DEVELOPMENT AND VALIDATION OF CHEMISTRY MASTERY TEST (CMT) FOR SENIOR SECONDARY STUDENTS ONE (SSS1) STUDENTS

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Abstract

This study focused on Development and Validation of Chemistry Mastery Test (CMT) For Senior Secondary Students One (SSS1) Students. The study adopted the instrumentation research design. In terms of the area of the study, it was conducted in Rivers and Bayelsa States of Nigeria. Both states are located in Niger Delta or South-South Geo-Political zones of Nigeria. The population for this study was made up of all the senior secondary students in SS1 unity schools in Rivers and Bayelsa State and as at the time of the study, they were 1701 students in unity schools in both Rivers and Bayelsa State. A sample size of 400 SS1 students was drawn using the multi-stage sampling technique. The CMT items was developed and written based on the Bloom's revised taxonomy. In analyzing the items, the difficulty and discrimination indices of CMT items were computed using their respective formula. The average difficulty index of CMT was established by computing their appropriate formula to arrive at their indices. The reliability coefficient of each sub-CMT was established using Cronbach Alpha, split halt method as well as KR_{20}. The content validity index Chemistry Mastery Test (CMT) was determined using TOS. Findings showed that 56 items were effectively represented in the instruments. Their reliabilities indices for Cronbach, Split Half and KR_{20} were .87, .82 and .88 respectively. This indicated that the instrument was reliable. Recommendations among other were that test administrators should adopt the CMT for testing of students in Chemistry.
Keywords: Validation, Development, Mastery,

Introduction

The purpose of education is to produce a wholesome, pleasant and understanding individual who will interact wisely and purposely within and outside the environment. Also, teaching aims at promoting the understanding of the concept being taught with a view to applying such knowledge to real life situations. Furthermore, there is a great demand for education in Nigeria today, which is largely because of its numerous and effective contributions to the nations' overall development. To achieve this, a lot of subjects are studied at different levels in secondary schools in Nigeria towards realizing the goal of education as an instrument for effective national development among the subjects that are studied and taught is Chemistry.

Chemistry which is a branch of science that deals with matter, its properties, structures, composition and uses Ababio (2015). In the views of Jumoke and Ezechukwu (2005), chemistry

is seen as a branch of science which deals with the study of the nature, composition and properties of matter and the changes matter may be subjected to under different conditions. Following the authors above, the researcher sees Chemistry as the branch of science that deals with the study of matter and all that affect matter. Chemistry is one of the subjects taught in the senior secondary schools in Nigeria. It is one of the science subjects offered by science students in the Senior Secondary Schools Certificate Examination (SSCE), National Examination Council (NECO), National Business and Technical Examination Board (NABTEB) and Joint Admission and Matriculation Board (JAMB) for candidates wishing to study sciences, medicines, pharmacy and other related science courses in Nigerian Universities, Polytechnics, Colleges of Health Sciences and School of Nursing.

"Chemistry is the mother of all sciences" Chemistry as a global part of human activities is characterized by chemical reactions going on around us and within complex system within our bodies. For example as anyone sits down at his computer and begins to type his body undergoes a huge amount of chemical reactions to make his eyes and hands move, and to make his brain think (Anuj, 2004). Chemistry is viewed as an important subject because it is associated with more academic and career opportunities (Jayanthi 2014), while Okereke and Ugwuegbulam (2014) have the opinion that chemistry prepares and stimulates the learner.

Chemistry has contributed greatly and is still contributing towards providing our basic needs and improving the quality of our life. The usefulness of chemistry is in food production. Fertilizers and insecticides have helped to increase food production greatly. Chemical processes are designed especially to preserve and store food for long periods, so that it can be exported to distant countries and is available to more people. Again clothing, man-made textile fibers, produced as a result of intensive chemical research, have made available a wide range of clothing materials, which can be bought cheaply. Chemistry contributes to the discovery and description of the theoretical bases for the behavior of chemical substances such as explosives used by the military. The gun-powder used in the earliest guns was made by mixing sulphur, charcoal, and potassium trioxonitrates (v), compounded by early Chemists (Ababio 2015). Building and housing are been constructed by materials like cement, concrete, steel, bricks and tiles which are produced by chemical industries. These are applications with the use of knowledge of chemistry.

Chemistry plays important role in enhancing the quality of teaching and research as well as ensuring that students are equipped with good knowledge to produce intensive goods and services to meet human needs for food, health care products and other materials aimed at improving the quality of life. Every single material thing in the universe is chemical and the ability to understand and manipulate these chemicals is responsible for everything from modern food and drugs to plastics and computers. Chemistry education is needed in the professional development of chemical industries required in the establishment of modern technology and operation of chemical industries. Presently, man is experiencing an era in scientific and technological development that affects his life in one way or the other.

