



Performance Evaluation of Senior Secondary School Students' Mock Examination Questions in Chemistry in Adamawa State, Nigeria

Maryamu Buba Atari^{1*}, Joseph Maundis Bika² and Stephen Tizhe Kojigili³

¹GGDSS Wajah, Hong Local Government Area Adamawa State, Nigeria.

²GDSSS Shangui Hong Local Government Area Adamawa State, Nigeria.

³Department of Educational Foundations, Adamawa State University Mubi, Nigeria.

Authors' contributions

This work was carried out in collaboration between the authors. Author MBA designed the study, managed the methodology aspect of the study and wrote the first draft of the manuscript. Author JMB performed the statistical analysis, discussed the findings, conclusion and recommendations. Authors MBA and STK managed the literature searches. Author STK finally edited the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

The study examined the content validity of Chemistry MOCK examination questions for senior secondary school students set by Adamawa State Educational Resource Centre (ERC), Yola. Students have been passing the MOCK examinations but unfortunately performance poorly in the subject in their final year external examination like WAEC in Adamawa State. The main objective of the study was to determine the representativeness of the topics in the senior secondary school Chemistry curriculum in the MOCK examination question papers from 2015 to 2019. Three research questions were raised and two research hypotheses formulated. An ex-post facto research design was used for the study. The population of the study comprised all MOCK examination questions in Chemistry and those involved in handling Chemistry MOCK question papers which includes both essay and objective examination questions. The research instrument

*Corresponding author: Email: maryamububa123@gmail.com;

used for the study was MOCK examination question papers in Chemistry in order to determine whether the contents are as indicated in Chemistry curriculum for senior secondary schools. The validity of the instrument was determined by some experts. And for the reliability of the instrument, a trial-test was conducted where a reliability index of 0.75 was obtained using Cronbach alpha. The research questions were answered using descriptive statistics while the null hypotheses were tested using Chi-square. The findings of study revealed that the content validity of the chemistry MOCK examination questions has not yet improved in order to prepare the students of senior secondary schools in Adamawa state for WAEC, NECO or NABTEB examinations.

Keywords: Content validity; senior secondary school; mock examination questions; chemistry; performance objectives; curriculum and cognitive domain.

1. INTRODUCTION

The importance of secondary education in an educational system cannot be over-emphasized. Apart from serving as a link between primary and tertiary education, secondary school education provides opportunity for a child to acquire additional knowledge, skills and desirable attitudes after the primary education level. Secondary education is for providing children with knowledge; skills, attitudes and ability that can enable them acquire tertiary education. In other words, secondary education is meant for developing a child for better education beyond the primary education level and for acquisition of better knowledge for literacy, numeracy and communication skills [1]. Senior secondary education is the third level in the Nigerian system of education. It is designed for children from age 14 years and above. Nine subjects are administered at the MOCK examination level and a senior secondary student is expected to sit for a minimum of 8 subjects and maximum of 9 subjects. Science students are expected to pass the MOCK at credit level with Mathematics, English Language, Biology, Chemistry and Physics as pre-requisite to register and sit for WAEC, NECO and NABTEB examinations. This is also similar for arts, vocational, business and technical students.

Examination in Nigerian schools dates back to the advent of formal education and has always been an integral part of educational system since its inception. Since then, examinations have always been at the centre of what occurs in the classroom setting. The Federal Republic of Nigeria [2] through the National Policy on Education (NPE) adopted six-year duration for secondary education given in two stages that is the junior secondary school and senior secondary school respectively. Students are expected to spend three years each at the junior secondary school and senior secondary school. These two levels of secondary school education

in Adamawa state have different examination bodies conducting certification examination for junior secondary school three (JSS3) students and senior secondary school three (SSS3) students. In order to improve the standard of education at senior secondary school level, Mock Examination was introduced in 1992 and the name changed from MOCK to qualifying examination in 2003 and the name was changed again to MOCK in 2009 in Adamawa State to prepare SS II students to pass their final year national and international examinations like West African Senior School Certificate Examination (WASSCE), National Examination Council (NECO) and National Business and Technical Examination Board (NABTEB). It was on that basis that Adamawa State government launched the programme in order to improve their students' performance at senior secondary school level.

