International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Relevance of Nigerian Chemistry Textbooks to STM Knowledge and Skills

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Abstract: ***The study examined the extent to which four Nigerian Chemistry textbooks satisfied the criteria for inculcating STM knowledge and skills. The study adopts descriptive design that involves content analysis of predefined themes in the textbook. The instrument for data analysis is Textbook Analysis Scale (TAS) which is a combination of thematic and quantitative approach to assessing the quality of selected Chemistry textbooks. TAS consists of four themes which are topical coverage, practical and project activities, study questions, readability and comprehensibility. The frequency of the themes in each textbook was determined through content analysis that involves coding the manifest content. The study found the topical coverage index (TCI) of the Chemistry textbooks to be 0.97and study questions indices (SQI)of the four Chemistry textbook to be 0.9, 1.5, 0.85 and 0.52. Also, the practical and project activities indices (PAI) of the Chemistry textbooks are 0.81, 0.25, 0.40 and 0.29. The readability and comprehensibility indices (RCI) for the four textbooks are 0.64, 0.56, 0.60 and 0.28. All the Chemistry textbooks meet the acceptable criterion for TCI. Also, two Chemistry textbook did not meet the criterion for SQI. The Chemistry textbooks with PAI values of 0.25 and 0.29 did not meet the criterion for promoting enquiry. Lastly, only one of the textbooks did not meet the criterion for readability and comprehensibility. The implication of the finding is that Chemistry textbooks should be reviewed to ensure they reflect the goal of the Chemistry curriculum and satisfy the criteria for inculcating STM knowledge and skills.***

Keywords: Chemistry textbooks, STM knowledge and skills, study questions, topical coverage, practical and project activities, readability and comprehensibility, relevance

1. Introduction

Among the goals of the Chemistry curriculum is the acquisition of Science, Technology and Mathematics (STM) knowledge and skills. STM is a curriculum based on the ideas of educating students on three specific disciplines-science, technology and mathematics in an interdisciplinary and applied approach. It can also be described as interdisciplinary approach to learning where academic concepts are coupled with real life world lessons. The National Research Council (NRC) (1996) viewed learning as an active process in which students construct their own understanding of the natural world and establish connections between science and technology. NRC argued that by engaging students in activities that are both "hands-on" and "minds-on, " teachers can guide their classes through challenging science experiences. These activities allow students to transfer concrete experiences to abstract concepts; explore, experiment, and use technology. In this way students are actively involved in their own learning by observing, comparing, classifying, measuring, predicting, and communicating results.

Chemistry is related to STM knowledge and skills because of the interdisciplinary nature of its concepts. There is a two way exchange of chemistry with physics and biology, therefore most problems that require physics or biological knowledge may also require chemistry principles. In addition, the Chemistry curriculum aims to inculcate STM knowledge and skills in students through organisation of the contents around four themes: Chemical world; Chemistry and environment; Chemistry and industry; and Chemistry and life (FME, 2012). The Chemical world centers on the theoretical aspect of Chemistry while other themes focus on relevance of chemistry to industry, environment, and life.

It is expected that themes on Chemistry and environment will contain contents on climate change, water and sanitation, affordable and clean energy. Moreover, the theme on Chemistry and industry are supposed to include contents on how chemical elements can be manipulated to produce various goods. Furthermore, contents that relates to life on land and life under water are expected to be components of theme on chemistry and life. However, this objective can be achieved when there is appropriate selection of contents that are sufficiently linked to these themes. Also, there must be interaction between the contents and teaching strategies that are used in teaching and learning of Chemistry. The objectives of chemistry curriculum to inculcate STM skills and knowledge cannot be achieved if learner centred teaching strategies are not employed in teaching and learning (Oloruntegbe, 2010; FME, 2012; Ayodele, 2020).

Appropriate selection of content and teaching strategies can be facilitated through the adaptations and utilization of relevant Chemistry textbooks. This position has been advocated by NEEDS that has a goal of producing education materials that reflect the revised curricula (IMF, 2005). Textbooks are essential components of instructional materials for teaching and learning of Chemistry. Sobremisiana, Aragon and Cruz (2013) stated that textbook is considered a written curriculum that links the intended National Curriculum statements to the implemented curriculum in the classroom. This is due to the curriculum document statements that specify the contents, learning and teaching activities, and assessment without a comprehensive detail for transforming them into the classroom activities. Thus, textbooks support and provide resources for teaching and learning.

