Alignment between Chemistry Certificate of Secondary Education Examinations and the Ordinary Level Chemistry Curriculum in Tanzania

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Abstract

This paper presents the findings of a study conducted to investigate the alignment between Chemistry Certificate of Secondary Education Examination (CSEE) and the ordinary level (O'level) chemistry curriculum in Tanzania. The study employed mixed methods research approach to collect data from 25 chemistry teachers, eight Chemistry CSEE past papers for the period from 2010 to 2013 and 2007chemistry curriculum. The findings revealed that the Chemistry CSEE was aligned to the chemistry curriculum in terms of content coverage. Most of the examination questions and the instructional objectives in the Chemistry CSEE and the Chemistry curriculum were at lower levels of the Bloom's cognitive domain. The study recommends revision of specific objectives in the chemistry curriculum to facilitate assessment of higher levels of the Bloom's cognitive domain.

Keywords: *alignment, chemistry curriculum, Certificate of Secondary Education Examination, chemistry examination, competence-based education*

Introduction

The concept of alignment is not new in the field of educational assessment because it has been recognised by several educators including Tyler (2013) and Bloom, Mandaus and Hastings (1981) as an evidence of the assessment's validity (Case, Jorgensen & Zucker, 2008). It is used in educational context to describe the degree to which curriculum, instruction and assessment are in agreement in order to achieve the educational goals (Ananda, 2003; Nasstrom, 2008; Webb, 2002). Alignment is also used to describe the degree to which learning objectives in a curriculum and assessment are in agreement and serve in conjunction with one another to guide the educational system towards enabling students learning the planned contents (Webb, 2002). It further describes the degree of match between curriculum contents for specific subject and the assessment used to measure achievement of the instructional objectives in the curriculum (Bhola, Buckendalh, & Impara, 2003). Therefore, in this study, the term *alignment* is used to describe the degree of match or correspondence between the Chemistry CSEE and the chemistry curriculum for ordinary secondary education in terms of content coverage and cognitive complexity.

Alignment is closely related to test validity especially content validity and consequential validity (Sireci & Shuhong, 2005; Webb, 1997, 2002). However, distinction can be drawn between the two concepts. Fonthal (2004) and Rothman, Slattery & Vranek (2002) argue that, although alignment and content validity share common analysis methods, alignment is not a 'yes' or 'no' question, rather, it involves a number of alignment criteria that collectively tell the degree of association between curriculum and assessment. In addition, alignment analysis relies on the trained, experienced and knowledgeable educators (subject matter specialists) who apply their experience and knowledge in the analysis process (Rothman et al., 2002).

Importance of alignment in education

Alignment between assessment and curriculum influences the teaching and learning practices in classroom, and students' performance in the assessment as well (Biggs, 2003; Kellaghan & Greaney, 2003). This is due to the fact that the degree of alignment between a public examination like the Chemistry CSEE and its respective curriculum guides teachers and students on what to teach and learn respectively (Kellaghan & Greaney, 2003). It is argued that some teachers tend to pay attention to the past examinations to identify the content and skills covered in the examinations, thereafter teach students the identified skills and content (Kellaghan & Greaney, 2003). This means that quality of instructional activities in classroom including exposure to the teaching and learning materials and coverage of the curriculum content depend on the nature of the examinations contents (Biggs, 2003). When the degree of alignment between assessment and curriculum is high the implication is that most of the topics in the curriculum were assessed. Thus, teachers may be influenced to teach all the topics in the curriculum (Nasstrom & Hendricksson, 2008). This suggests that students' performance and achievement of the instructional objectives in curriculum can improve only when assessment and curriculum are aligned (Johnson, 2005; Manyooe, 2002).

The nature of examination also has effects on students' approaches to their work (Scouller, 1998). Additionally, when students find out that there are topics in the curriculum that do not appear in the examinations frequently they may not be motivated to study them (Doriye, 2008). This implies that students' performance in a particular examination can improve when the examination is aligned to curriculum because an opportunity to learn is a significant predictor for students' performance on the examinations (Stephen, 1997).

Alignment between curriculum and assessment is an important issue to education reform because it acts as a lever in the reform effort. This is because public examinations such as Chemistry CSEE send some information to teachers on what and how to teach (Kellaghan & Greaney, 2003). For example, although competence - based curriculum has been operational in China for many years, teachers continued to adopt traditional teacher-centred instructional methods in classroom because examinations were not aligned to their respective curricula (Hoingjia, Gavin, Fulmer, Laiang, Xintu & Yuan, 2013). Therefore, the high-stakes nature of the consequences associated with students' performance on examination has led educators to focus their attention on improving students' learning and eventually improve performance in examinations.

Curriculum reform was conducted in Tanzania in 2005 for the purpose of improving students' learning. The process resulted in a change from content-based curriculum which promoted teacher-centred teaching methodology to competence-based curriculum (CBE) (MoEVT, 2005). However, the studies conducted to investigate the implementation of CBE in various subjects including Chemistry revealed that teaching and learning approaches in classroom continued to be teacher-centred (Banda, 2011; Kagisi, 2009; Masyole, 2011; Shemwelekwa, 2008; Stuart, 2012; Timothy, 2011).

Furthermore, literature has shown that the degree of alignment between assessment and curriculum has impact on students' performance (Jacques, 2011, Johnson, 2005; Manyooe, 2004; Nasstrom, 2008), methods of teaching and learning in classroom (Alphonce, 2011; Boud & Falchikov, 2006; Kellaghan & Greaney, 2003), and coverage of curriculum contents (Edwards, 2010; Kellaghan & Greaney, 2003; Webb, 2005).

Despite the importance of alignment between assessment and curriculum in education, literature (Alphonce, 2011; Chonjo & Welford, 2001; Doriye, 2008; HakiElimu, 2012; Kirei, 2009) have shown that there are limited empirical studies on the alignment between Chemistry CSEE and the chemistry curriculum in terms of content coverage and cognitive complexity in Tanzania. In particular, several issues remain unknown regarding the degree of alignment between Chemistry CSEE and chemistry curriculum that can influence teaching and learning practices in classroom as well as the students' performance in Chemistry CSEE.