Despite, the benefits derived from the study of chemistry, it has been observed that most students who enroll for chemistry do not perform very well in chemistry both for internal and external examinations like West African Senior School Certificate Examination (WASSCE), National Examination Council (NECO), and University Tertiary Matriculation Examination (UTME) etc. The reason for this has been attributed to different factors such as students'

factors, school factors, teachers and parental factors. However, to some extent Onunkwo (2002) asserted that most times students fail examination not due to their own in capabilities but also due to fault inherent in the questions. This means that students may not perform very well in a test due to error in the test as a result of poor internal and external psychometric properties.

Students have continued to show weakness in content knowledge and meaningful understanding of chemical concepts, leading to very poor performances in external Chemistry examinations as reported in the West African Examinations council (WAEC, 2003 – 2016) Chief Examiner's Annual Reports of the West African Senior School certificate Examinations results in Chemistry, May/June option see appendix A. This shows that it was only in 2003, 2010, 2015 and 2016 that up to 50% of the candidates had credit level and above in chemistry. Results of other years showed a decline in which between 30% and 49% of candidates obtained failure. Eguridu (2014), supports this argument in the daily post gathered that in 2014 WAEC result recorded mass failure in Chemistry, Mathematics and English language. He stated also that a total of 529,425 candidates representing 31.28% obtained credits in five (5) subjects and above, including Chemistry, English and Mathematics. He noted that when compared with the 2012 and 2013 May/June WASSCE, there was marginal decline in the performance of candidates as 38.81% was recorded in 2012 and 36.57% in 2013, respectively. In other hand, Amoke (2020) reported that the breakdown of NECO examinations reveals the poor performance of students in chemistry has resulted in an average failure rate of 72%, 74%, 74% and 75% in 2015 – 2018 respectively. These consistent poor performances of students in external Chemistry examinations like WASSCE, NECO and NABTEB have become a serious threat to our drive toward scientific and technological breakthrough.

Hence, Kpolovie (2014), defined test as the presentation of a standard set of questions to be answered which qualify as a valid and reliable information gathering instrument for effective evaluation of the examinee`s cognitive, affective, psychomotor or psycho-productive traits. Linn, Miller and Gronlund in Opara (2016) stated that a test is a particular type of assessment that typically consist of a set of questions administered during a fixed period of time under reasonably, comparable conditions for all students. According to Orluwene (2012) test is an instrument used to determine the relative presence or absence of the trait measured for. Students are given test to measure and evaluate what they know. Tests are given to students to seek information on their feelings, anxiety, interest, attitudes, self-concept and mastery. A test may be administered verbally, on paper, on a computer, or in a confined area that requires a test taker to physically perform a set of skills. A test score can be interpreted with regards to a norm or criterion, or probably both. For effective teaching, learning and improvement in student`s performances, there must be a valid and reliable testing instrument for teachers to tests Chemistry skills but these tests are either scarce or absence in our schools.

A Chemistry Mastery Test (CMT) is a test designed to measure students' mastery of the meaning of Chemistry such as properties, structures, composition, chemical symbols, and uses of matter. The mastery learning is more work for teachers, especially in the beginning, as the intended class is the foundation class (SS1) the teacher needs to decide what is absolutely essential to be mastered, creates parallel forms of mastery test, invents activities and scoring keys for mastery of performances and enrichment activities, organizes and orders units or

lessons to facilitates transfer of learning, publishes and able to defend the grading scheme. Chemistry mastery test can be influenced significantly by students', teachers', parents' and their socio-economic status. Today, most teachers after assuming to have covered the chemistry curriculum will resorts to assessing students with unreliable chemistry mastery test that lack psychometric properties. Most teachers hurriedly copy questions from any past questions papers to compose their final examination mastery test. This implies that teachers do not establish validity and reliability for such test.

Hence, Kpolovie (2010) stated that the validity of a test deals with how well the test measures what it purports to measure. Similarly, Onunkwo (2002) explained that validity of an instrument means the degree of qualities, abilities, skills, traits, information it was designed to measure. A valid test ensures that questions are set from all parts of the syllabus. This emphasizes the need to ensure adequate coverage of both subject matter and the instructional objectives which the students learning centered on Kpolovie (2014) explained that there is a table of specification used to ensure the precise manner, the scope and emphasis of a test in terms of the various topics of subject matter and the different levels of taxonomy of educational objectives.

It is noted that another psychometric property of a test is its reliability. Urbina, in Orluwene (2012), defined reliability of a test as the consistency of scores obtained by the same person when they are re-examined with the same test on different occasions or with different sets of equivalent items or under other variable examining conditions. For Opara (2016), test reliability means the consistency to which that instrument measures what it was designed to measure. The acceptable level of reliability for an instrument is dependent upon the decision to be made about the attribute being measured which is based on the result of the instrument.
The researcher had identified that there were records of mass failures of students in Chemistry in public examinations like WAEC, NECO and NABTEB. This has not been unconnected with poor foundation arising from lack of understanding of Chemistry concepts by students due to the teachers' incompetency in the process of development and standardization of the instrument. This means that for Chemistry teachers to use valid and reliable tests experts in test development have to develop them, otherwise the objective of our education system may not be achieved. The unavailability of construction of Chemistry Mastery Test for SS1 students prompted the researcher to embark on this research such test would be able to discriminate between mastery (intelligent students) and non-mastery (dull students) that enable teachers on the instruction to determine the strategies to put in place to enable mastery and non-mastery students to benefit from the teaching and learning processes.