It acts as effective tools to ensure consistency, coverage, appropriate spacing, and better quality in terms of

instruction and content. Well planned activities are likely to aid teachers in selection of appropriate teaching strategies, and make delivery of lessons less difficult. It could be argued that teachers at the secondary school level rely mainly on textbooks for development of lesson plan and contents taught to students. Also, textbook is one of the teaching materials that students depend on for home work, class work, assignments and projects. Thus, it is important that instructional design of textbooks should align with the goals of inculcating STM knowledge and skills.

The chemistry textbooks that are recommended by the Ministry of Education for use in secondary schools are:

- New School Chemistry for Senior Secondary Schools Students by Ababio.
- Macmillan Chemistry for Senior Secondary Schools
- Essential Chemistry for Senior Secondary School by I.A. Odesina.
- Understanding Chemistry for Schools and Colleges by G.O Ojokuku. (FME, 2013).

However, there were claims that the textbooks were not examined by practicing chemistry teachers before they were recommended (Akani and Aboniyi, 2011; Igwe, 2015). The importance of examining textbook is to ensure that it satisfy the criteria for effectiveness in the teaching and learning process. The effectiveness of an instructional material is best determined using appropriate evaluation instruments.

Khaveci (2010) utilized thematic and quantitative analysis to determine the effectiveness of ten Chemistry textbooks. The components of the Chemistry textbooks analysed included gender equity, questioning level, science vocabulary load and readability level. The result indicated that the textbook has unfair gender representations, considerable higher number of input and processing than output level, and a high load of science terminology. The researcher suggested that the analysis procedures can be calibrated with science textbooks in different international settings. The procedures could also be modified and improved to meet specific evaluation needs.

Akani and Abonyi (2011) evaluated the chemistry textbooks used in Nigerian secondary schools with the 8-Point qualitative model of science textbooks developed by Emerole and Rammiki in 2004. The 8-point model evaluates science textbooks using the following indices: Topical coverage index (TCI); Learning activities index (LAI); Study questions index (SQI); Illustration index (ILI); Chapter summary index (CSI); Under-representation population index (UPI); Readability and comprehensibility index (RCI); and Teacher perception rating index (TPI).The result of the findings revealed a number of inadequacies in the recommended chemistry textbooks. These inadequacies are in the areas of topical coverage, learning activities, readability and efficiency in instructional delivery

Mergo (2012) investigated the extent to which the Chemistry textbooks of grade 11 is appropriate for learner centred approach. The contents of the Chemistry textbooks were analysed through the suggested evidence of learner centred technique. The analysis covered objectives, activities, questions, figures and diagrams. The finding revealed that only the activities in the textbook encourage students involvement in teaching and learning.

Upahi and Jimoh (2016) classified end-of-chapter questions of three Chemistry textbooks through the use of Bloom Revised Taxonomy (BRT) of Objectives.. The result indicated that the majority (76%) of the questions were at the lower order (understand, remember and apply). The result further revealed that the number of questions in the category of evaluate and create differ significantly from the other categories of the cognitive process skills.

Andergie and Asmellash (2020) analysed the learning objectives and activities of 8 grade Chemistry textbook using Bloom Revised Taxonomy (BRT). The BRT content analysis result revealed that the learning objectives and activities mainly focused on lower order thinking skills while experiments are more at the higher order thinking skills of BRT. The researcher recommended that the learning objectives, activities and experiments in the textbook should be organised to equip students with higher order thinking skills.

The American Association for the Advancement of Science (AAAS) designed a textbook evaluation that is based on how close they stand to defined benchmarks (Gholami, Noordin, and Rafik-Galea, 2017). The primary stage in benchmarks-based method is to recognize the learning goals. This helps decide whether the textbooks match such goals or not. In addition, Dalim and Mubarrak (2013) recommended that it would be easier to determine the advantages and setbacks of the textbook's instructional design and support by adopting the principles of benchmarks-approach through investigating a material dealing with a few learning goals. There are studies that attempted to determine the extent to which the instructional design of Chemistry textbooks reflects the goals of STM knowledge and skills. Some of the studies examined Chemistry textbooks that are no more in use by students and teachers (Akani and Abonyi, 2011).