Conceptual framework of the study

The conceptual framework for this study consists of concepts which represent the Webb's alignment criteria. Figure 1 presents the conceptual framework for alignment between curriculum and assessment in terms of content coverage and cognitive complexity as used in this study.

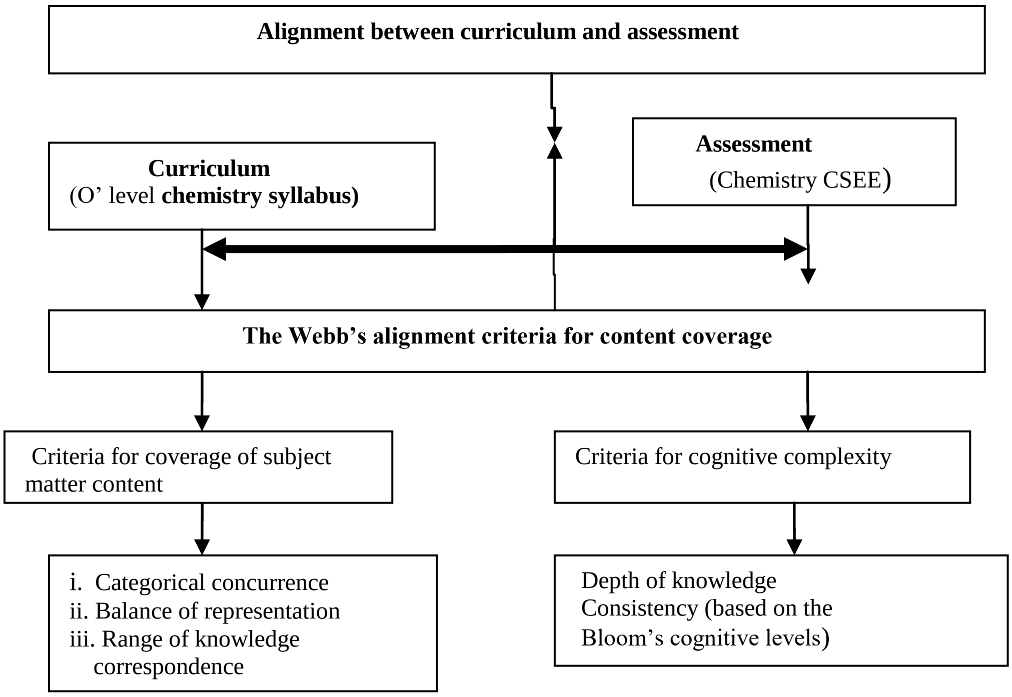

***Figure 1*:** Conceptual framework for alignment between curriculum and assessment in terms of content coverage
Source: Adapted from Webb (1997) alignment model

The study employed four of five alignment criteria of the Webb's alignment model namely: categorical concurrence, range of knowledge correspondence, balance of representation, and depth of knowledge consistency.

Categorical concurrence was used to judge whether both curriculum and assessment addressed the same content or not. The minimum acceptable level for this criterion was six hits per topic as suggested by Webb (1997). This means that a topic was considered as aligned to the examination when six questions in the Chemistry CSEE were set to measure attainment of the instructional objectives in the topic.

Range of knowledge correspondence was used to judge whether span of knowledge in the curriculum was the same and corresponded to the span of knowledge in the assessment item or not. The minimum acceptable level for this criterion in this study was set at 50 percent. This means that a topic in the curriculum was considered to be aligned to the examination when at least 50% of its objectives had at least one related assessment item in the Chemistry CSEE.

Balance of representation was used to measure distribution of the examination items among the objectives in a topic. The minimum acceptable level for this criterion in this study was 0.6 (60%). The index value of 1(100%) was obtained when all of the items assigned to a topic were evenly distributed among the objectives in the topic.

Depth of knowledge consistency was used to measure the degree of alignment between assessment items and the instructional objectives in the curriculum in terms of cognitive demand based on the levels of the Bloom's cognitive domain. The acceptable level for this criterion is at least 50 % (Webb, 1997). This means a topic was considered as aligned to the examination when at least 50% of the examination items were **at,** or **above** the cognitive level of the instructional objectives in the curriculum (Webb, 1997).

Purpose of the study

The purpose of this study was to investigate the alignment between Chemistry CSEE and the ordinary level Chemistry curriculum in terms of content and cognitive complexity. Specifically, the objectives of the study were to:

i) analyse the extent to which the Chemistry CSEE assessed the Chemistry curriculum in terms of content and Bloom's cognitive levels.

ii) explore teachers' views on the alignment between Chemistry CSEE and Chemistry curriculum in terms of content coverage.

Research Methodology

This study employed the mixed methods research approach. This approach involves both qualitative and quantitative research approaches to offset the weaknesses inherent in one research approach in order to enhance the validity of the data collected (Creswell, 2003; Creswell & Plano-Clark, 2007). It also applied the embedded mixed methods case study design. This deign fitted well in this study because it enabled the researchers to collect and analyse both qualitative and quantitative data to provide answers to the research questions.

Sampling procedures

The researchers employed purposive and random sampling techniques. Simple random sampling technique was used to select schools in Kilimanjaro region from which the chemistry teachers were obtained. Simple random sampling technique was used in order to minimize the potential bias in the selection of participants. It also enhanced generalisability of the findings. On the other hand, purposive sampling technique was used to select the Chemistry CSEE papers, curriculum, the NECTA examination officer; and the four Chemistry teachers who reviewed the Chemistry CSEE document and the Chemistry curriculum.