Assessment of learning outcomes by using questions to assess students' academic performance is one of the basic issues in educational system of Adamawa State. Tests, such as teacher made-test and the MOCK questions are usually used to measure how well students understand Chemistry at the senior secondary school level. Chemistry is one of the compulsory subjects for all science students in senior secondary schools in Nigeria. As a subject, it is one of the pre-requisite for admission into Nigerian institutions of higher learning to study any of the science and science related courses like Medicine, Pharmacy, Micro-Biology, Biochemistry, Zoology, Botany, Human Anatomy, Hydrobiology, Biotechnology and other Applied Science courses. Hence, it is necessary to look at the content validity of the MOCK examination Chemistry test items in Adamawa state so as to help the examiners construct test or examination with valid contents that would improve students' understanding of the test items and consequently their performance as well as to expose the students to the nature of questions

expected in all other external examinations. Just like [1] asserted, learning is content bound and effective evaluation involves developing questions from the curriculum used for a particular level of students, that if teachers are ignorant of their disciplines and impact wrong information, they are not only useless but dangerous. Lack of knowledge of a particular concept and negligence to teach because of personal reasons may be the reasons why contents in schools are not covered, hence leading to students' poor performance in examinations. This is because a content valid test items should cover the topics skipped by the teacher and the students may not visit the topics during their personal study. Some of the factors to be considered in judging the quality of a good test are relevance, fairness, efficiency, objectivity, specificity, discrimination index, reliability, speediness and validity [3]. Validity is the degree to which a test items measure what it intends to measure accurately. Hence, validity of a test depends on the content and purpose, meaning a test which is valid for one purpose may not be valid for another [4]. Also, [1] stressed that content validity is the extent to which questions consist of a representative sample of subject matter and objectives the question is designed to measure. It is very important that examination questions make a fair coverage of the subject matter contents because if few areas of the subject matter are consistently emphasized by the questions designed, students may not discover their ability, capability, skills and knowledge over a given few testing period by the examiners and consequently study only these areas for examination sake, while the other areas not tested may be neglected.

Other causes of students' poor performance in examination might be the presence of bias in the questions and this contributes to poor representation of the questions, thus, threatening the content validity of such examination. Where this happens, the questions will be measuring attributes that are not necessary or relevant to the construct being measured by the examination. According to [5], test item arrangement plays a vital role in determining the performance of students in examinations. Test item arrangement based on particular order of difficulty arrangement (descending order of difficulty) has negative effect on students' performance among secondary school students. Similarly [6], in a study carried out in Akwa Ibom state, reported that majority of the questions designed by WAEC examiners test lower levels

of the cognitive domain, which might be responsible for the poor performance of students in Chemistry May/June WAEC examinations in Nigeria. To ensure adequate coverage [7], suggested that a test blueprint be used as it assists in developing a well-balanced question in terms of appropriate coverage of component behaviours of the objectives in question, for the questions to have fair coverage of the content and the behavioural objectives it purport to measure.

Ale and Omodara [8] Also conducted a study on predictive validity of MOCK examination for academic Performance in Senior Secondary Certificate Examination in Ekiti-State, Nigeria and the result revealed that the correlation between MOCK examination and Senior Secondary Certificate Examination were significant for three subjects (Yoruba, Economics and Biology) out of the five subjects selected for the research. [9] Conducted a study on predictive validity of English language and Mathematics Mock examination results of Senior Secondary School Students' performance in WASSCE in Ekiti State, Nigeria and the result revealed that Mock examination has a low content validity. Also [10], conducted a study on factors attributing to students' poor performance in Lesotho, South Africa to determine factors attributing to students' poor performance and found out that poor performance of learners in Lesotho was attributed to various factors including teachers' qualification, attitudes of students' towards study and lack of coverage of the curriculum by the teachers. [11] Conducted a study on analysis of written examination papers of undergraduate Anatomy. The study revealed that different subdivisions of Anatomy are not given proper weightage in the Anatomy written examination. On the other hand [12], carried out a study on content validity of independently constructed curriculum-based examinations in Malawi. The findings showed that Malawi School Certificate of Education curriculum was a well-defined operational universe of admissible observations because independently constructed test equivalently tapped the same content. That means, there was inadequacy in the rating of the cognitive levels because the questions emphasized the high levels of cognition than the lower levels.

Furthermore [6], in their study assessed the content validity of May/June WASSCE questions in Chemistry from 1999 to 2002 in Akwa Ibom State, Nigeria and they found out that some

topics were over-emphasised, under-emphasised or totally ignored and the questions emphasized lower cognitive domain levels as knowledge, comprehension and application. Again [13], carried out a study on content coverage and students' achievement in senior secondary School Physics in Delta state, Nigeria and the study revealed that there was significant difference between Ministry Made Test (MMT) and Teacher-Made Test (TMT). On the contrary [14], conducted a study on determining reliability and content validity of mathematics tests conducted by senior secondary school mathematics teachers in Edo state, Nigeria and the results indicated that the tests have moderate internal consistency reliability and low in content validity. [15] Carried out a study on content validity of the West African Senior School Certificate Examination (WASSCE) questions in Biology. The findings indicated that the WAEC (May/June) Biology has a low content validity which may be as a result of the examiners over-emphasized some cognitive levels while others are under-emphasized and some are totally ignored by the examiners, hence leading to students' poor performance.