Also, there are studies reviewed that contained learning goals which are not related to STM knowledge and skills (Akani and Abonyi, 2011; Khaveci, 2010). These include gender representation, illustration index, and chapter summary which are not related to STM knowledge and skills. Also, there is none of the studies that have criteria on project and practical activities which is a very important component of strategies for inculcating STM knowledge and skills. Lastly, there are studies that focus only on study questions (Andergie and Asmellash, 2020; Upahi and Jimoh, 2016). The studies did not focus on definite guidelines and criteria that are stipulated in the curriculum document for attaining STM knowledge and skills. Therefore, this study intends to streamline criteria for evaluating chemistry textbooks to those that are closely related to acquisition of STM knowledge and skills. The criteria are topical coverage, practical and project activities, study questions, readability and comprehensibility.

2. Statement of the Problem

The objective of the Chemistry curriculum to inculcate STM skills and knowledge is achieved through appropriate selection of content and teaching strategies. This can be achieved through the adaptation and utilization of Chemistry textbooks that its instructional design aligns with the objective of STM knowledge and skills. Studies that evaluated the extent to which new edition of Chemistry textbooks reflect the revised curriculum are not many. Some of the studies examined Chemistry textbooks that are no more in use by students and teachers.

In addition, the studies did not focus on definite guidelines and criteria that are stipulated in the Chemistry curriculum document for attaining STM knowledge and skills. Such guidelines and criteria include topical coverage, study questions, practical and project activities, readability and comprehensibility. Also, the study question index (SQI) in the Chemistry textbooks used in Nigeria classifies the questions into lower and higher order thinking skills. But SQI can provide a more in depth study when it has three categories. The categories are input (remembering and understanding), processing (applying and analysing), and output (evaluation and create). Furthermore, there is need to investigate the extent to which project and practical activities in the textbooks promote inquiry.

The study intends to streamline relevance of Chemistry textbooks to those criteria that are closely related to acquisition of STM knowledge and skills. Thus, the study seeks to determine the extent to which Nigerian Chemistry textbooks satisfy the criteria for topical coverage, study questions, practical and project activities, readability and comprehensibility.

3. Methodology

The study adopts descriptive design that involves content analysis of predefined themes in the textbook. The instrument for data analysis is Textbook Analysis Scale (TAS). The scale is a combination of thematic and quantitative approach to assessing the quality of selected Chemistry textbooks using guides provided by literature. The criteria for selection are recommendation by the curriculum published by FME, WAEC, NECO and in use by students and teachers in secondary schools.TAS consists of four themes which are topical coverage, practical and project activities, study questions, readability and comprehensibility. The frequency of the themes in each textbook was determined through content analysis that involves coding the manifest content. The reliability was enhanced through discussion and agreement on the coding of the themes. We coded to consensus because we did not want to overlook nuisance details.

Research Questions:

1) How adequate are the topical coverage of the Nigerian recommended Chemistry textbooks for attaining STM knowledge and skills?
2) How adequate are the practical and project activity of the Nigerian recommended Chemistry textbooks for attaining STM knowledge and skills?
3) How adequate are the study questions of the Nigerian recommended Chemistry textbooks for attaining STM knowledge and skills?
4) How adequate are the readability and comprehensibility of the Nigerian recommended Chemistry textbooks for attaining STM knowledge and skills?

Research question 1

1) How adequate are the topical coverage of the Nigerian Chemistry textbooks for attaining STM knowledge and skills?

a) The adequacy of the contents of the textbooks is measured by Topical Coverage Index (TCI)

Topical Coverage Index (TCI)

T_t represents Number of topics sufficiently covered by the textbooks.

T_c is the number of topics specified in the curriculum.

S_t is number of subtopics sufficiently covered by the textbook

S_c is the number of subtopics in the curriculum.

$TCI = (T_t - S_{t//}T_c - S_c)^{1/2}$ (Emerole and Rammiki, 2004).

Topical Coverage Index for Abbabio Chemistry Textbook

T_t= 33; T_c = 34; S_t= 190; S_c = 200.