Data collection procedures

Qualitative data were obtained through content analysis of the curriculum and the Chemistry CSEE papers. According to Council of Chief State School Officers [CCSSO] (2002), an alignment analysis which employs the Webb's alignment model involved qualitative experts' judgment in data collection followed by quantified coding and analysis of the data from curriculum and assessment. Therefore, in this study, data on alignment between curriculum and the Chemistry CSEE were collected qualitatively by reviewers using checklists and analysis forms. Then, they were quantified in the coding and analysis process. The process involved three stages namely: selection of subject matter experts, training of reviewers, and assemblage of qualitative data through content analysis. In order to ensure reliability of coding, the reviewers were asked to code a sample of 5-10 items from the examinations and then they went through the items together to make sure that every reviewer understood the coding process before the analysis process. This step was followed by collection of data through systematic analysis of the Chemistry CSEE papers and the respective curriculum. The process involved: reviewing, interpretation and assigning depth of knowledge to the specific objectives in Chemistry curriculum and the Chemistry CSEE items with reference to levels of the Blooms' cognitive domain. The descriptions which were obtained in this step helped to clarify how well the different levels of the Bloom's cognitive domain were represented in the specific objectives and the examination items. They were also used in the analysis of the alignment between the examination and the curriculum in terms of cognitive complexity. Furthermore, the reviewers investigated the alignment between the examinations and curriculum in terms of their content coverage. Collection of quantitative data involved administration of Likert type questionnaires to the Chemistry teachers to get their views about the alignment between the examinations and the curriculum. A total of 21 Chemistry teachers from government and private schools filled in the questionnaires willingly and returned them to the researchers. The questionnaire had three commitments namely: *examined, I am not sure* and *not examined*. Therefore, teachers were requested to indicate the extent of their agreement or disagreement with the expressions. However, the commitment for *I am not sure* did not receive any comment from any of the respondents so it was not considered in the analysis process.

Data analysis

Qualitative data were coded into the Web Alignment Tool (WAT). This step was followed by computation of categorical concurrence, depth of knowledge consistency, range of knowledge correspondence and balance of representation from the data collected by the reviewers. For example, the following formula was used to compute the balance of representation.

The Webb's balance index $=1-\left(\sum_{k=1}^{o}\left|\frac{1}{(O)}-\frac{I(k)}{(H)}\right|\right)/2$

Where O =Total number of objectives hit for the standard

I (k) = Number of items hit corresponding to objective k

H =Total number of items hits for a standard

An index value of 1(100%) signifies perfect balance. It was obtained when the hits (items) corresponding to a topic were equally distributed among the objectives in the topic.

Quantitative data collected by questionnaires were organized and sorted. Thereafter, they were coded into the Statistical Packages for the Social Sciences (SPSS) software version 20 for computation of Chi-square values. The choice of Chi-square statistical test in this research was due to the fact that the research sample size was small and the data were categorical in nature.

Research Findings

Alignment in terms of content coverage and cognitive complexity

Tables 1, 2 and 3 present the WAT analysis findings from documentary review on alignment in terms of content coverage and cognitive complexity. While Table 1 presents the findings of the alignment in terms of content coverage, Table 2 presents alignment in terms of cognitive complexity and Table 3 provides a summary of attainment of the Webb's acceptable levels in the alignment in terms of content and cognitive complexity.

Table 1: *Alignment between Chemistry CSEE and Chemistry Curriculum in Terms of Content Coverage*

S/N	Topics in the 2007 chemistry curriculum	Categorical Concurrence			Range of Knowledge Correspondence			Balance of Representation		
		No. of Hits (Mean %)			Range of Objectives (mean %)			Balance Index Value (Mean %)		
		YEARS			YEARS			YEARS		
		2011	2012	2013	2 011	2012	2013	2011	2012	2013
1	Introduction to chemistry	0	0.8	0	0	20	0	0	0.8	0
2	Laboratory technique and safety	1.83	1.2	1	8	11	9	0.83	1	1
3	Heat sources and flames	1	4	2	25	30	25	1	0.9	1
4	Scientific procedure	0	0	0	0	0	0	0	0	0
5	Matter	1.83	4.2	4.8	10	22	9	1	1	0.76
6	Air, combustion, rusting and fire fighting	1.5	4.8	1	11	21	7	0.83	0.8	1
7	Oxygen	0.17	1	0.2	3	20	4	0.17	1	0.2
8	Hydrogen	1	1.8	2	25	40	25	1	1	1
9	Water	1.33	2	0.8	8	20	8	0.83	1	0.8
10	Fuel and energy	0	1.8	3.2	0	16	9	0	1	1
11	Atomic structure	3	2	8.2	33	22	60	1	1	0.84
12	Periodic classification	1	3	5.8	25	50	75	1	0.8	0.78

S/N	Topics in the 2007 chemistry curriculum	Categorical Concurrence			Range of Knowledge Correspondence			Balance of Representation		
		No. of Hits (Mean %)			Range of Objectives (mean %)			Balance Index Value (Mean %)		
		YEARS			YEARS			YEARS		
		2011	2012	2013	2 011	2012	2013	2011	2012	2013
13	Formula, bonding and nomenclature nomenclature	7.5	5.2	6.4	58	42	42	0.92	0.9	0.83

S/N	Topics in the 2007 chemistry curriculum	Categorical Concurrence			Range of Knowledge Correspondence			Balance of Representation		
		No. of Hits (Mean %)			Range of Objectives (mean %)			Balance Index Value (Mean %)		
		YEARS			YEARS			YEARS		
		2011	2012	2013	2 011	2012	2013	2011	2012	2013
14	Chemical equation	5.33	6.4	11	40	40	60	0.88	0.7	0.53
15	Hardness of water	1.17	1.2	1.2	14	17	17	1	1	1
16	Acid, bases and salts	12.83	9	2.6	53	40	18	0.77	0.8	0.97
17	The mole and related calculations	3.83	5.4	2.2	48	46	29	0.92	0.8	0.97
18	Volumetric analysis	0.5	6.2	11.2	48	40	44	0.82	0.8	0.8
19	Ionic theory and electrolysis	4.83	3	2.4	24	27	22	0.73	1	1

20	Chemical kinetics, equilibrium and energetic	5.67	6.6	11.6	24	29	60	0.68	0.8	0.8
21	Extraction of Metals	2	3.2	5	18	29	25	1	1	0.7
22	Compounds of metals	1.17	6.2	2.6	6	24	10	1	0.9	0.9
23	Non metals and their compounds	1.83	7.8	9.6	7	22	26	1	0.8	0.8
24	Organic Chemistry	3	4.2	11.6	8	13	25	0.83	0.9	0.8
25	Soil chemistry	1.83	1.2	5.2	5	4	21	1	0.8	0.8
26	Pollution	4	4.4	2.8	14	15	13	1	0.9	1
27	Qualitative Analysis	1.33	2	2.4	14	14	20	1	1	1
	Total	79.5	98.6	116.6	19	25	24	0.78	0.9	0.78