1.1 Statement of the Problem

In Adamawa State, the MOCK examination is conducted by Adamawa State Ministry of Education (MOE) for both public and private senior secondary schools in the state. Educational Resource Centre (ERC) under the directive of the state ministry of education construct questions and conduct the examinations, mark the scripts, grade them and award certificates to the examinees under their jurisdiction. In the construction of the questions, they usually request secondary school teachers of various subjects to set questions and send them to the ERC. From the preliminary survey of past question papers by the Inspectors of Science's annual reports, some questions are repeated many times in one question paper, some with wrong spellings and with some options missing or left out blank. It may be that, many of the teachers been used from various schools to set these questions do not have the requisite knowledge to construct valid questions covering the entire levels of the cognitive domain with adequate representation of topics in the curriculum. These could be responsible for students' poor performance in MOCK examinations in the state [16]. In such situations, such questions may not groom students for national and even external examinations like,

NECO, NABTEB and WASSCE. Also, this may explain why academic performances of students in chemistry at SSCE have been poor particularly in Adamawa state. In the state for example, from the survey of the past results, about 57% of senior secondary school students' performed below average. Hence, the academic performance of students' in chemistry in Adamawa State has been deteriorating. At state level, the trends of the rate of low performance percentage pass were as follows: 39% in 2015; 40.6% in 2016; 30% in 2017; 28% in 2018 and 20.1% in 2019. Thus, this situation is not progressive to the state and students' at large. Therefore, there is need for search for the solution to students' poor performance and get the way forward.

From the researchers' review of literature, a number of study have been carried out on content validity of some subjects offered in senior secondary school levels but there is no study conducted in Adamawa State to examine content validity of MOCK questions set by ERC. Hence, there is need to conduct a research on content validity of the MOCK questions in Chemistry in Adamawa State.

The main purpose of this study therefore is to validate the content of Chemistry questions set for MOCK examination in Adamawa state, Nigeria. Specifically, the objectives of the study are to determine:

1. The representativeness of the topics in the senior secondary school Chemistry curriculum in the MOCK examination questions from 2015 to 2019.
2. The performance objectives stated in the Chemistry curriculum to the various levels of the cognitive domain.
3. The various levels of the cognitive domain in the MOCK examination Chemistry questions from 2015 to 2019.

The following research questions were raised to guide the study:

1. What percentages of the topics in the Chemistry curriculum were covered in the MOCK examination questions from 2015 to 2019?
2. How are the performance objectives that are stated in the Chemistry curriculum assigned to the various levels of the cognitive domain?
3. What are the spread of MOCK examination chemistry questions along the various

levels of the cognitive domain in percentages from 2015 to 2019?

The following hypotheses were formulated and tested at 0.05 level of significance:

H0₁. There is no significant difference between Chemistry topics in the curriculum and the questions assigned to them in the MOCK examination questions in the years 2015 to 2019.

H0₂. There is no significant difference between the weightage assigned to the various levels of the cognitive domain in the senior secondary school Chemistry curriculum and those assigned to them in the MOCK examination questions.

2. METHODOLOGY

This study employed document research design. The population of the study is 11 question papers, consisting of all past Chemistry MOCK examination question papers of Adamawa state from 2009 to 2019. Purposive sampling technique was used for the study; where a sample of five MOCK examination Chemistry question papers from 2015 to 2019 were selected. This was because only the most recent MOCK examination question papers in Chemistry (from 2015 to 2019) were selected to ensure recency in coverage over time. The instrument used for data collection was MOCK examination question papers in Chemistry from 2015 to 2019 and the instrument was validated by an expert in Tests and Measurement and experienced Chemistry teachers. A pilot test was carried out where some Chemistry MOCK examination question papers were given to some teachers in two senior secondary schools to rate the questions based on the levels of representativeness of the cognitive domain of the topics covered. The reliability of the instrument was established using Pearson Product Moment correlation coefficient through SPSS, which yielded value of 0.76.

The researchers obtained all the topics expected to be examined in MOCK examinations from the Chemistry curriculum for senior secondary school. The actual topics tested in Chemistry MOCK examination over the five years were also obtained from Adamawa State MOCK examination question papers in Chemistry from 2015 to 2019. For each year, there was one paper comprising objective and essay questions for the MOCK examination in Chemistry. The total number of questions set for each topic of

the Chemistry curriculum was determined and this became the observed weight of the topics tested by Adamawa state MOCK examinations in Chemistry. The cognitive levels as outlined in Bloom's taxonomy of educational objective were used in classifying the performance objectives stated in the Chemistry curriculum for senior secondary schools. Classification was also used along table of specification for all the questions used in the study. The total number of each cognitive level of the classified performance objectives in the curriculum was calculated. The number of objectives for a particular level was analysed using percentages. Research questions 1, 2 and 3 were answered using percentages while hypotheses 1 and 2 were tested using Chi-square at 0.05 level of significance.

