ANALYSIS OF GRADE 8 CHEMISTRY STUDENT TEXTBOOK CONTENTS VIS-À-VIS BLOOM'S REVISED TAXONOMY

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ABSTRACT

Analysis of textbooks in different aspects is pivotal to improvise the overall expected goal and outcome of textbooks. The overall information accumulated as a nation on different textbooks is also scanty. Therefore, the objective of this study was to analysis grade 8 chemistry student textbook contents vis-á-vis bloom's revised taxonomy for the cognitive domain**.** The six levels of BRT cognitive domain were used as framework for undertaking the content analysis. The BRT content analysis result revealed that the learning objectives and activities of the textbook mainly focus on the lower order thinking levels, while experiments are more of at the higher order thinking levels of BRT. Moreover, the chi-square test result showed the difference between lower and higher BRT level of learning objectives, experiments and activities are statistically significant. This value indicated that the content of the textbook is not encouraging students to be active. Therefore, the learning objectives, somehow experiments and activities of the textbook should be organized in a manner that equips students with higher order thinking level of learners in the learning process. This implies grade 8 chemistry student textbook should be revised in a way scaffolding students to higher order thinking level. *[African Journal of Chemical Education— AJCE 10(2), July 2020]*

INTRODUCTION

Textbooks play a very crucial role in supporting specific types of curricula and have a major influence on students' learning and the nature as well as type of learning activities used in the classroom [10]. The textbooks are organized in a purposeful way, and consequently their content and structure are very key for the promotion of a particular vision of a curriculum [24]. Textbooks serve as medium of instruction to increase the effectiveness and efficiency in the teaching and learning process. In choosing an interesting textbook to be used in classroom for the teaching and learning process, textbook analysis is very crucial and key [4]. Besides, if textbooks are not used appropriately, they may spoil the process of teaching and learning [18]. In contrast to this, some scholars argue that if the students' involvement is limited or very low in the textbooks, the teaching approach is textbooks-based teaching which is teacher-centered approach [1, 4, 13].

Chemistry is a branch of science, which deals with the properties, the composition, the structure and the transformation of matter [17]. It is a toll language or backbone for industries. Chemistry as a school subject has passed through various patterns concerning the science curriculum. Until early 1980s, chemistry was offered as part of the subject called Physical Science until the end of Grade 10. Later, it became a discrete subject starting from Grade 9. Currently, Chemistry is offered as a discrete school subject starting from Grade 7, and continued to be given as one subject starting from Grade 7 to 12 [17]. Moreover, by its subject nature, chemistry must focus on all levels of Bloom's Revised Taxonomy; however, it should be more of higher levels of Bloom's Taxonomy.

The attention given to the development and organization of textbooks determines the mental development of the students in particular and the community at large. The developed countries pay a great attention to their curricula in line with their sustainable development goal

[5]. The differences in between well-developed countries and under developed countries are not climate, weather condition, or natural resources; it is the difference in the educational system. Literatures revealed that the weakness of most African countries curricula is more of a mere theory, outdated and teacher-centered [26].

In a country like Ethiopia, which is plan to transforming from agriculture-led economy to industrialized economy, the quantities as well as the quality of well-equipped professional chemists are required. To achieve this, we need to prepare the textbook from the grass root level. Therefore, the objectives, experiments, and activities of the textbooks should show high thinking order in BRT process dimension. The science education reform calls for pedagogical shift from a traditional, textbook-based instructional paradigm to active learning inquiry-based [1, 13].

Ethiopia changes curricula and textbooks as the government changes. Currently, the Ethiopian government has determined and introduced what is now as a "70:30 professional mix"- 70% for Science and technology - 30% for Social Sciences and Humanities streams at higher education. This shows that the government has given much consideration for science education [21]. However, the scientific curriculum related studies on the textbooks analysis are very few. As far as researcher knowledge this is a specialized and unique study in its field; no similar study were conducted in this context, this means that there is no any published data about the current Ethiopian Grade 8 chemistry student textbook by using BRT. Hence, analyzing the textbooks in a scientific manner and providing appropriate feedback to stakeholders is the current homework for scholars in the field. Therefore, the researcher analyzed the levels of learning objectives, experiments and activities in each unit of the selected textbook using the six levels of Bloom's Revised Taxonomy cognitive domains process dimension.

According to the revised syllabus of MOE, (2013), teaching chemistry is important that a student acquires factual knowledge, and skills such as application, analysis, synthesis and evaluation. Since chemistry is an experimental science, experimental and investigative skills should be also acquired in a sufficient way that makes students much more familiar with advanced chemistry laboratories in their future endeavor. Therefore, this study has focused on the analysis of textbooks' contents.

The significance of this study can provide useful information and identify the gaps and gives invaluable recommendations and suggestions to stakeholders, decision makers, curriculum and syllabus designers, teachers and students as well for the future use; an initial step for other researchers to depend on to analyze others textbooks in different classes and subjects. Helps to improve the contents (objectives, experiments and activities) of Grade 8 chemistry student textbook which is in line with the educational reformation and stemmed from the fact that according to the distribution of learning objectives, experiments and activities among the six levels of Bloom Revised Taxonomy process dimension.

Conceptual Framework of the Study: The Analysis of the Textbooks

For the purpose of this study, "Analysis" is a detailed examination or test of anything complex in order to understand its nature or appearances'; to determine its essential features or elements and statements of such examinations. Evaluation refers to systematically collecting data with the intention of making paramount decisions. To suit this purpose, evaluation then includes certain procedures to obtain adequate data about a course or curriculum leading in their improvements [9]. Policy makers, textbooks and syllabus designers of a country require plenty of

research-driven information. Thereby, this research has been designed to generate appropriate evidence-based data on Grade 8 Chemistry student textbook.