$TCI = (T_t - S_t/T_c - S_c)^{1/2}$

$= \left(\frac{33-190}{34-200}\right)^{1/2} = \left(\frac{157}{166}\right)^{1/2} = 0.97$

Topical Coverage Index for Macmillan Chemistry Textbook

T_t= 33; T_c = 34; S_t= 194; S_c = 200.

$TCI = (T_t - S_t/T_c - S_c)^{1/2}$

$= \left(\frac{33-194}{34-200}\right)^{1/2} = \left(\frac{161}{166}\right)^{1/2} = 0.97$

Topical Coverage Index for Essential Chemistry Textbook

T_t= 34; T_c = 34; S_t= 196; S_c = 200.

$TCI = (T_t - S_t/T_c - S_c)^{1/2}$

$= \left(\frac{34-196}{34-200}\right)^{1/2} = \left(\frac{162}{166}\right)^{1/2} = 0.97$

Topical Coverage Index for Understanding Chemistry Textbook

T_t= 33; T_c = 34; S_t= 196; S_c = 200.

$TCI = (T_t - S_t/T_c - S_c)^{1/2}$

$= \left(\frac{33-189}{34-200}\right)^{1/2} = \left(\frac{156}{166}\right)^{1/2} = 0.97$

Table 1: Summary of Topical Coverage Index of Nigerian Chemistry Textbooks

S/N	Textbook	Tt	Tc	St	Sc	Index
1	Chemistry Textbook A	33	34	194	200	0.97
2	Chemistry Textbook B	33	34	190	200	0.97
3	Chemistry Textbook C	34	34	196	200	0.97
4	Chemistry Textbook D	33	34	189	200	0.97

Acceptable range is 0.8 to 1.0

The four textbooks have TCI of 0.97. This is higher than the acceptable TCI of 0.8. The implications are that the textbooks sufficiently cover the topics and subtopics in the Chemistry curriculum. Hence, the textbooks can function effectively as a written Chemistry curriculum that links the intended Curriculum statements to what is implemented in the classroom. In addition, the textbooks can provide support for selection of appropriate contents. However, it is only Essential Chemistry textbook that cover all the topics in the Chemistry curriculum. The topic Ethical, Legal and Social Issues is present only in Essential Chemistry textbook. The topic is strongly relevant to STM knowledge and skills. This is because it focuses on the role of government in preventing degradation of the environment through elimination of industrial pollutants and chemical wastes.

Research Question 2:
How adequate are the practical and project activity of the Chemistry textbooks for attaining STM knowledge and skills?

(ii)The adequacy of the projects and practical activities is measured by the Practical and Project Activity Index (PAI)
Practical and Project Activities Index (PAI).

Level Zero: the aim, the method, conclusion/ inference/generalisation are provided.

Level One: the aim and the method are provided; the student has to make and record observations, inference/ generalization/ conclusion

Level Two: the aim is given, the student has to design a method, and make inference/ generalization/ conclusion.

Level Three: the student is presented with the phenomenon; formulate a relevant aim, design method and make inference/ generalization/ conclusion

In analyzing the activities, level zero is classified as passive involvement while level one, two and three are classified as active involvement.

$$\textbf{PAI} = \frac{\text{Level one + Level two + Level Three}}{\text{Level zero}}$$

Enquiry Level of Practical and Project Activities in Chemistry Textbook A

Twenty experiments were analysed in the textbook A. 9 experiments are classified as L_1 while 11 experiments are in the category of Lo. Three is no experiments in the L_2 and L_3 categories. The practical activities index is calculated below.

$$\textbf{PAI} = \frac{\text{Level one + Level two + Level Three}}{\text{Level zero}}$$

$$= \frac{9 + 0 + 0}{11} = \frac{9}{11} = 0.81$$

Enquiry Level of Practical and Project Activities Chemistry Textbook B

5 of the experiments are in L_1category while 19 experiments are classified as L_0. There are no experiments in L_2 and L_3. The practical activities index is calculated below:

$$\textbf{PAI} = \frac{\text{Level one + Level two + Level Three}}{\text{Level zero}}$$