3. RESULTS AND DISCUSSION

The results of the data analyses are presented as below in the following tables.

Research Question 1: What is the percentage of each topic in the Chemistry curriculum that is assigned to the MOCK examination questions from 2015 to 2019?

Table 1 presents the results of the analysis of Chemistry Mock examination questions with respect to topics from which the questions were set from 2015 to 2019. When these results are arranged in descending order of their percentages for 2015, quantitative and qualitative come first with 12.61%; metals and their compounds and organic chemistry occupy second position with 9.01% each. While separation techniques and periodic table are third having 8.11% each; gas laws, chemical reactions and hydrocarbon become forth with 7.20%. The fifth is chemical industries which has 4.50%. Others that follow are chemical combinations, water, non-metals and their compounds and electrolysis (3.60%) each. Next are particulate nature of matter; acids, bases and salts and oxidation-reduction reactions (2.70%). 1.80% goes to carbon and its compounds as well as mass-volume relationship. The least percentage of 0.90 belongs to petroleum. The total percentage of topics considered in setting chemistry mock examination questions in year 2015 is 86%. The topics symbols, formulae and equations, air, ethical, social and legal issues in chemistry were not considered.

For 2016, presenting the percentage of how each topic was assigned question gives: hydrocarbon

compounds (11.76%) each > Gas laws (10.29%) > particulate nature of matter and metals and their compounds (8.82%) each > acids, bases and salts, carbon and its compounds and periodic table (7.35%) each > chemical reactions, non-metals and their compounds and quantitative and qualitative analysis (5.88%) each > Organic chemistry (4.41%) > chemical combinations, air and chemical industries (2.94%) each > separation techniques, water, mass-volume relationship and electrolysis (1.47 % each). This means that total of 82% of the topics were used in setting the mock questions. No question(s) from symbols, formulae and equations, oxidation-reduction reactions, petroleum and ethical, social and legal issues in chemistry. In 2017 from the same Table 1, when the topics and their percentages are ordered from highest to the lowest, it looks as following: Particulate nature of matter (18.87%); acids, bases and salts (10.38%); gas laws (7.55%); chemical reaction and petroleum (5.66% each); carbon and its compounds and non-metals and their compounds (4.72% each); quantitative and qualitative analysis, water and hydrocarbon compounds (3.77% each); chemical combination and oxidation-reduction reactions (2.83% each); separation techniques, electrolysis and metals and their compounds (1.89% each); periodic table, mass-volume, air, organic chemistry and chemical industries (0.94% each). The overall percentage of topics utilized in the setting the questions in the year is 91%. No question(s) from symbols, formulae and equations as well as ethical, social and legal issues in chemistry.

From 2018 chemistry mock questions, the percentage of questions of each topic listed in decreasing order of the percentage commences with periodic table (17.72%); followed by particulate nature of matter (16.46%); next is acids, bases and salts (12.66%); then separation techniques and chemical reaction (6.33%); others are oxidation-reduction reactions (5.06%); chemical combination, water and carbon and its compounds (4.00% each); quantitative and qualitative analysis (3.80%) and the last are symbols, formulae and equations, non-metals and their compounds as well as ethical, social and legal issues in chemistry (2.53%). Only 77% of the topics in the curriculum were used in the year. Some topics such as air, electrolysis, hydrocarbon compounds, petroleum and chemical industries were not inclusive in the questions. Also, from Table 1 for 2019 chemistry mock questions, ordering the percentages of the topics considered descending order gives:

periodic table (15.49%); acids, bases and salts (11.27%); gas laws and quantitative and qualitative analysis (9.86%); particulate nature of matter and organic chemistry (8.45% each); chemical combination (7.04%); water, mass-volume relationship, oxidation-reduction reactions, electrolysis, metals and their compounds (4.23% each); chemical reaction and hydrocarbon compounds (2.82% each); separation techniques, air and petroleum (1.41% each). Total percentage of topics used in 2019 chemistry mock questions is 77%. Other topics which include symbols, formulae and equations, carbon and its compounds, non-metals and their compounds, ethical, social and legal issues in chemistry and chemical industries were not used for questions in this year.

Research Question 2: How are the performance objectives stated in the Chemistry curriculum assigned to the various levels of the cognitive domain?

From Table 2, the cognitive level that has the highest percentage of performance objective is comprehension (29.25%), this is followed by Knowledge (17.90%). Next to these are evaluation (17.03%), synthesis (14.35%) and application (12.66%). Analysis has the least percentage of only 8.30%

Research Question Three 3: How are the 2015 to 2019 MOCK examination chemistry questions spread along the various levels of the cognitive domain in percentages?