With proper application of a valid and reliable Chemistry Mastery Test by Chemistry Teachers during instructions, students' performance in the subject would be improved for the better. Hence, to develop and validate Chemistry Mastery Test for measuring students' proficiency in Chemistry was addressed. Again, the psychometric properties (Validity and reliability) must be established for the test instrument to be useful.

In line with this, the researcher in this paper developed and validated Chemistry Mastery Test (CMT) for senior secondary students one (SSS1) students. Specifically, the objectives of the study were to;

1.   To ascertained the content validity of the Chemistry Mastery Test (CMT) using table of specification (TOS)
2.   To determine the difficulty index of Chemistry Mastery Test (CMT)
3.   To ascertain the discrimination index of Chemistry Mastery Test (CMT).
4.   To determine the internal consistency of Chemistry Mastery Test (CMT) using Cronbach Alpha method, Split Half method, Kuder Richardson formula 20 (KR_{20}).

Research Questions
The following research questions were put forward to guide the study;
1.   Is Chemistry Mastery Test (CMT) content valid for use?
2.   What is the difficulty index of Chemistry Mastery Test (CMT)
3.   What is the discrimination index of Chemistry Mastery Test (CMT)?
a.   What is the internal consistency of Chemistry Mastery Test (CMT) using Cronbach Alpha method, Split Half method, Kuder Richardson formula 20 (KR_{20})?

Methodology
The study adopted the instrumentation research design. Instrumentation is the process of constructing research instrument that could be used appropriately in gathering data on the study. According to Kpolovie (2010), an instrumentation research is a very special and important design that is primarily used for the purpose of test development on the basis of test theories to ensure satisfactorily high validity and reliability as well as most appropriate norm, criterion or design in the measurement and evaluation of psychological attributes or human abilities. In this type of research design, instruments used to collect data were developed and validated for evaluating SS1 students. The researcher adopted the research design to develop a new measuring instrument (CMT) which can be used by chemistry teachers in the course of evaluating and enhancing students' mastery in the subject.

In terms of the area of the study, it was conducted in Rivers and Bayelsa States of Nigeria. Both states are located in Niger Delta or South-South Geo-Political zones of Nigeria. The population for this study was made up of all the senior secondary students in SS1 unity schools in Rivers and Bayelsa State as at the time of the study, they were 1701 students in unity schools in both Rivers and Bayelsa State.

A sample size of 400 SS1 students was drawn using the multi-stage sampling technique. First, census sampling techniques was used to sampling all the federal colleges in both Rivers state and Bayelsa states. Also, the researcher used Taro Yemen formula to determine the size using the formula, n = N/1+N $(e)^2$, where n = corrected sample size, N = population size and e = margin of error (e = 0.05 based on the research condition).This gave a total of 324. However, since this was the minimum sample, the researcher increased the number to 400. Finally, the non-proportionate sampling technique was used to draw 67 students from each of the six schools in both Rivers and Bayelsa States. This gave a total of 402 students.

In developing the instruments, the first step to develop the Chemistry Mastery Test (CMT) was to identify the instructional contents, objectives and learning activities as contained in the senior secondary school one Chemistry curriculum. The SS 1 Chemistry curriculum content was used in developing the test items. The curriculum contents are: particulate nature of matter, separation technique, mole concepts, acids/bases and salts, chemical equation, and carbon and its compounds, Laws of Chemical Combination; Periodic table, Gaseous state and

Chemical bonding. After this, table of specification was used in determining the content validity. The researcher also gave the instrument to subject specialist for face validity to check for errors in spelling of concept. The CMT items was developed and written based on the Bloom's revised taxonomy. In analyzing the items, the difficulty and discrimination indices of CMT items were computed using their respective formula**.** The average difficulty index of CMT was established by computing their appropriate formula to arrive at their indices. The reliability coefficient of each sub-CMT was established using Cranach Alpha, split halt method as well as KR_{20}. The content validity index Chemistry Mastery Test (CMT) was determined using TOS

Results Presentation
Research Question One
Is Chemistry Mastery Test (CMT) content valid for use?

In order to determine the content validity of Chemistry Mastery Test (CMT) for use in federal Unity Secondary Schools, the researcher subjected the major topics in the SS1 syllabus to a table of specification with the following calculations.

Table 1.1   Shows Table of specification of the Chemistry Mastery Test (CMT) based on the Revised Blooms Taxonomy.