$$= \frac{5 + 0 + 0}{19} = \frac{5}{19} = 0.26$$

Enquiry Level of Practical and Project Activities in Chemistry Textbook C

6 experiments in the textbook are in L_1 category while 15 experiments are categorised as L_0. There is no experiment in L_2 and L_3 categories. The practical activities index is calculated below:

$$\textbf{PAI} = \frac{\text{Level one + Level two + Level Three}}{\text{Level zero}}$$

$$= \frac{6 + 0 + 0}{15} = \frac{6}{15} = 0.40$$

Enquiry Level of Practical and Project Activities in Chemistry Textbook D
14 of the experiments are in L_0 category and 4 experiments in L_1. There are no experiments in L_2 and L_3 categories. The practical activities index is calculated below:

$$\textbf{PAI} = \frac{\text{Level one + Level two + Level Three}}{\text{Level zero}}$$

$$= \frac{4 + 0 + 0}{14} = \frac{4}{14} = 0.28$$

Table 2: Summary of Practical and Project Activities Index (PAI) of Chemistry Textbooks

S/N	Textbook	L0 %	L1 %	L2%	L3%	Index
1	Chemistry Textbook A	19	5	0	0	0.81
2	Chemistry Textbook B	11	9	0	0	0.26
3	Chemistry Textbook C	15	6	0	0	0.40
4	Chemistry Textbook D	14	4	0	0	0.28

Acceptable range is 0.5 to 1.0

Table 2 reveals that Chemistry textbooks A, B, C and D have PAI of 0.81, 0.26, 0.40 and 0.28 respectively. Thus, Chemistry textbooks A meet the acceptable range of 0.5. However, Chemistry textbooks B, C and D do not meet the criteria. Chemistry textbook A is introduced as an experiential textbook. This is attested to by the challenging practical activities in the textbook that involve students in critical thinking. The finding about practical activity is further illustrated by comparing experiments titled ‘’ To

verify the law of conservation of mass (or) matter'' in Chemistry textbooks A and B.

Chemistry textbook A
The experiment is illustrated in the textbook in a way that will inculcate acquisition of STM knowledge and skills. The students were asked questions that facilitate the acquisition of STM knowledge and skills. The questions are:

Do you notice any colour change?- Observation skill

If not, do you observe any precipitate?- Observation skill

Write down very briefly your observation. – Communication skill.

Now weigh, the flask and contents again after the experiment and record the mass before and after the experiment- Measurement and communication skill.

What is now your comment on the statement of the law of conservation of mass?- Inference and generalization. Thus, the experiment is an L1.

The students are further given different substances to be used in replicating the experiments.

Chemistry textbook B
In the experiment, the aim, method, result and conclusion are given. The approach of this experiment does not give students opportunities to construct knowledge, make deduction and discover scientific principles on their own. It guides and makes it easier for teachers to use demonstration method. This approach is referred to as textbook made science and is classified as L_0

Research question 3
How adequate are the study questions of the Nigerian Chemistry textbooks for attaining STM knowledge and skills?

The adequacy of the study questions is measured by the Study Question Index (SQI).

Study Questions Index (SQI).
Input questions require recall of information and explanation of chemistry principles (remembering and understanding).

Processing questions invite students to draw relationships among information (application and analysis)

Output questions require students to critique information and use it in new ways to produce new ideas (evaluation and creating).

$$SQI = \frac{P + O}{I}$$

The value of the ratio is interpreted as follows: between 0 and 0.4 = lower order thinking skills; above 0.4= higher order thinking skills.

Calculation of SQI Chemistry Textbook B
The total number of study questions on the four topics is 58. 22 questions are set on applying which account for 37% of the questions. Also, Analysing level contain 12 questions and account for 21% of the questions. Application and analyzing with jointly contribute 58% of the questions. Remembering and understanding have 14 and 9 questions respectively. Though, Evaluating has 1 question and Creating has no question, the textbook contains higher order level thinking questions than the lower order thinking questions.

Total number of questions= 58;

Input questions = Remembering + Understanding=23;

Processing questions = Applying + Analysing=34;

Output questions= 1.

$$\textbf{SQI} = \frac{P + O}{I} = \frac{34 + 1}{23} = 1.5$$

Calculation of SQI for Chemistry Textbook C
There are 87 study questions for the four topics. The number of study questions on remembering is 38 and account for 44% of the questions. Also, there are 9 questions on understanding. This accounts for 10% of the questions. Remembering and understanding jointly contribute 54% of the questions. Applying, Analysing, Evaluating and Creating have 19, 19, 1 and 1 questions respectively. They jointly contribute 46% of the questions. The study questions are well distributed between the lower order thinking level and higher order thinking level.