Table 3 reveals that for the year 2015 Chemistry Mock Examination questions, comprehension has the highest percentage (34.23%). Next to comprehension is knowledge (27.93%), followed by analysis (13.51%). Application is next to analysis (9.00%) Evaluation is next with 8.10%. Synthesis has the least percentage of 7.21%. The 2016 questions percentage spread across the cognitive level when ordered in descending gives: comprehension (31.34%) > Knowledge (28.36%) > Application (17.91%) > Analysis (11.94%) > Synthesis (5.97%) > Evaluation (4.48%). Chemistry Mock Examination questions used for 2017 on the other hand arranged in decreasing order shows that Knowledge (37.74%) > Comprehension (22.64%) > Evaluation (17.92) > Synthesis (10.32) > Analysis (7.55%) > Application (3.77%). Just as in 2017; in 2018, Knowledge tops with 37.97%. It is followed by comprehension (32.91%). However, next to comprehension here is

Table 1. Percentage of Chemistry Topics in the Curriculum as Assigned to the MOCK Examination Questions from 2015 to 2019

Topics	2015(%)	2016(%)	2017(%)	2018(%)	2019(%)
1. Particulate nature of matter (PNM)	3(2.70)	6(8.82)	20(18.87)	13(16.46)	6(8.45)
2. Symbols, formulae and equations (SFE)	0(0.00)	0(0.00)	0(0.00)	2(2.53)	0(0.00)
3. Chemical combinations(CCM)	4(3.60)	2(2.94)	3(2.83)	3(4.00)	5(7.04)
4. Gas laws (GL)	8(7.20)	7(10.29)	8(7.55)	7(8.86)	7(9.86)
5. Separation techniques (ST)	9(8.11)	1(1.47)	2(1.89)	5(6.33)	1(1.41)
6. Acids, base and salts (ABS)	3(2.10)	5(7.35)	11(10.38)	10(12.66)	8(11.27)
7. Water (W)	4(3.60)	1(1.47)	4(3.77)	3(4.00)	3(4.23)
8. Carbon and its compound(CCP)	2(1.80)	5(7.35)	5(4.72)	3(4.00)	0(0.00)
9. Periodic table (PT)	9(8.11)	5(7.35)	17(16.04)	14(17.72)	11(15.49)
10. Chemical reaction (CR)	8(7.20)	4(5.88)	6(5.66)	5(6.33)	2(2.82)
11. Mass volume relationship(MVR)	2(1.80)	1(1.47)	1(0.94)	1(1.27)	3(4.23)
12. Air (A)	0(0.00)	2(2.94)	1(0.94)	0(0.00)	1(1.41)
13. Non-metals and their compounds (NMC)	4(3.60)	4(5.88)	5(4.72)	2(2.53)	0(0.00)
14. Oxidation-reduction (O-R)	3(2.70)	0(0.00)	3(2.83)	4(5.06)	3(4.23)
15. Electrolysis (E)	4(3.60)	1(1.47)	2(1.89)	0(0.00)	3(4.23)
16. Hydrocarbons (HC)	8(7.20)	8(11.76)	4(3.77)	0(0.00)	2(2.82)
17. Organic chemistry (OC)	10(9.01)	3(4.41)	1(0.94)	1(1.27)	6(8.45)
18. Qualitative and quantitative analysis (QQ)	14(12.61)	4(5.88)	4(3.77)	3(3.80)	7(9.86)
19. Petroleum/crude oil (PCO)	1(0.90)	0(0.00)	6(5.66)	0(0.00)	1(1.41)
20. Metals and their compounds (MC)	10(9.01)	6(8.82)	2(1.89)	1(1.27)	3(4.23)
21. Ethical, social and legal issues in chemistry (ESL)	0(0.00)	0(0.00)	0(0.00)	2(2.53)	0(0.00)
22. Chemical industries (CI)	5(4.50)	2(2.94)	1(0.94)	0(0.00)	0(0.00)
Total questions per year	111(99.97)	68(99.98)	106(99.88)	79(99.96)	71(99.99)
Total topics covered	19(86%)	18(82%)	20(91%)	17(77%)	17(77%)