Table 2: *Alignment between Chemistry CSEE and Chemistry Curriculum in Terms of Cognitive Complexity*

S/N	Topics in the 2007chemistrycurriculum	**Depth of Knowledge Consistency** (Mean **%)**								
		YEARS 2011			2012			2013		
		%Under	**%At**	**%Above**	**%Under**	**%At**	**%Above**	**%Under**	**%At**	**%Above**
1	Introduction to Chemistry	0	0	0	0	0	100	0	0	0
3	Laboratory techniques and	10	90	0	50	33	17	20	80	0

S/N	Topics in the 2007chemistrycurriculum	Depth of Knowledge Consistency (Mean %)								
	YEARS	2011			2012			2013		
		%Under	**%At**	**%Above**	**%Under**	**%At**	**%Above**	**%Under**	**%At**	**%Above**
	safety									
3	Heat sources and flames	50	50	0	14	12	74	0	0	100
4	Scientific procedure	0	0	0	0	0	0	0	0	0
5	Matter	82	18	0	62	14	24	29	71	0
6	Air, combustion, rusting and fire fighting	0	0	100	42	21	37	0	0	100
7	Oxygen	0	0	100	80	20	0	0	0	100
8	Hydrogen	100	0	0	58	42	0	10	80	10
9	Water	23	57	20	50	50	0	0	100	0
10	Fuel and energy	0	0	0	44	45	11	0	0	100
11	Atomic structure	28	72	0	60	40	0	39	61	0
12	Periodic classification	0	100	0	60	33	7	34	45	21
13	Formula, bonding and	0	29	71	5	50	45	27	39	34

S/N	Topics in the 2007chemistrycurriculum	Depth of Knowledge Consistency (Mean %)									
		YEARS	2011			2012			2013		
			%Under	**%At**	**%Above**	**%Under**	**%At**	**%Above**	**%Under**	**%At**	**%Above**
	nomenclature										
14	Chemical equations		38	3	59	6	29	65	5	22	73
15	Hardness of water		0	50	50	83	0	17	0	67	33
16	Acid , Bases and salts		92	8	0	44	29	27	88	6	6
17	The mole and related calculations		22	69	9	0	100	0	53	47	0
18	Volumetric analysis		6	76	18	16	45	39	42	33	25
19	Ionic theory and electrolysis		0	76	24	40	7	53	50	8	42
20	Chemical kinetic, equilibrium and energetics		32	41	27	18	15	67	26	43	31
21	Extraction and properties of metals		0	50	50	31	31	38	4	28	68
22	Compounds of metals		43	57	0	67	26	7	7	30	63

S/N	Topics in the 2007chemistrycurriculum	Depth of Knowledge Consistency (Mean %)								
		YEARS 2011			2012			2013		
		%Under	**%At**	**%Above**	**%Under**	**%At**	**%Above**	**%Under**	**%At**	**%Above**
23	Non metals and their compounds	91	9	0	46	8	46	7	60	33
24	Organic chemistry	33	67	0	54	38	8	18	52	30
25	Soil chemistry	100	0	0	0	92	8	58	34	8
26	Pollution	0	0	100	26	35	39	29	7	64
27	Qualitative analysis	0	11	89	100	0	0	0	0	100
	Total	30	40	30	42	30	28	28	39	33

Key:* *%Under *= cognitive level of the examination item was under the cognitive level of the instructional objectives*

%At = cognitive level of the examination item was at the cognitive level at the cognitive level of the instructional objectives

%Above= cognitive level of the examination item was above the cognitive level of the instructional objectives

Table 3: *Summary of Attainment of Webb's Acceptable Levels in the Alignment in Terms of Content and Cognitive Complexity*

			Categorical Concurrence			**Depth of knowledge Consistency**			**Range of knowledge Correspondence**			**Balance of Representation**		
S/N	Topics in the 2007 Curriculum		No. of Hits			Mean (%)			Range of objectives mean (% of total)			Balance Index Value (mean)		
		YEARS	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013
	Chemistry curriculum													
1	Introduction to Chemistry		NO	NO	NO	NO	YES	NO	NO	NO	NO	NO	YES	NO
2	Laboratory technique and safety		NO	NO	NO	YES	YES	NO	NO	NO	NO	YES	YES	YES

			Categorical Concurrence			Depth of knowledge Consistency			Range of knowledge Correspondence			Balance of Representation		
S/N	Topics in the 2007 Curriculum		No. of Hits			Mean (%)			Range of objectives mean (% of total)			Balance Index Value (mean)		
		YEARS	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013
3	Heat sources an nes		NO	NO	NO	YES	YES	YES	NO	NO	NO	YES	YES	YES
4	Scientific procedure		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5	Matter		NO	NO	NO	NO	NO	WEA	NO	NO	NO	YES	YES	YES
6	Air, combustion, rusting and fire fighting		NO	NO	NO	YES	NO	YES	NO	NO	NO	YES	YES	YES
7	Oxygen		NO	NO	NO	YES	NO	YES	NO	NO	NO	NO	YES	YES

			Categorical Concurrence			**Depth of knowledge Consistency**			**Range of knowledge Correspondence**			**Balance of Representation**		
S/N	Topics in the 2007 Curriculum		No. of Hits			Mean (%)			Range of objectives mean (% of total)			Balance Index Value (mean)		
		YEARS	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013
8	Hydrogen		NO	NO	NO	NO	WEA	NO	NO	WEAK	NO	YES	YES	NO
9	Water		NO	NO	NO	YES	YES	NO	NO	NO	NO	YES	YES	NO
10	Fuel and energy		NO	NO	NO	NO	YES	YES	NO	NO	NO	NO	YES	NO
11	Atomic structure		NO	NO	YES	YES	WEA	YES	NO	NO	YES	YES	YES	YES
12	Periodic classification		NO	NO	NO	YES	NO	YES	NO	YES	YES	YES	YES	YES
13	Formula, bonding and		YES	NO	YES	YES	YES	YES	YES	WEAK	WEAK	YES	YES	YES