No. of wks	Content Areas	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating	
		20%	20%	25%	10%	15%	10%	100%
1	Particulate Nature of matter	2	2	2	1	1	1	9
1	Separation Techniques	2	2	3	1	1	1	10
2	Mole Concepts	4	3	5	2	3	2	19
1	Chemical Equations	2	2	2	1	1	1	9
1	Acids, Bases and Salts	2	2	3	1	1	1	10
2	Carbon and its Compounds	4	3	5	2	3	2	19
1	Chemical Combination	2	2	2	1	1	1	9
1	Periodic Table	2	2	3	1	1	1	10
2	Gaseous Table	4	3	5	2	3	2	19
1	Chemical Bonding	2	2	3	1	1	1	10
13		**26**	**23**	**33**	**13**	**16**	**13**	**124**

The table above demonstrated the major topics in the SS1 curriculum, the number of weeks taught as well as the number of items in each cognitive level. From the analysis, it was established that particulate nature of matter will have a total of 9 items, separation techniques with 10 items, mole concept with 19 items, chemical equations having 9 items, acid bases and salt having 10, carbon and its compounds had 19 items, chemical combination had 9 items, periodic table had 10 items, gaseous state had 19 items while chemical bonding had 10 items. These represented a fair distribution depending on the cognitive levels and the number of weeks used in teaching them.

Research Question Two: What are the;

a.   Difficulty index of Chemistry Mastery Test (CMT)

Table 1.2 below shows the difficulty indices of the items.

Item Numbers	U	L	U+L	DI (U+L/T)	REMARKS
i1	131	127	258	0.65	Moderate Difficulty (Acceptable)
i2	133	111	244	0.61	Moderate Difficulty (Acceptable)
i3	133	101	234	0.59	Moderate Difficulty (Acceptable)
i4	131	123	254	0.64	Moderate Difficulty (Acceptable)
i5	131	102	233	0.58	Moderate Difficulty (Acceptable)
i6	116	104	220	0.55	Moderate Difficulty (Acceptable)
i7	133	100	233	0.58	Moderate Difficulty (Acceptable)
i8	133	117	250	0.63	Moderate Difficulty (Acceptable)
i9	133	127	260	0.65	Moderate Difficulty (Acceptable)
i10	129	111	240	0.60	Moderate Difficulty (Acceptable)
i11	133	121	254	0.64	Moderate Difficulty (Acceptable)
i12	133	134	267	0.67	Moderate Difficulty (Acceptable)
i13	133	117	250	0.63	Moderate Difficulty (Acceptable)
i14	133	125	258	0.65	Moderate Difficulty (Acceptable)
i15	132	81	213	0.53	Moderate Difficulty (Acceptable)
i16	129	128	257	0.64	Moderate Difficulty (Acceptable)
i17	133	125	258	0.65	Moderate Difficulty (Acceptable)
i18	133	111	244	0.61	Moderate Difficulty (Acceptable)
i19	133	121	254	0.64	Moderate Difficulty (Acceptable)
i20	132	91	223	0.56	Moderate Difficulty (Acceptable)
i21	129	34	163	0.41	Moderate Difficulty (Acceptable)
i22	36	24	60	0.15	Hard Item (Discard)
i23	90	111	201	0.50	Moderate Difficulty (Acceptable)
i24	90	80	170	0.43	Moderate Difficulty (Acceptable)
i25	15	16	31	0.08	Hard Item (Discard)
i26	106	50	156	0.39	Moderate Difficulty (Acceptable)
i27	129	42	171	0.43	Moderate Difficulty (Acceptable)
i28	111	59	170	0.43	Moderate Difficulty (Acceptable)
i29	64	117	181	0.45	Moderate Difficulty (Acceptable)
i30	105	87	192	0.48	Moderate Difficulty (Acceptable)
i31	131	84	215	0.54	Moderate Difficulty (Acceptable)
i32	73	45	118	0.30	Moderate Difficulty (Acceptable)
i33	70	11	81	0.20	Hard Item (Discard)
i34	112	62	174	0.44	Moderate Difficulty (Acceptable)
i35	79	48	127	0.32	Moderate Difficulty (Acceptable)
i36	131	26	157	0.39	Moderate Difficulty (Acceptable)
i37	115	71	186	0.47	Moderate Difficulty (Acceptable)