Table 2. Summary of Spread Performance Objectives to Levels of Cognitive Domain

Topics	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Total
1. Particulate nature of matter	3(1.31)	1(0.44)	0(0.00)	0(0.44)	1(0.44)	2(0.87)	7
2. Symbols, formulae and equations	0(0.00)	2(0.87)	1(0.44)	1(0.44)	1(0.44)	1(0.44)	6
3. Chemical combinations	1(0.44)	3(1.31)	2(0.87)	1(0.44)	3(1.31)	4(1.75)	14
4. Gas laws	0(0.00)	2(0.87)	1(0.44)	0(0.00)	2(0.87)	2(0.87)	7
5. Separation techniques	0(0.00)	2(0.87)	1(0.44)	0(0.00)	1(0.44)	1(0.44)	5
6. Acids, base and salts	3(1.31)	4(1.75)	4(1.75)	2(0.87)	2(0.87)	1(0.44)	16
7. Water	4(1.75)	3(1.31)	2(0.87)	1(0.44)	2(0.87)	2(0.87)	14
8. Carbon and its compound	1(0.44)	4(1.75)	0(0.00)	0(0.00)	0(0.00)	2(0.87)	7
9. Periodic table	0(0.00)	0(0.00)	0(0.44)	11(0.4)	2(0.87)	2(0.87)	6
10. Chemical reaction	1(0.44)	1(0.44)	1(0.44)	1(0.44)	2(0.87)	2(0.87)	8
11. Mass volume relationship	0(0.00)	1(0.44)	0(0.00)	0(0.00)	0(0.00)	2(0.87)	3
12. Air	2(0.87)	1(0.44)	1(0.44)	0(0.00)	0(0.00)	0(0.00)	4
13. Non-metals and their compounds	6(2.62)	15(6.55)	2(0.87)	3(1.31)	5(2.18)	7(3.06)	38
14. Oxidation-reduction	4(1.75)	1(0.44)	0(0.00)	0(0.00)	2(0.87)	0(0.00)	7
15. Electrolysis	1(0.44)	3(1.31)	1(0.44)	0(0.00)	1(0.44)	3(1.31)	9
16. Hydrocarbons	2(0.87)	0(0.00)	1(0.87)	1(0.87)	2(0.87)	0(0.00)	6
17. Organic chemistry	3(1.31)	11(4.80)	4(1.75)	4(1.75)	5(2.18)	3(1.31)	30
18. Qualitative and quantitative analysis	0(0.00)	0(0.00)	3(1.31)	2(0.87)	0(0.00)	0(0.00)	5
19. Petroleum/crude oil	1(0.44)	1(0.44)	0(0.00)	2(0.87)	2(0.87)	3(1.31)	9
20. Metals and their compounds	8(3.49)	9(3.93)	3(1.31)	0(0.00)	0(0.00)	0(0.00)	20
21. Ethical, social & legal issues in chem.	1(0.44)	2(0.87)	1(0.44)	0(0.00)	0(0.00)	0(0.00)	4
22. Chemical industries	0(0.00)	1(0.44)	0(0.00)	0(0.00)	1(0.44)	2(0.87)	4
Total	41(17.0)	67(29.25)	29(12.6)	19(8.3)	34(14)	39(17.)	229(9)

Table 3. Percentage Spread of MOCK Examination Chemistry Questions to the Various Cognitive Domain Levels

Cognitive levels Years	2015(%)	2016(%)	2017(%)	2018(%)	2019(%)	Total
Knowledge	31(27.93)	19(28.36)	40(37.74)	30(37.97)	14(19.72)	134(30.88)
Comprehension	38(34.23)	21(31.34)	24(22.64)	26(32.91)	27(38.03)	135(31.11)
Application	10(9.00)	12(17.91)	4(3.77)	4(5.06)	7(9.86)	37(8.53)
Analysis	15(13.51)	8(11.94)	8(7.55)	4(5.06)	10(14.08)	45(10.37)
Synthesis	8(7.21)	4(5.97)	11(10.32)	7(8.86)	3(4.25)	35(8.06)
Evaluation	9(8.10)	3(4.48)	19(17.92)	8(10.13)	10(14.08)	48(11.06)
Total	111(99.98)	67(100)	106(99.94)	79(99.99)	71(100.02)	434(100.0)

evaluation with 10.13%. Next to evaluation is synthesis (8.86%). Both application and analysis have 5.06% each. 2019 arrangement of percentage spread of the chemistry mock questions to the cognitive levels from highest to the lowest indicates that Comprehension (38.03%) > Knowledge (19.72%) > Evaluation and analysis (14.08% each) > Application (9.86%) > Synthesis (4.25%). Considering cumulative percentage spread of the question to the cognitive levels, Comprehension (31.11%) > Knowledge (30.88%) > Evaluation (11.06%) >

analysis (10.37% each) > Application (8.53%) > Synthesis (8.06%). This indicates that comprehension carries the highest percentage most of the years followed by knowledge, because there is a wide range in between the percentage of the two levels (comprehension and knowledge) and the rest of the levels.