S/N	Topics in the 2007 Curriculum		**Categorical Concurrence**			**Depth of knowledge Consistency**			**Range of knowledge Correspondence**			**Balance of Representation**		
			No. of Hits			Mean (%)			Range of objectives mean (% of total)			Balance Index Value (mean)		
		YEARS	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013
14	Nomenclature Chemical equation		NO	YES	YES	YES	YES	YES	NO	WEAK	YES	YES	YES	NO
15	Hardness of water		NO	NO	NO	YES	NO	YES	NO	NO	NO	YES	YES	WEAK
16	Acid, bases and salts		YES	YES	NO	NO	WEA	NO	YES	WEAK	NO	YES	YES	YES
17	The mole and related Calculations		NO	NO	NO	YES	YES	YES	WEAK	WEAK	NO	YES	YES	YES
18	Volumetric		YES	YES	YES	YES	YES	YES	WEAK	WEAK	WEAK	YES	YES	YES

			Categorical Concurrence			**Depth of knowledge Consistency**			**Range of knowledge Correspondence**			**Balance of Representation**		
S/N	Topics in the 2007 Curriculum		No. of Hits			Mean (%)			Range of objectives mean (% of total)			Balance Index Value (mean)		
		YEARS	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013
	analysis													
19	Ionic theory and ctrolysis		NO	NO	NO	YES	YES	YES	NO	NO	NO	YES	YES	YES
20	Chemical kinetic, equilibrium and energetic		NO	YES	YES	YES	YES	YES	NO	NO	YES	WEAK	YES	YES
21	Extraction and properties of metals		NO	NO	NO	YES	YES	YES	NO	NO	NO	YES	YES	YES
22	Compounds of		NO	YES	NO	YES	NO	YES	NO	NO	NO	YES	YES	YES

			Categorical Concurrence			**Depth of knowledge Consistency**			**Range of knowledge Correspondence**			**Balance of Representation**		
S/N	Topics in the 2007 Curriculum		No. of Hits			Mean (%)			Range of objectives mean (% of total)			Balance Index Value (mean)		
		YEARS	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013
	metals													
23	Non metals and their Compounds		NO	YES	YES	NO	WEA	YES	NO	NO	NO	YES	YES	YES
24	Organic chemistry		NO	NO	YES	YES	WEA	YES	NO	NO	NO	YES	YES	YES
25	Soil chemistry		NO	NO	NO	NO	YES	NO	NO	NO	NO	YES	YES	YES
26	Pollution		NO	NO	NO	YES	YES	YES	NO	NO	NO	YES	YES	YES
27	Qualitative analysis		NO	NO	NO	YES	NO	YES	NO	NO	NO	YES	YES	YES

Note: *The acceptable level for categorical concurrence = 6 hits*
The acceptable level for range of knowledge correspondence = 0.5 (50%) and above
The acceptable level for balance of presentation = 0.6 (60%) and above
The acceptable level for depth of knowledge consistency = 0.5 (50%) and above

Key: **YES** means the Webb's acceptable level was reached
NO means the Webb's acceptable level was not reached

Alignment in terms of content coverage

The findings in Table1 and Table 3 revealed that 22 (81.5%), 26 (96.3%), and 23 (85.2%) of 27 topics in 2007 curriculum which were examined in the 2011, 2012, and 2013 Chemistry CSEE respectively had items which were well distributed among the objectives in the topics. This means that the Chemistry CSEE was strongly aligned with the Chemistry curriculum in terms of balance of representation.

However, the Webb's acceptable level for categorical concurrent and range of knowledge correspondence were not reached in most of the topics in the curriculum. The findings show that only 3 (10%), 6 (22.2%) and 7(25.9%) of the 27 topics in the curriculum which were examined in the 2011, 2012 and 2013 Chemistry CSEE respectively reached the Webb's acceptable level for categorical concurrence. Similarly, the findings showed that 2 (7.4%), 1 (3.7%) and 4 (14.8%) of the 27 topics in the 2007 curriculum which were examined in the 2011, 2012 and 2013 Chemistry CSEE reached the acceptable level for range of knowledge correspondence; and 2 (7.4%), 6 (22.2%) and 2 (7.4%) of the topics in the curriculum which were examined in the 2011, 2012 and 2013 Chemistry CSEE respectively were weakly accepted. Moreover, it was revealed that one of the examinations questions in the 2013 Chemistry CSEE on *extraction of metal* was out of the objectives in the curriculum.

Alignment in terms of cognitive complexity

The findings in Table 2 and Table 3 show that 19 (70.4%), 17 (63%) and 22 (81.1%) of the 27 topics in the curriculum examined in 2011, 2012 and 2013 Chemistry CSEE respectively reached the Webb's acceptable level for depth of knowledge consistency. Additionally, depth of knowledge of instructional objectives and the examinations items were identified and classified by the reviewers into Lower Order Cognitive Skills (LOCS) and the Higher Order Cognitive Skills (HOCS) based on the levels of the Bloom's cognitive domain. The LOCS include knowledge and comprehension levels and the HOCS include application, analysis, synthesis and evaluation levels (Fredrick, 2012). The findings showed that 56.3% of the instructional objectives in the 2007 chemistry curriculum were set in LOCS and 43.8% in HOCS. It was also found out that 54.3%, 50.9% and 52.1% of the 2011, 2012 and 2013 Chemistry CSEE items were set in LOCS respectively. These findings indicate that the examinations were strongly aligned with the curriculum in terms of cognitive demand. However, larger percent of the examination questions in the Chemistry CSEE and the instructional objectives in curriculum are found in lower levels of the Bloom's cognitive domain.

Teachers' views on the alignment between Chemistry CSEE and Chemistry curriculum in terms of content coverage

Table 4 presents the findings of the Chi-square test for teachers' views on the alignment between the Chemistry CSEE and the chemistry curriculum in terms of content coverage.