Total number of questions= 87;

Input questions = Remembering + Understanding=47;

Processing questions = Applying + Analysing=38;

Output questions= 2.

$$\textbf{SQI} = \frac{P + O}{I} = \frac{38 + 2}{47} = 0.85$$

Calculation of SQI for Chemistry Textbook A
The total number of study questions for the four topics are 83. There is no question on Evaluating and Creating. Remembering, understanding, applying and Analysing have 23, 20, 22 and 18 questions. Remembering and understanding jointly contribute 52% of the questions. The joint contribution of Analysing and Applying is 48%. The study questions are well distributed between the higher order and lower order thinking levels.

Total number of questions= 83;

Input questions = Remembering + Understanding=43;

Processing questions = Applying + Analysing=40;

Output questions= 0.

$$\textbf{SQI} = \frac{P + O}{I} = \frac{40 + 0}{43} = 0.9$$

Calculation of SQI for Chemistry Textbook D

The four topics contain 165 questions. There is no question on Evaluating and Creating. Remembering has 85 questions which account for 50% of the questions. Understanding contains 25 questions and account for 15 % of the questions. Remembering and understanding jointly contribute 65% of the questions. Applying and Analysing have 29 and 28 questions respectively. They contribute 35% of the questions. The study questions are dominated by lower order thinking level of remembering and understanding.

Total number of questions= 165;

Input questions = Remembering + Understanding=108;

Processing questions = Applying + Analysing=57;

Output questions= 0

$$\textbf{SQI} = \frac{P + O}{I} = \frac{57 + 0}{105} = 0.5$$

Table 3: Summary of Study Questions Index (SQI) of Chemistry Textbooks

S/N	Textbook	I	P	O	T	Index
1	Chemistry Textbook A	43	40	0	83	0.90
2	Chemistry Textbook B	23	34	1	58	1.50
3	Chemistry Textbook C	47	38	2	87	0.85
4	Chemistry Textbook D	105	57	0	165	0.52

Acceptable value is 0.5

In table 3, SQI for Chemistry textbooks A, B, C and D are 0.9, 1.5, 0.85 and 0.52 respectively. The four textbooks satisfy the criteria of 0.5 for Chemistry textbooks. Chemistry textbook B has the highest index of 1.5. This implies that for every three higher order thinking skill questions, there will be two lower order thinking questions. The study questions may be relatively difficult for students. Sufficient study questions on lower order thinking level are necessary for providing foundation that enables students to build confidence, have ownership of their learning and allow them to apply the knowledge and skill to make decisions and create model.

SQI for Chemistry textbooks A and B are ideal for assessment of students. The SQI is a ratio of one higher order level question to 1 of lower order thinking question. In the case of Chemistry, textbook D, there is need to increase the amount of higher order thinking questions. The SQI is 0.52 which is a ratio of one higher order thinking questions to two lower order thinking questions. Remembering thinking levels involve memorizing and recalling of Chemistry theories and principles. In addition, understanding thinking level focuses on explanation of concepts. The use of the lower order thinking levels for assessment promote rote and surface learning. Chemistry textbooks A and D do not have study questions on Evaluating and Creating. Also, the percentage of study questions on Evaluating and Creating in Chemistry textbooks B and C is 2%. Evaluating and Creating questions allow students to apply their understanding to make hypothesis, create models and make critical judgment.

Research question 4

How adequate are the readability and comprehensibility of the Nigerian Chemistry textbooks for attaining STM knowledge and skills?

The adequacy of readability and comprehensibility is measured by Readability and Comprehensibility Index (RCI).

RCI will be determined using Cloze Text analysis (Vaca, 1981) cited in Khavici (2010). A reading passage of about 275 words that the students are yet to read will be selected. The first and the last sentences will be left intact while the fifth successive words in each sentence of the remaining passage will be deleted until missing words of 50 is reached. One student will be randomly selected without paying attention to any specific characteristics to read the text and provide the missing words. Every exact word the students supply will be counted and multiplied by two to determine the students Cloze percentage scores. N represents number of missing words correctly provided while T is the total number of missing words.