HO1: There is no significant difference between performance objectives assigned to Chemistry topics in the curriculum and the questions assigned to the topics in the MOCK examination questions in the years 2015 to 2019.

From Table 4, χ^2 (df=21) = 1.143; P = .000 < .05. This reveals that there is statistical significant difference between the performance objectives stated on the topics in chemistry curriculum and the questions assigned to the topics in chemistry mock examination for the years in consideration (2015 to 2019). Meaning that, the performance objective(s) in each topic and the mock question(s) assigned to each of the topics do not tally. Therefore, the null hypothesis is rejected.

HO2. There is no significant difference between the weights assigned to the various levels of the cognitive domain in the senior secondary school Chemistry curriculum and those assigned to them in the MOCK examination questions.

From Table 5, χ^2 (df=5) = 23.668; P = .000 < .05. The result indicates that the weights (performance objectives) assigned to the various levels of the cognitive domain in the senior secondary school Chemistry curriculum and those assigned to them in the MOCK examination questions Statistically differs. Hence, the null hypothesis is rejected.

Table 4. Chi-square Analysis of Performance Objectives Assigned to Chemistry Topics in the Curriculum and MOCK Questions Assigned to the Topics

Sources	Curriculum		Mock Questions		
	Observed	Expected	Observed	Expected	
Sources	PNM	7	19	48	36.0
	SFE	6	2.8	2	5.2
	CCM	14	10.7	17	20.3
	GL	7	15.2	37	28.8
	ST	5	7.9	18	15.1
	ABS	16	18.3	37	34.7
	W	14	10.0	15	19.0
Topics	CCP	7	7.6	15	14.4
	PT	6	21.4	56	40.6
	CR	8	11.4	25	21.6
	MVR	3	3.8	8	7.2
	A	4	2.8	4	5.2
	NMC	38	18.3	15	34.7
	OR	7	6.9	13	13.1
	ER	9	6.6	10	12.4
	HCC	6	9.7	22	18.3
	OC	30	17.6	21	33.4
	QQ	5	12.4	31	23.6
	PCO	9	5.9	8	11.1
	MC	20	14.5	22	27.5
	ESL	4	2.1	2	3.9
	CI	4	4.1	8	7.9
χ^2			1.143		
df			21		
P			.000		

Table 5. Chi-square Analysis of Weights Assigned to the Levels of Cognitive Domain in Chemistry Curriculum and those assigned to MOCK Examination Questions

Sources Test	Cognitive levels	Curriculum		Mock Questions	
		Observed	Expected	Observed	Expected
	Knowledge	41	60.4	134	114.6
	Comprehension	67	69.8	135	132.2
	Application	29	22.8	37	43.2
	Analysis	19	22.1	45	41.9
	Synthesis	34	23.8	35	45.2
	Evaluation	39	30.0	48	57.0
χ^2				23.668	
df				5	
P				.000	

4. DISCUSSION

This finding has revealed that the topics in the chemistry curriculum are not appropriately represented and some not considered at all in the MOCK examination questions. Hence, the MOCK examination questions may lead students to unpreparedness because of selective readings. According [1] it is important that examination questions should be in a good representative of the subject matter content to avoid selective reading by examinees, leading to failure if questions to be attempted by the examinees cover every topic in the contents of the subject matter. Therefore, since the result of this current study reveals that MOCK examination questions did not cover all the topics in the curriculum for chemistry; the MOCK examination questions in chemistry for these five years cannot prepare students very well for the other external examinations (WAEC, NECO and NABTEB). [13] study is in line with this result, the researcher also reported that ministry made test in Delta state, Nigeria differs from teacher made test. This may mean that ministry made test might be contrary to the curriculum or vice-versa. [14] discovered in their study that senior secondary school test in Edo state has low content validity which is supported by this study. The result of this study confirms the discovery of preliminary survey of past question papers of MOCK by [1] who stated that some questions are repeated many times in one question paper, wrong spellings and correct options are missing to some questions. All these result to low content validity. This finding is however contrary to [8] who reported a significant relationship between MOCK examination questions in Yoruba, Economics and Biology in Ekiti State, Nigeria. The difference could be as a result of different location and subjects considered.

Performance objectives stated in chemistry are not properly represented in the MOCK examination questions. This means the chemistry questions for MOCK is not according to how chemistry performance objectives are stated in the curriculum: and are not assigned to the cognitive domain levels according to how the performance objectives are stated in the curriculum. In agreement with the findings here in this study are studies conducted by [14] and [1]. These researchers found low content validity of questions set by state ministries. Hence, such examinations may not prepare students for standard examinations such as WASSCE and NECO. However, [15] in his study to determine content validity of WASSCE questions in Biology reported that WAEC Biology question papers have low content validity. This can be another reason why ministry examination question papers could not prepare students for the Chemistry WAEC examination. This is stressed by [1] who reported that low content validity leads students not to discover their ability, capabilities, skills and knowledge that can prepare them for any examination in the subject matter.