***Table** 4: Chi-square Test Analysis Results for Teacher's Views on Coverage of the Curriculum by the 2011-2013 Chemistry CSEE Items*

2007 curriculum contents			**Teachers' views (in %) on content coverage**					
			Examination Year					
			2011		2012		2013	
S/N	Topic	Sub topics	Examined	Not Examined	Examined	Not Examined	Examined	Not Examined
1	Introduction chemistry	Concept of chemistry	0.0	100.0	14.3	85.7	0.0	100.0
2	Laboratory technique and	Rules and safety precautions	0.0	100.0	0.0	100.0	42.9	57.1

2007 curriculum contents			**Teachers' views (in %) on content coverage**					
			Examination Year					
			2011		2012		2013	
S/N	Topic	Sub topics	Examined	Not Examined	Examined	Not Examined	Examined	Not Examined
		First aid kit and First aid kit	100.0	0.0	0.0	100.0	57.1	42.9
		Chemical laboratory apparatus	95.2	4.8	100.0	0.0	81.0	19.0
3	Heat sources and flames	Heat sources and frame	100.0	0.0	81.0	19.0	85.7	14.3
4	Scientific procedure	Scientific procedure	0.0	100.0	0.0	100.0	0.0	100.0
5	Matter	Concept of matter	0.0	100.0	28.6	71.4	0.0	100.0

			Teachers' views (in %) on content coverage					
2007 curriculum contents			**Examination Year**					
			2011		2012		2013	
S/N	Topic	Sub topics	Examined	Not Examined	Examined	Not Examined	Examined	Not Examined
		States of matter	71.4	28.6	19.0	81.0	0.0	100.0
		Physical and chemical changes	95.2	4.8	0.0	100.0	0.0	100.0
		Element and symbols	95.2	4.8	76.2	23.8	66.7	33.3
		Compound and mixtures	81.0	19.0	38.1	61.9	85.7	14.3
		Separation of mixtures	100.0	0.0	76.2	23.8	100.0	0.0
6	Air, combustion and fire fighting	Composition of air	0.0	100.0	0.0	100.0	71.4	28.6
		Combustion	4.8	95.2	9.5	90.5	0.0	100.0

2007 curriculum contents			Teachers' views (in %) on content coverage					
			Examination Year					
			2011		2012		2013	
S/N	Topic	Sub topics	Examined	Not Examined	Examined	Not Examined	Examined	Not Examined
7	Oxygen	Fire fighting	0.0	100.0	0.0	100.0	0.0	100.0
		Rusting	14.3	85.7	4.8	95.2	0.0	100.0
		Preparation and properties of oxygen	0.0	100.0	14.3	85.7	100.0	0.0
		Uses of oxygen	100.0	0.0	61.9	38.1	0.0	100.0
8	Hydrogen	Preparation and properties of hydrogen	100.0	0.0	33.3	66.7	81.0	19.0
		Uses of hydrogen	10 0.0	0.0	0.0	100.0	0.0	100.0
9	Water	The nature and properties of water	85.7	14.3	90.5	9.5	85.7	14.3

	2007 curriculum contents		Teachers' views (in %) on content coverage					
			Examination Year					
			2011		2012		2013	
S/N	Topic	Sub topics	Examined	Not Examined	Examined	Not Examined	Examined	Not Examined
10	Fuel and energy	Water treatment and purification	100.0	0.0	100.0	0.0	81.0	81.0
		Fuel	0.0	100.0	42.9	57.1	0.0	100.0
		Conservation of energy	0.0	100.0	0.0	100.0	42.9	57.1
11	Atomic structure	Sub atomic particles	95.2	4.8	57.1	42.9	100.0	0.0
		Atomic number, mass number and isotopy	100.0	0.0	76.2	23.8	81.0	19.0
12	Periodic classification	General periodic trend	100.0	0.0	90.5	9.5	100.0	0.0
13	Formula bonding	Valence and Chemical	85.7	14.3	81.0	19.0	42.9	57.1

2007 curriculum contents			Teachers' views (in %) on content coverage					
			Examination Year					
			2011		2012		2013	
S/N	Topic	Sub topics	Examined	Not Examined	Examined	Not Examined	Examined	Not Examined
	and nomenclature	formulae						
		Oxidation states	9.5	90.5	47.6	52.4	19.0	81.0
		Radicals	9.5	90.5	9.5	90.5	61.9	38.1
		Covalent bonding	0.0	100.0	19.0	81.0	9.5	90.5
		Electrovalent bonding	100.0	0.0	42.9	57.1	0.0	100.0
14	Chemical equations	Molecular equations	100.0	0.0	57.1	42.9	100.0	0.0
		Ionic equations	85.7	14.3	0.0	100.0	100.0	0.0
15	Hardness of	Hardness of water	76.2	23.8	9.5	90.5	100.0	0.0

			Teachers' views (in %) on content coverage					
2007 curriculum contents			**Examination Year**					
			2011		2012		2013	
S/N	Topic	Sub topics	Examined	Not Examined	Examined	Not Examined	Examined	Not Examined
	water							
16	acids, bases and salts	Acids and bases	100.0	0.0	81.0	19.0	100.0	0.0
		Salt	82.4	17.6	71.4	28.6	85.7	14.3
17	Mole and related Calculations	Mole as a unit of measurement	77.1	22.9	28.6	71.4	19.0	81.0

2007 curriculum contents			Teachers' views (in %) on content coverage					
			Examination Year					
			2011		2012		2013	
S/N	Topic	Sub topics	Examined	Not Examined	Examined	Not Examined	Examined	Not Examined
		Application of the mole concept	90.5	9.5	81.0	19.0	95.2	4.8
18	Volumetric analysis	Standard volumetric apparatus	95.2	4.8	19.0	81.0	81.0	19.0
		Standard solutions	100.0	0.0	100.0	0.0	100.0	0.0
		Volumetric calculation	100.0	0.0	100.0	0.0	100.0	0.0
		Application of volumetric analysis	95.2	4.8	38.1	61.9	71.4	28.6
		Ionic theory	71.4	28.6	28.6	71.4	19.0	81.0
19	Ionic theory and	The Mechanism of	85.7	14.3	100.0	0.0	76.2	23.8