i38	3	34	37	**0.09**	Hard Item (Discard)
i39	3	14	17	**0.04**	Hard Item (Discard)
i40	131	53	184	**0.46**	Moderate Difficulty (Acceptable)
i41	14	17	31	**0.08**	Hard Item (Discard)
i42	45	31	76	**0.19**	Hard Item (Discard)
i43	22	17	39	**0.10**	Hard Item (Discard)
i44	6	17	23	**0.06**	Hard Item (Discard)
i45	12	15	27	**0.07**	Hard Item (Discard)
i46	31	53	84	**0.21**	Hard Item (Discard)
i47	22	42	64	**0.16**	Hard Item (Discard)
i48	59	14	73	**0.18**	Hard Item (Discard)
i49	17	60	77	**0.19**	Hard Item (Discard)
i50	10	14	24	**0.06**	Hard Item (Discard)
i51	10	14	24	**0.06**	Hard Item (Discard)
i52	8	6	14	**0.04**	Hard Item (Discard)
i53	132	56	188	**0.47**	Moderate Difficulty (Acceptable)
i54	133	67	200	**0.50**	Moderate Difficulty (Acceptable)
i55	133	67	200	**0.50**	Moderate Difficulty (Acceptable)
i56	124	56	180	**0.45**	Moderate Difficulty (Acceptable)
i57	133	95	228	**0.57**	Moderate Difficulty (Acceptable)
i58	123	103	226	**0.57**	Moderate Difficulty (Acceptable)
i59	133	103	236	**0.59**	Moderate Difficulty (Acceptable)
i60	133	134	267	**0.67**	Moderate Difficulty (Acceptable)
i61	105	117	222	**0.56**	Moderate Difficulty (Acceptable)
i62	132	78	210	**0.53**	Moderate Difficulty (Acceptable)
i63	133	98	231	**0.58**	Moderate Difficulty (Acceptable)
i64	133	81	214	**0.54**	Moderate Difficulty (Acceptable)
i65	132	35	167	**0.42**	Moderate Difficulty (Acceptable)
i66	123	80	203	**0.51**	Moderate Difficulty (Acceptable)
i67	96	15	111	**0.28**	Moderate Difficulty (Acceptable)
i68	80	98	178	**0.45**	Moderate Difficulty (Acceptable)
i69	69	47	116	**0.29**	Moderate Difficulty (Acceptable)
i70	132	67	199	**0.50**	Moderate Difficulty (Acceptable)
i71	59	22	81	**0.20**	Hard Item (Discard)
i72	133	49	182	**0.46**	Moderate Difficulty (Acceptable)
i73	60	78	138	**0.35**	Moderate Difficulty (Acceptable)
i74	99	35	134	**0.34**	Moderate Difficulty (Acceptable)
i75	96	31	127	**0.32**	Moderate Difficulty (Acceptable)
i76	66	28	94	**0.24**	Moderate Difficulty (Acceptable)
i77	117	9	126	**0.32**	Moderate Difficulty (Acceptable)
i78	62	38	100	**0.25**	Moderate Difficulty (Acceptable)

i79	88	9	97	0.24	Moderate Difficulty (Acceptable)
i80	104	19	123	0.31	Moderate Difficulty (Acceptable)
i81	71	34	105	0.26	Moderate Difficulty (Acceptable)
i82	16	7	23	0.06	Hard Item (Discard)
i83	52	14	66	0.17	Hard Item (Discard)
i84	72	61	133	0.33	Moderate Difficulty (Acceptable)
i85	117	40	157	0.39	Moderate Difficulty (Acceptable)
i86	30	15	45	0.11	Hard Item (Discard)
i87	29	16	45	0.11	Hard Item (Discard)
i88	13	20	33	0.08	Hard Item (Discard)
i89	56	18	74	0.19	Hard Item (Discard)
i90	20	17	37	0.09	Hard Item (Discard)
i91	13	17	30	0.08	Hard Item (Discard)
i92	46	31	77	0.19	Hard Item (Discard)
i93	4	17	21	0.05	Hard Item (Discard)
i94	2	31	33	0.08	Hard Item (Discard)
i95	5	38	43	0.11	Hard Item (Discard)
i96	131	95	226	0.57	Moderate Difficulty (Acceptable)
i97	131	128	259	0.65	Moderate Difficulty (Acceptable)
i98	133	111	244	0.61	Moderate Difficulty (Acceptable)
i99	133	101	234	0.59	Moderate Difficulty (Acceptable)
i100	131	123	254	0.64	Moderate Difficulty (Acceptable)
i101	131	102	233	0.58	Moderate Difficulty (Acceptable)
i102	116	105	221	0.55	Moderate Difficulty (Acceptable)
i103	133	100	233	0.58	Moderate Difficulty (Acceptable)
i104	133	117	250	0.63	Moderate Difficulty (Acceptable)
i105	133	127	260	0.65	Moderate Difficulty (Acceptable)
i106	129	111	240	0.60	Moderate Difficulty (Acceptable)
i107	133	121	254	0.64	Moderate Difficulty (Acceptable)
i108	133	134	267	0.67	Moderate Difficulty (Acceptable)
i109	133	117	250	0.63	Moderate Difficulty (Acceptable)
i110	133	125	258	0.65	Moderate Difficulty (Acceptable)
i111	132	81	213	0.53	Moderate Difficulty (Acceptable)
i112	129	128	257	0.64	Moderate Difficulty (Acceptable)
i113	125	124	249	0.62	Moderate Difficulty (Acceptable)
i114	133	111	244	0.61	Moderate Difficulty (Acceptable)
i115	133	121	254	0.64	Moderate Difficulty (Acceptable)
i116	132	91	223	0.56	Moderate Difficulty (Acceptable)
i117	129	34	163	0.41	Moderate Difficulty (Acceptable)
i118	36	24	60	0.15	Hard Item (Discard)
i119	90	110	200	0.50	Moderate Difficulty (Acceptable)