Readability = N x 2/ T

Table 4: Readability and Comprehensibility Index (RCI) of Chemistry Textbooks

S/N	Textbook	N	T	Index
1	Chemistry Textbook A	16	50	0.54
2	Chemistry Textbook B	14	50	0.56
3	Chemistry Textbook C	15	50	0.60
4	Understanding Chemistry for Schools and Colleges	7	50	0.28

Acceptable range is 40% and above.

RCI for Chemistry textbooks A, B, C and D are 0.64, 0.56, 0.60 and 0.28 respectively. RCI for Chemistry textbooks A, B and C are above the acceptable range of 0.4. This implies that students can easily read and comprehend the textbooks. However, Chemistry textbook D with RCI of 0.28 does not meet the acceptable range. Hence, students will find it relatively difficult to read and comprehend.

Note:

Chemistry textbook A: Macmillan Chemistry for Senior Secondary School
Chemistry textbook B: New School Chemistry for Senior Secondary School
Chemistry textbook C: Essential Chemistry for Senior Secondary School
Chemistry textbook D: Understanding Chemistry for Schools and Colleges

4. Discussion

The finding of the study on topical coverage of the textbooks is contrary to that of Abonyi (2011) who found that there are inadequacy in the topical coverage of Chemistry textbooks. All the textbooks analysed in the study meet the criteria for topical coverage. However, the study aligns with that of Sobriesima et al that the Chemistry textbook entitled "Concept in Inorganic and Organic Chemistry" is effective in term of subject and content coverage. The finding also

collaborates that of Sunday (2014) on Mathematics textbooks and Ogbu et al (2016) on Biology textbooks that they cover the content's stipulated in the curriculum. The finding of the study that the practical activities in New Chemistry and Understanding Chemistry textbooks are inadequate supports the finding of Abonyi (2011). Also, Ogbu et al (2016) found that three of the four Biology textbooks analysed did not contain learning activities. But, the finding that the practical activities in Macmillan and Essential Chemistry textbooks are adequate collaborates the finding of Mergo (2012) and Andergie and Asmellash (2020) that practical activities involved in the Chemistry textbooks promotes higher order thinking skills and encourage students involvement in teaching and learning.

The finding of the study on study question index for New School, Essential, Macmillan and Understanding Chemistry textbooks is in accordance with that of Abonyi (2011) and Khaveci (2013). In support of the finding of the study, Khaveci (2013) reported that majority of the study questions are input and processing; and there are low output questions. But, the finding is at variance to that of Upahi and Jimmy that reported that the majority of the questions on gas laws were at the lower order of remembering and understanding. Similarly, Mergo (2012) found that the study questions in the textbook do not involve students in the teaching and learning process.

The finding of the study reveals that Understanding Chemistry may be relatively difficult for students to read and comprehend. But, New School, Essential and Macmillan Chemistry textbooks meet the suggested criteria for readability index. The finding on the textbooks collaborates that of Sobriesima et al (2013) that reported the textbook language to be effective. Also, Khaveci (2013) find the readability of the textbook to be average. In contrast, Abonyi (2011) found that the readability index of the textbook is not adequate.

5. Implication and Recommendation

The low index of readability and comprehensibility of Chemistry textbooks may result in students regarding the subject as abstract and difficult to understand. Consequently, the students may lose interest in the subject.

Textbooks are usually the available resource for organizing course instructional materials. The use of textbooks with low inquiry index does not give students opportunities to pose questions, plan and conduct experiments, and reach conclusions. This will limit the acquisition of science process skills.

The use of textbooks study questions that emphasize lower level cognitive thinking for developing assessment does not enhance ability of to apply and transfer knowledge

The Federal Ministry of Education should establish an agency for regulating the publishing of Chemistry textbooks. The responsibility of the agency should include defining benchmarks that textbooks must satisfy before they can be published. In addition, all the Chemistry textbooks should be reviewed to ensure they reflect the goal of the Chemistry curriculum. In the review, emphasis should be placed on readability and comprehensibility, practical and project activities, and study questions.

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