2007 curriculum contents			Teachers' views (in %) on content coverage					
			Examination Year					
			2011		2012		2013	
S/N	Topic	Sub topics	Examined	Not Examined	Examined	Not Examined	Examined	Not Examined
	electrolysis	electrolysis						
		Laws of electrolysis	76.2	23.8	19.0	81.0	81.0	19.0
		Application of electrolysis	95.2	4.8	14.3	85.7	76.2	23.8
20	Chemical kinetics and equilibrium	Rate of chemical reactions	100.0	0.0	52.4	47.6	57.1	42.9
		Factors affecting rate of reactions	91.0	9.0	90.5	9.5	76.2	23.8
		Reversible reactions	100.0	0.0	0.0	100.0	100.0	0.0
		Equilibrium reactions	100.0	0.0	0.0	100.0	100.0	0.0
		Endothermic and	100.0	0.0	0.0	100.0	61.9	38.1

2007 curriculum contents			Teachers' views (in %) on content coverage					
			Examination Year					
			2011		2012		2013	
S/N	Topic	Sub topics	Examined	Not Examined	Examined	Not Examined	Examined	Not Examined
		exothermic reactions						
21	Extraction of Metals	Occurrence and location of metals in Tanzania	0.0	100.0	9.5	90.5	0.0	100.0
		Chemical properties of metals	95.2	4 .8	85.7	14.3	81.0	19.0
22	Compounds of	Extraction of metals	100.0	0.0	100.0	0.0	100.0	0.0

2007 curriculum contents			Teachers' views (in %) on content coverage					
			Examination Year					
			2011		2012		2013	
S/N	Topic	Sub topics	Examined	Not Examined	Examined	Not Examined	Examined	Not Examined
		Oxides	95.2	4.8	85.7	14.3	100.0	0.0
		Hydroxides	76.7	13.3	85.7	14.3	85.71	14.3
		Carbonates and hydrogen Carbonates	81.0	19.0	4.8	95.2	90.5	9.5
		Nitrates	90.5	9.5	76.2	23.8	90.5	9.5
		Chlorides	100.0	0.0	9.5	90.5	81.0	19.0
	Non metals and	Sulphates	14.3	85.7	15.3	100.0	90.5	9.5

2007 curriculum contents			Teachers' views (in %) on content coverage					
			Examination Year					
			2011		2012		2013	
S/N	Topic	Sub topics	Examined	Not Examined	Examined	Not Examined	Examined	Not Examined
		General chemical properties of non metals	95.2	4.8	28.6	71.4	38.1	61.9
		Chlorine	0.0	100.0	100.0	0.0	100.0	0.0
		Hydrogen chloride	4.8	95.2	95.2	4.8	85.7	14.3
		Sulphur	100.0	0.0	100.0	0.0	100.0	0.0
		Sulphuric acid	100.0	0.0	100.0	0.0	14.3	85.7
		Sulphur dioxide	100.0	0.0	95.2	4.8	66.7	33.3
		Nitrogen	100.0	0.0	100.0	0.0	100.0	0.0
		Ammonia	100.0	0.0	71.4	28.6	4.8	95.2
		Carbon	100.0	0.0	100.0	0.0	100.0	0.0

			Teachers' views (in %) on content coverage					
2007 curriculum contents			Examination Year					
			2011		2012		2013	
S/N	Topic	Sub topics	Examined	Not Examined	Examined	Not Examined	Examined	Not Examined
23	Organic chemistry	Carbon dioxide	86.7	13.3	95.2	4.8	85.7	14.3
		Introduction to organic chemistry	77.1	22.9	81.0	19.0	85.7	14.3
		Families of hydrocarbons	100.0	0.0	85.7	14.3	81.0	19.0
		Properties of hydrocarbons	61.9	38.1	28.6	71.4	81.0	19.0
		Alcohol	100.0	0.0	0.0	100.0	66.7	33.3
		Carboxylic acids	23.8	76.2	100.0	0.0	85.7	14.3
24	Soil chemistry	Soil reaction	47.6	52.4	0.0	100.0	81.0	19.0

			Teachers' views (in %) on content coverage					
2007 curriculum contents			Examination Year					
			2011		2012		2013	
S/N	Topic	Sub topics	Examined	Not Examined	Examined	Not Examined	Examined	Not Examined
25	Pollution	Plant nutrients in the soil	96.2	3.8	0.0	100.0	28.6	71.4
		Manures and fertilizers	66.7	33.3	71.4	28.6	9.5	90.5
		Terrestrial pollution	0.0	100.0	0.0	100.0	19.0	81.0
		Water pollution	90.5	9.5	76.2	23.8	52.4	47.6
		Air pollution	0.0	100.0	66.7	33.3	66.7	33.3
26	Qualitative analysis	Concept of qualitative analysis	0.0	100.0	0.0	100.0	0.0	100.0
		Qualitative analysis procedure	100.0	0.0	100.0	0.0	100.0	0.0

Key: Examined= the topic was examined (question(s) were set to assess attainment of instructional

Not Examined= the topic was not examined (no question was set to assess attainment of instructional objectives)

The findings in Table 4 indicate that 24 (88.9%), 26 (96.3%) and 25 (92.6%) of the 27 topics in the curriculum were examined in the 2011, 2012 and 2013 Chemistry CSEE respectively. This means most of the topics in the curriculum were examined in the CSEEs. The findings also revealed that all topics and subtopics in the Chemistry curriculum were examined at least once in the years studied except for one topic on *scientific procedure*; and 2 subtopics which are *fire fighting* and *conservation energy.* The topic on *scientific procedure* is usually examined in the Continuous Assessment (CA) project work (NECTA, 2003).

Discussion of Findings

This section presents the discussion of findings of the study in accordance with the respective objectives.