i120	90	80	170	**0.43**	Moderate Difficulty (Acceptable)
i121	16	13	29	**0.07**	Hard Item (Discard)
i122	106	50	156	**0.39**	Moderate Difficulty (Acceptable)
i123	129	42	171	**0.43**	Moderate Difficulty (Acceptable)
i124	111	59	170	**0.43**	Moderate Difficulty (Acceptable)

From the analysis in the table, it is seen that ninety two (92) items including items 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 24, 26, 27, 28, 29, 30, 31, 32, 34, 35, 36, 37, 40, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 84, 85, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 119, 120, 122, 123 and 124 had moderate difficulty index and were within the acceptable difficulty range of .26-.75. On the contrary, 32 items including items 22, 25, 33, 38, 39, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 71, 82, 83, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 118 and 121 were discarded because they did not meet up with the difficulty index range. This means that these items were removed from the CMT.

The discrimination index;
The discrimination index was arrived by the formula U+L/0.5*T

Where;

U= Total number of those in upper group who got each item right
L= Total number of those in the lower group who got each item right
T= total number of Items= 124
0.5*T= 0.5*124=62.

Table 4.2 Discrimination indices of the remaining items after difficulty index determination.

Item Number	U	L	U-L	U-L/62	Remarks
i1	131	127	**4**	0.06	Rejected
i2	133	111	**22**	0.35	Accepted
i3	133	101	**32**	0.52	Accepted
i4	131	123	**8**	0.13	Rejected
i5	131	102	**29**	0.47	Accepted
i6	116	104	**12**	0.19	Rejected
i7	133	100	**33**	0.53	Accepted
i8	133	117	**16**	0.26	Accepted
i9	133	127	**6**	0.10	Rejected
i10	129	111	**18**	0.29	Accepted
i11	133	121	**12**	0.19	Rejected
i12	133	134	**-1**	-0.02	Rejected
i13	133	117	**16**	0.26	Accepted
i14	133	125	**8**	0.13	Rejected
i15	132	81	**51**	0.82	Accepted
i16	129	128	**1**	0.02	Rejected
i17	133	125	**8**	0.13	Rejected
i18	133	111	**22**	0.35	Accepted

i19	133	121	**12**	0.19	Rejected
i20	132	91	**41**	0.66	Accepted
i21	129	78	**51**	0.82	Accepted
i23	111	90	**21**	0.34	Accepted
i24	90	80	**10**	0.16	Rejected
i26	106	50	**56**	0.90	Accepted
i27	116	69	**47**	0.76	Accepted
i28	111	59	**52**	0.84	Accepted
i29	64	117	**-53**	-0.85	Rejected
i30	105	87	**18**	0.29	Accepted
i31	131	84	**47**	0.76	Accepted
i32	73	45	**28**	0.45	Accepted
i34	112	62	**50**	0.81	Accepted
i35	79	48	**31**	0.50	Accepted
i36	131	26	**105**	1.69	Accepted
i37	115	71	**44**	0.71	Accepted
i40	131	98	**33**	0.53	Accepted
i53	132	79	**53**	0.85	Accepted
i54	133	87	**46**	0.74	Accepted
i55	133	92	**41**	0.66	Accepted
i56	124	89	**35**	0.56	Accepted
i57	133	95	**38**	0.61	Accepted
i58	123	103	**20**	0.32	Accepted
i59	133	103	**30**	0.48	Accepted
i60	133	134	**-1**	-0.02	Rejected
i61	117	105	**12**	0.19	Rejected
i62	132	78	**54**	0.87	Accepted
i63	133	98	**35**	0.56	Accepted
i64	133	81	**52**	0.84	Accepted
i65	132	35	**97**	1.56	Rejected
i66	123	80	**43**	0.69	Accepted
i67	96	15	**81**	1.31	Rejected
i68	98	80	**18**	0.29	Accepted
i69	69	47	**22**	0.35	Accepted
i70	132	128	**4**	0.06	Rejected
i72	133	116	**17**	0.27	Rejected
i73	60	78	**-18**	-0.29	Rejected
i74	99	89	**10**	0.16	Rejected
i75	96	84	**12**	0.19	Rejected
i76	66	28	**38**	0.61	Accepted
i77	117	110	**7**	0.11	Rejected
i78	62	38	**24**	0.39	Accepted

