2 (4%) required students to think at evaluating level and 3 (6%) required students to think at creating level. It implies that more items (56%) of WAEC Mathematics 2018 required students to think at understanding level.

Research Question Three: At what thinking levels are the 2019WAECMathematics Multiple choice items in Katsina State, Nigeria?

Table 5: Frequency and Percentage of Thinking Levels of 2019WAECMathematics Multiple choice items in Katsina State, Nigeria

Levels of Thinking	Frequency	Percentage
Remembering	7	14%
Understanding	19	38%
Applying	12	24%
Analyzing	-	-
Evaluating	8	16%
Creating	4	8%
Total	50	100%

Table 6: Order of Thinking Required of 2019 Mathematics Multiple Choice Items in Katsina State, Nigeria

Order of Thinking	Frequency	Percentage (%)
Higher Order	12	24%
Lower Order	38	76%
Total	50	100%

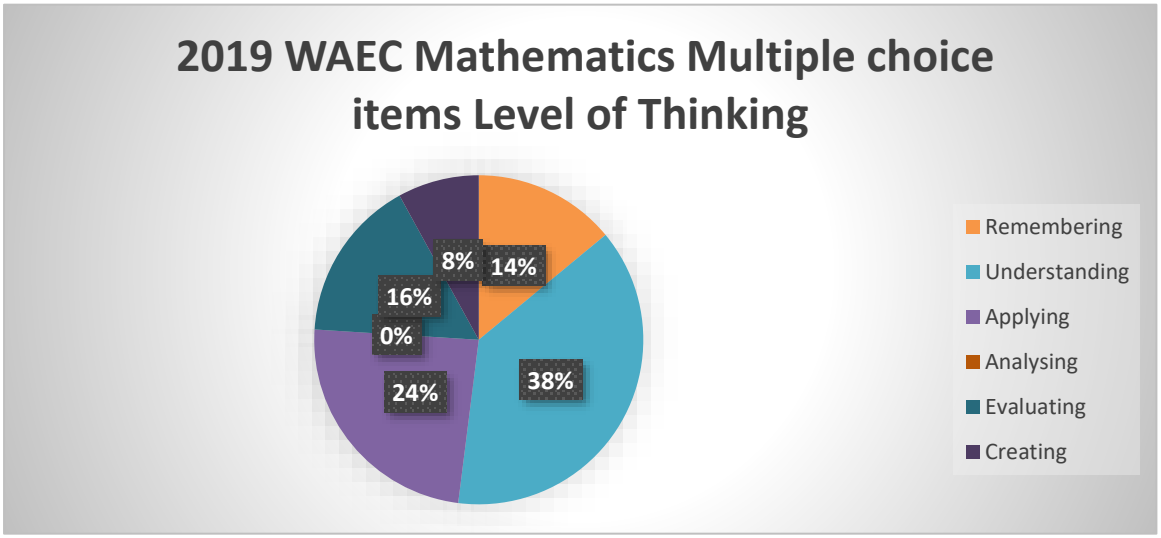

Figure 3: Pie Chart showing Thinking Levels of 2019WAECMathematics Multiple choice items in Katsina State, Nigeria

Table 5,6 and Figure 3 reveals the frequency and percentage of thinking levels required in 2019WAECMathematics Multiple choice items, 7 (14%) of the items required students to think at remembering level, 19 (38%) required students to think at understanding level, 12 (24%) of the items required students to think at applying level, none 0 (0%) required students to think at analyzing level, 8 (16%) required students to think at evaluating level and 4 (8%) required students to think at creating level. It implies that more items (38%) of WAEC Mathematics 2019 required students to think at understanding level.

Discussion

The findings from the study revealed a disproportionate concentration of WAEC mathematics multiple-choice items at the "understanding" and "applying" levels of Bloom's taxonomy. While these levels do indicate a modest depth of cognitive engagement beyond rote memorization, they still fall short of the analytical and creative demands expected in a subject like mathematics. This trend supports earlier assertions by scholars such as Ugodulunwa (2018) and Olutola (2015) who observed that Nigerian standardized tests tend to emphasize lower-order thinking skills.

The underrepresentation of higher-order thinking skills such as analyzing, evaluating, and creating poses serious pedagogical concerns. These cognitive levels are essential for developing problem-solving skills, logical reasoning, and decision-making abilities. In an increasingly complex and technological world, students need to move beyond basic understanding to become innovators, critical thinkers, and problem solvers (Zhou et al., 2022). The lack of such emphasis in national

assessments indicates a misalignment between educational objectives and assessment practices.

Furthermore, the statistically significant differences observed across the years (as shown by Chi-square tests) suggest inconsistencies in item development practices. This irregularity may stem from a lack of standardized guidelines for constructing cognitively balanced test items (Osunde, 2019). If examination bodies such as WAEC continue to vary the thinking levels required from year to year, it becomes difficult for teachers to align instruction and for students to adequately prepare for higher-order tasks.

This inconsistency also raises questions about equity and fairness in assessment. Students who face exams rich in higher-order items may find them more challenging if their prior preparation has been limited to lower-order tasks. Conversely, students who sit for easier papers may be less prepared for future academic challenges, particularly in post-secondary institutions where critical thinking is paramount.

In light of these findings, it is clear that national examination bodies must take deliberate steps to integrate higher-order cognitive demands into test blueprints. Training item writers, adopting Bloom's taxonomy during test construction, and implementing validation procedures can help ensure a more balanced and fair assessment structure (Anderson & Krathwohl, 2001). Only then can standardized tests in Nigeria fulfill their purpose as tools for meaningful learning and intellectual growth.

Conclusion

The study investigated the levels of thinking required in WAEC mathematics multiple-choice items within Katsina State from 2017 to 2019. The findings have shown that a majority of the items tested only lower-order thinking skills such as understanding and applying, with very limited representation of higher-order cognitive demands like analyzing, evaluating, and creating. This unbalanced distribution suggests a systemic underutilization of the full cognitive spectrum recommended by Bloom's Revised Taxonomy.

The implications of these findings are significant. When national assessments fail to challenge students beyond basic recall and comprehension, they inadvertently promote shallow learning, reduce opportunities for critical thinking, and limit the development of real-world problem-solving skills. Furthermore, the year-to-year inconsistencies in the distribution of cognitive levels highlight a lack of uniform assessment standards within WAEC item construction, which may negatively affect curriculum alignment, teacher instruction, and student preparedness.

Therefore, it is concluded that without deliberate reforms, the cognitive demands of WAEC mathematics multiple-choice items may continue to underprepare students for the intellectual challenges of higher education and future careers—especially in STEM-related fields where analytical skills are indispensable.

Recommendations

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

1. Teachers should deliberately include higher levels of thinking skills in their daily lesson plan and class activities to acquaint students with the critical thinking skills.
2. Government through the ministry of education should organize seminar and workshops to teachers

to improve their skills of teaching

3. Curriculum experts should do their best to include higher levels of thinking skills into school curriculums at all levels.
4. WAEC should balance their mode of items that will take care of all the examinees level of performances (higher and lower levels of thinking).

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