Alignment in terms of cognitive complexity

The findings revealed that most of the examinations were strongly aligned with the curriculum in terms of cognitive demand. However, the findings indicated that larger percentage of the instructional objectives in the curriculum and the examination questions were set at lower levels of the Bloom's cognitive domain. Therefore, since the aim of introducing CBE in Tanzania was to produce graduates who are able to apply the knowledge and skills in real-life situation (MoEVT, 2005), then both the examination questions and the instructional objectives should put emphasis on Higher Order Cognitive Skills (HOCS). This is important because it has been acknowledged that it is assessment rather than teaching that influences students' learning and it has powerful effect on students' approaches on their work (Bound & Falkchikov, 2006). For example, when examinations consist of knowledge questions while the instructions emphasized on problem solving skills, students tend to memorize information and ignore much of the instructions in order to pass the examinations (Kellaghan & Greaney, 2003).

The concern that most of the items in the CSEE measured achievement of the instructional objectives in curricula in Lower Order Cognitive Skills (LOCS) had also been reported in earlier studies. Caldwell and Pate (2013) in a study which investigated the effects of question format on students' performance found out that 70% of the examination questions were set at LOCS. Similarly, HakiElimu (2012) found out that 73% and 57% of the items in the Biology CSEE and Geography CSEE respectively were set at LOCS. Similar findings were obtained by Alphonce (2011) in a study that investigated the extent to which the national examinations including Biology CSEE and FTSEE were used as a tool for promoting development of higher order cognitive skills among students in Tanzania. The findings of the study revealed that 55%, 69% and 70% of the examination questions in the 2008, 2009 and 2010 Biology CSEE respectively were set at LOCS.

Alignment in terms of content coverage

The findings show that the Chemistry CSEE was strongly aligned with the Chemistry curriculum in terms of balance of representation. However, most of the topics examined in the curriculum did not reach the Webb's acceptable levels for categorical concurrence and range of knowledge correspondence. This could be attributed to the nature of the examinations and the curriculum studied because categorical concurrence and range of knowledge correspondence are influenced by the length of the examination and curriculum. The curriculum consists of 27 topics with 306 objectives which are studied from Form One to Form Four secondary education. In addition, the questions per examination were limited to 57, 59 and 71 in the Chemistry CSEE in 2011, 2012 and 2013 respectively. As such, it could not be possible to reach the Webb's acceptable levels for categorical concurrence and range of knowledge for every topic in the curriculum.

Although the Webb's acceptable level for categorical concurrence was not met for most of the topics in the curriculum due to the reasons stated earlier, the findings in Tables 1 and 4 on the alignment in terms of content coverage revealed that most of the topics in the curriculum were examined. However, the findings show that one examination question on *extraction of aluminium metal* in the 2013 Chemistry CSEE was set out of the objectives in the curriculum. This might have imposed some effect on students' performance because classroom instructions are based on the curriculum content.

Similar findings were obtained in a related study conducted by HakiElimu (2012) on Biology CSEE. The study found that, one of the questions in the 2008 Biology CSEE on '*Risk behaviour*' and another question in the 2009 biology CSEE on '*Soil*' topic had no corresponding objectives in the Biology curriculum. According to the National Council for Accreditation of Teacher Education [NCATE] (2001), the examinations whose items were lacked corresponding objectives in the curriculum were not fair to the candidates because a fair examination ought to be constructed from the contents that candidates were guided by the curriculum to learn and practice.

The findings also indicated that some of the topics in the curriculum were overrepresented in the examinations while others were examined with few questions. Also, some of the topics were not examined at all. According to Biggs (2003), it is important for the examinations to include all the topics in the curriculum because quality of instructional activities in classroom including exposure to the teaching and learning materials and coverage of the curriculum content are determined by the nature of the examination content. This is due to the fact that some teachers tend to study the content of the examination and teach the students the contents covered in the examination (Kellaghan & Greaney, 2003). Thus, if they found out that there are topics which do not appear in the examination frequently they would not teach the topics as required. In the same vein, when students found out that there are topics in the curriculum that do not appear in the examinations frequently they are generally not motivated to study those topics (Doriye, 2008).This implies that students’ performance in an examination can improve when the examination items cover all the topics in the curriculum because an opportunity to learn is a significant predictor of students’ performance in the examinations (Stephen, 1997).

Other empirical studies in the same variables showed similar findings. For example, Smith (2012) conducted a study to determine the extent to which assessments in the Victorian middle years’ science programme in Australia aligned with their respective curricula. The findings revealed that most of the assessment tasks studied were strongly aligned with the curricula materials. However, some of the assessment tasks did not reach the Webb’s acceptable level for categorical concurrence. A related study was conducted by Webb (2002) that involved three States in USA namely: State E which included

Grades 4, 7, and 9; State F which included Grades 5 and 8; and State G which included Grades 4, 8, and 11. The findings showed that assessment of State E was strongly aligned with the standards because the acceptable level for categorical concurrence was met in all grade 7 standards; and in one of the grade 9 standard. This means that some of the assessments including those of States F and G were not aligned with their respective curriculum.

HakiElimu (2012) conducted a similar study to investigate the relationship between CSEE and curriculum objectives in Geography, Mathematics, English language and Biology for 2008, 2009, 2010, and 2011 in Tanzania. The findings showed that examinations reflected the contents of the curriculum and more than 60% of the examination questions were based on the respective subject curriculum.

Conclusion and Recommendations

The findings revealed that the Chemistry CSEEs were aligned with the chemistry curriculum in terms of content coverage. However, the items which were lacking corresponding objectives in the curriculum might have affected students' performance in the respective examination. This is because classroom instruction is guided by the curriculum. Therefore, the study recommends that setting examination questions should reflect on the curriculum in terms of content and cognitive demand. This can be achieved through appropriate use of table of specification which matches the examination items and the instructional objectives. This will ensure that each examination question corresponds to at least one of the objectives in the curriculum.

The study also recommends for improvements that involve revision of the specific objectives in the curriculum to ensure that most of the expected outcomes are set in higher levels of the Bloom's cognitive domain. This would fit well with one of the goals of introducing CBE that aimed to help learners demonstrate abilities including application of the knowledge in real- life situations (MoEVT, 2005).

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