i79	88	78	10	0.16	Rejected
i80	104	98	6	0.10	Rejected
i81	52	14	38	0.61	Accepted
i84	72	61	11	0.18	Rejected
i85	38	5	33	0.53	Accepted
i96	131	95	36	0.58	Accepted
i97	131	128	3	0.05	Rejected
i98	133	111	22	0.35	Accepted
i99	133	101	32	0.52	Accepted
i100	131	123	8	0.13	Rejected
i101	131	102	29	0.47	Accepted
i102	116	105	11	0.18	Rejected
i103	133	100	33	0.53	Accepted
i104	133	117	16	0.26	Accepted
i105	133	127	6	0.10	Rejected
i106	129	111	18	0.29	Accepted
i107	133	121	12	0.19	Rejected
i108	133	134	-1	-0.02	Rejected
i109	133	117	16	0.26	Accepted
i110	133	125	8	0.13	Rejected
i111	132	81	51	0.82	Accepted
i112	129	128	1	0.02	Rejected
i113	125	124	1	0.02	Rejected
i114	133	111	22	0.35	Accepted
i115	133	121	12	0.19	Rejected
i116	132	91	41	0.66	Accepted
i117	129	98	31	0.50	Accepted
i119	90	110	-20	-0.32	Rejected
i120	16	13	3	0.05	Rejected
i122	106	50	56	0.90	Accepted
i123	129	115	14	0.23	Accepted
i124	111	59	52	0.84	Accepted

Acceptable Limit =0.20-.99 (Gretzel, 1982).

The table above reveals that fifty six (56) items including items 2, 3, 5, 7, 8, 10, 13, 15, 18, 20, 21, 26, 27, 28, 29, 30, 31, 32, 34, 35, 36, 37, 40, 53, 54, 55, 56, 57, 58, 59, 62, 63, 64, 65, 66, 68, 69, 76, 78, 81, 85, 96, 98, 99, 101, 103, 104, 106, 109, 111, 114, 116, 117, 122, 123 and 124 were accepted as having proper discrimination. On the contrary, thirty six (36) items were rejected. These include items 1, 4, 6, 9, 11, 12, 14, 16, 17, 19, 27, 29, 60, 61, 65, 67, 70, 72, 73, 74, 75, 77, 79, 80, 84, 97, 100, 102, 105, 107, 108, 110, 112, 113, 115, 119 and 120. This means that these items were removed from the CMT.

Hence, the following table shows the final items
Table 4.3: Final item numbers selected for CMT

i2	133	111	22	**0.35**	Accepted
i3	133	101	32	**0.52**	Accepted
i5	131	102	29	**0.47**	Accepted
i7	133	100	33	**0.53**	Accepted
i8	133	117	16	**0.26**	Accepted
i10	129	111	18	**0.29**	Accepted
i13	133	117	16	**0.26**	Accepted
i15	132	81	51	**0.82**	Accepted
i18	133	111	22	**0.35**	Accepted
i20	132	91	41	**0.66**	Accepted
i21	129	78	51	**0.82**	Accepted
i23	111	90	21	**0.34**	Accepted
i26	106	50	56	**0.90**	Accepted
i27	116	69	47	**0.76**	Accepted
i28	111	59	52	**0.84**	Accepted
i30	105	87	18	**0.29**	Accepted
i31	131	84	47	**0.76**	Accepted
i32	73	45	28	**0.45**	Accepted
i34	112	62	50	**0.81**	Accepted
i35	79	48	31	**0.50**	Accepted
i36	131	26	105	**1.69**	Accepted
i37	115	71	44	**0.71**	Accepted
i40	131	98	33	**0.53**	Accepted
i53	132	79	53	**0.85**	Accepted
i54	133	87	46	**0.74**	Accepted
i55	133	92	41	**0.66**	Accepted
i56	124	89	35	**0.56**	Accepted
i57	133	95	38	**0.61**	Accepted
i58	123	103	20	**0.32**	Accepted
i59	133	103	30	**0.48**	Accepted
i62	132	78	54	**0.87**	Accepted
i63	133	98	35	**0.56**	Accepted
i64	133	81	52	**0.84**	Accepted
i66	123	80	43	**0.69**	Accepted
i68	98	80	18	**0.29**	Accepted
i69	69	47	22	**0.35**	Accepted
i76	66	28	38	**0.61**	Accepted
i78	62	38	24	**0.39**	Accepted
i81	52	14	38	**0.61**	Accepted
i85	38	5	**33**	0.53	Accepted
i96	131	95	**36**	0.58	Accepted
i98	133	111	**22**	0.35	Accepted

i99	133	101	**32**	**0.52**	Accepted
i101	131	102	**29**	**0.47**	Accepted
i103	133	100	**33**	**0.53**	Accepted
i104	133	117	**16**	**0.26**	Accepted
i106	129	111	**18**	**0.29**	Accepted
i109	133	117	**16**	**0.26**	Accepted
i111	132	81	**51**	**0.82**	Accepted
i114	133	111	**22**	**0.35**	Accepted
i116	132	91	**41**	**0.66**	Accepted
i117	129	98	**31**	**0.50**	Accepted
i122	106	50	**56**	**0.90**	Accepted
i123	129	115	**14**	**0.23**	Accepted
i124	111	59	**52**	**0.84**	Accepted