The allocation of chemistry Mock examination questions to the cognitive domain levels is not consistent throughout the five years considered in this research work. [12] in agreement with this study stated that there is inadequacy in allocation of questions to cognitive levels in Malawi School Certificate Examination (MSCE) because the questions emphasize the high levels than the lower levels of the cognitive domain. This current research finding also supports [6], who revealed that lower levels of cognitive domain (knowledge, comprehension and application) were more emphasized in chemistry questions in Akwa-Ibom state, Nigeria than the higher levels of cognitive domain.

5. CONCLUSION

The content validity of chemistry Mock examinations across the five years is discovered to be too low to prepare the students boldly face the Senior Secondary Schools Examinations in Adamawa State. This has led the students to have difficulty in obtaining University requirement to pursue engineering, science or related courses in tertiary institution. Hence there is need for the State Education Resource Centre which is responsible for setting the questions to employ experts or experienced secondary school teachers in setting the questions.

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

1. In-service training, workshops, conferences and seminars should be organized by the Government for those being used in setting Chemistry Mock examination questions so as to enable them have knowledge on test construction procedures for better content validity of the questions and better performance of students in chemistry.
2. Experts in Tests and Measurement or Measurement and Evaluation should be charged with the responsibility of developing MOCK examination questions in order to help minimize the error of over-emphasizing or under-emphasizing certain topics during test items constructions.

CONSENT AND ETHICAL APPROVAL

As per international standard or university standard guideline participant consent and ethical approval has been collected and preserved by the authors.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Buba MA, Kojigili ST. Content validation of Basic Education Certificate Examination (BECE) questions in Basic Science in Adamawa State, Nigeria. *Journal of Education, society and behavioural sciences*. 2020; 33(2-3):42-52.
2. FRN, Federal Republic of Nigeria National Policy on Education (4th Edition). NERDC Press. Lagos, Nigeria; 2014.
3. Kojigili ST. Test and testing. In ST Kojigili: Approaches to testing, measurement and evaluation in education, (1st edition). Kaduna, Wazobia Printing and Publishing Company, Nigeria; 2018.
4. Bika JM, Buba MA. Assessment of secondary schools science teachers' experience, profession and gender influence on knowledge of tests construction procedures in Hong local government, Adamawa state. *International Journal of Engineering, Technology Research and management*. 2020; 4(2): 115-121.
5. Opara IM, Uwah IV. Effect of test item arrangement on performance in Mathematics among junior secondary school students. *Journal of Education*. 2017;5(8):1-9.
6. Amajuoyi IJ, Eme UJ, Udoh NA. Content validity of May/June West African senior secondary school certificate examination questions in Chemistry. *Journal of Education and Practice*. 2013;4(7):15-17.
7. Onunkwo GIN. Measurement and evaluation. In GIN Onunkwo (Ed): Fundamentals of educational measurement and evaluation. Owerri Cape Publishers International, Nigeria, Ltd; 2002.
8. Ale VM, Omodara MF. Predictive validity of unified examination for academic performance in senior secondary school certificate examination. *Palgo Journal of Education Research*. 2015.3(1):140-141.
9. Omirin MS, Ale RM. Predictive validity of English and Mathematics mock examination results of senior secondary school students performance in WASSCE. *Pakistan Journal of Social Sciences*. 2008; 5(2):139-141.
10. Jackson MM. An investigation into the factors contributing to the poor performance of learners in Lethoso. M. Ed. Thesis, University of Zululand, South Africa; 2009.

11. Robin G, Dharaj S, Sushila S, Neha D. Analytical study of written examination papers of undergraduate anatomy: Focus on its content validity. *Indian Journal of Basic and Applied Medical Research*. 2013;8(2):1110-1116.
12. Elias WJK. Content validity of independently constructed curriculum-based examinations; 2018. Retrieved: 16th April, 2018 Available:<http://scholarworks.umass.edu/dissertations/1/2371>, 2014.
13. Ikechukwu EA. Content coverage and students' achievement in senior secondary school Physics. *Journal of Asian-Pacific Forum on Science Learning and Teaching*. 2012;13(14):1-5.
14. Chinelo BO, Osaze DE. Determining the reliability and content validity of the mathematics tests constructed by senior secondary school mathematics teachers. *African Journal of Education and Technology*. 2016; 3(2):83-84.
15. Iweka FEO. Content validity of the senior secondary school certificate examination questions in Biology. *Journal of Education and Practice*. 2008;1(1):1-8.
16. Adamawa State Ministry of Education, Inspectorate Division. Annual reports on Education; 2014.

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