The final version of the test is presented thus;

Research Question Three: What is the Internal Consistency of CMT Using;
Cronbach Alpha?
Table 1.4 Cronbach Reliability Statistics of CMT

Cronbach's Alpha	N of Items	Valid N of Cases	Excluded Cases	Total N of Cases	% of Representation	Remark
.87	56	400	1	400	100%	Very High Coefficient

From table 1.4, it is seen that the overall number of items was 56 while the total number of cases entered were 400. This represented 100% of the entire entered cases. Cronbach Alpha correlation coefficient was .87. This value was remarked to be very high and is good enough to guarantee the reliability of the overall CMT.

Split-Half Reliability?
Table 1.5 Split Half Reliability of CMT

N of items (Half 1)	N of items (Half 2)	N of Items	Valid N cases	rht.	rft.	Remarks
28	28	56	400	.70	**.82**	High Reliability

The table above shows that N of the half test was 28 while N of the totals was 56. Total N of cases was 400. The table also revealed that split-half reliability of the half test (rht) was .70. However, when Spearman brown prophecy formula was used to substitute the half test, a Guttman reliability test (rft) was .82. This index shows that CMT was reliable.

What is the Reliability via KR$_{20}$?
Table 1.6 Reliability of CMT wing KR$_{20}$

$\sum X$	$\sum X^2$	St.D	V(St.D^2)	K	$\sum pq$	KR$_{20}$
16483	**702725**	**7.67**	**58.90**	**56**	**8.46**	**.88**

It can be descended from table 1.6 that 400 students have a sum of 16483, their sum of squares is 702725 on CMT. Their standard deviation and variance are 7.67 and 58.90

respectively. The table also shows number of items on CMT to be 56. The sum of product of the examinees answering each item correctly and wrongly is 8.46. Finally the KR_{20} internal consistency reliability of CMT is 0.88. This has indicated a high reliability.

Discussions of Findings

The test blueprints in Table 1 shows the weights of the various content areas covered by the test proportionately. That is, the weights are assigned and number of items drawn in accordance with the way each topic appears relative to others in the scheme of work. The constructed test blue print also shows an unbiased distribution of weights across all the various behavioural processes as classified by the revised Bloom's taxonomy. This is also in accordance with the way they are presented by the Chemistry curriculum and the scheme of work for SS1. And based on Gretzel cited in Tinner (2007), test items determine using the test blue print are certain and sure of total validity.

From finding two, it is revealed that the analysis of the difficulty index, of ninety two (92) items were accepted as having moderate difficulty index because they were within the acceptable difficulty range of .26-.75. On the contrary, 32 items were discarded because they did not meet up with the difficulty index range. This means that 32 items were either too difficult or too easy for the testees. This finding means that by the end of the analysis, only 92 items were fit to proceed with other analysis. It is important to remove these items so as not to affect the performance of the students in the entire test. It was also found that after the discrimination analysis only 56 items fell within the 0.20-.99acceptable limit as specified by Gretzel (1982). On the other hand, it means that 36 items did not meet up.

Furthermore, for a test to be valid, it must also measure consistently what it claims to measures. Hence, the reliability of the Chemistry Mastery Test (CMT) for Federal government colleges were also determined using Kuder-Richardson Formula 20, Cronbach Alpha as well as Split-Half reliability. In all these, a reliability index of 0.87, 0.82 and 0.88 were realized. As demonstrated by Gronlund (1976), an easy test has an approximate reliability coefficient of about 0.50. This figure is also applicable to a difficult test while an ideal test has a reliability coefficient of 0.90 approximately. The 0.82, 0.87 and 0.88 reliability coefficient of the Chemistry Mastery Test is also in line with the Jayanthi (2014) valid and reliable achievement test in Mathematics for high school students of Standard 10 in Chennai District which has a reliability coefficient of 0.888. This showed that the Chemistry Achievement Test (CAT) is highly reliable. Most importantly, it is also in line with the study of Ayibapiriyekekon (2019) who constructed and Validated Chemistry Achievement Test for senior secondary schools in Bayelsa State. He showed that the Chemistry Achievement Test was highly reliable and valid.

Conclusion

The Chemistry Mastery Test (CMT) is a valid cognitive evaluation instrument. The content validity index (CVI) was found perfect based on the numbers obtained from table of specification.

Recommendations
The following recommendations are made;

1.   Based on the findings that CMT is suitable, it is recommended that it should be adopted and applied by both standard examination body or in a classroom assessment in Rivers and Bayelsa States.
2.   CMT should be used as a basis to assess students in Chemistry in secondary schools. It should also be used in establishing the validity of similar instruments.
3.   It should as well be used in determining reliability in similar instrument. Also, any researcher using CMT may not need to carry out reliability check again since the present one has been established already.

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