Different techniques can be employing to analyze textbooks. The most common techniques are:

- ✓ Bloom's taxonomy [2, 16, 20].

- ✓ Students involvement analysis [4, 11, 34].

- ✓ The analysis of conceptual development of the textbooks [34]

- ✓ Analysis of the inquiry level of the textbooks [34]

- ✓ Analysis of the degree of Science Technology Society (STS) orientations of the textbooks [34]

However, selecting an appropriate technique of analyzing textbooks is dependent up on at our contexts or situations. Therefore, the researcher was selected the six levels of Bloom's Revised Taxonomy - cognitive domain process dimension in order to analyze the current Ethiopian curriculum grade 8 chemistry student textbook content (learning objectives, experiments and activities) which was written by English language and published in 2013 G.C by MOE.

According to Lorin Anderson and David Krathwohl the process dimension of Bloom's Revised Taxonomy Cognitive Domain Educational Objective has six hierarchically arranged categories [2, 16].
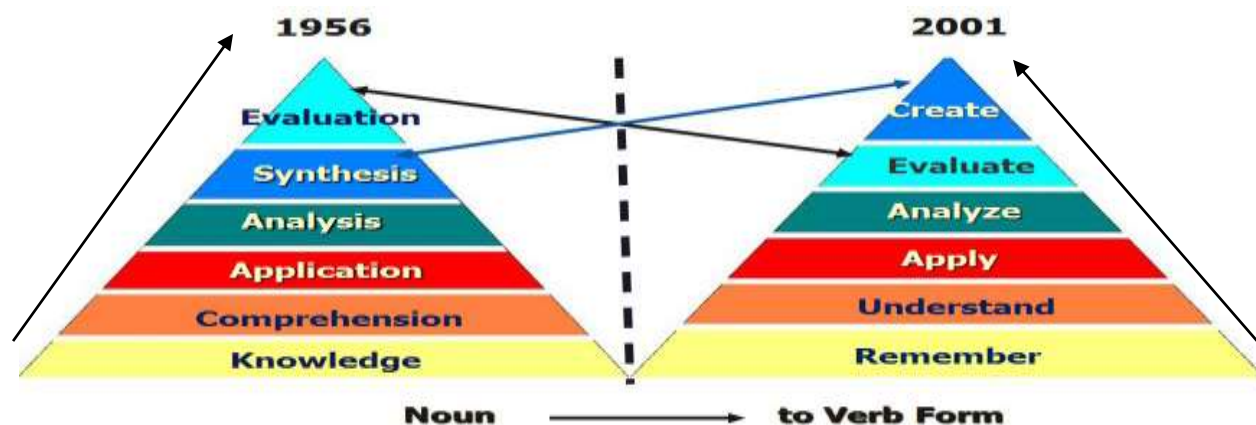
Figure 1: Terminology changes between Bloom's Taxonomy and Bloom's Revised Taxonomy

Adopted from [2; Table 1.1 – Bloom vs. Anderson/Krathwoh]

These BRT categories are; remember, understand, apply, analyze, evaluate and create. In terms of thinking order skills remember, understand and apply are lower orders thinking skills while, analyze, evaluate and create are under in higher order thinking skills. This criterion were employed to analyzed the learning objectives, experiments and activities that exist at each chapter of grade 8 current Ethiopian curriculum chemistry students' textbooks.

Research question are a frame of the whole activities of the research work and the study seeks answer the following research question. Therefore, the basic research questions of this study were:

✓ How are the current Ethiopian curriculums (Grade 8 Chemistry student textbook) learning objectives, experiments and activities distributed in terms of the six levels of Bloom's Revise Taxonomy cognitive process dimensions?

✓ Is there any significant difference or association between lower and higher levels of BRT cognitive domain process dimensions in Grade 8 chemistry student textbook?

The purpose of this study was to analyze the contents of current Ethiopian Curriculum Grade 8 chemistry student textbook contents against the six levels of BRT.

METHODOLOGY

This research aimed at analyzing the current Ethiopian Curriculum Grade 8 chemistry student textbook contents vis-á-vis bloom's revised taxonomy. Quantitative approach content analysis design was applied in this research. The Content analysis is one of the research methods of design; [30] defined content analysis as a systematic and replicable technique for compressing many words of text into fewer content categories based on explicit rules of coding.

From the current Ethiopian curriculum textbooks, the researcher has selected Grade 8 chemistry student textbook written in English language and published in 2013 G.C. The reason is that the researcher has focused on Grade 8 chemistry in order to suggest possible corrections or improvements for student textbook [17] and to determine the status of the student textbook from the grass root levels, since chemistry is given as a sole linear subject starting from Grade 8. All the learning objectives, experiments and activities of the textbook were included in the analysis. The data gathering instrument was Document Analysis using the six thinking levels of Bloom's Revised Taxonomy Cognitive Domain [2, 3, 12, 19]. These six categories of the process dimension Bloom's Revised Taxonomy (BRT) were used to analyze the learning objectives, experiments and activities exist in the Grade 8 chemistry student textbook by counting the frequencies and calculating percentages each levels of BRT using the action verbs adopted from the literatures.

Table 1**:** The coding scheme for distributions of objectives, experiments and activities by BRT

Grade 8 text	Remember	Understand	Apply	Analyze	Evaluate	Create	Total

Book	F	%	F	%	F	%	F	%	F	%	F	%	F	%
Objectives														
Experiments														
Activities														
Total														

NB: F = frequency and % = percentage

After gathering, the quantitative data from the contents of Grade 8 chemistry student textbook in different parts, the data was analyzed via Bloom's Revised Taxonomy, the frequency and the percentage of each one of the six levels of learning objectives, experiments and activities in the textbook were identified. The Chi- Square test was calculated in order to answer the significance differences or association between the frequencies of different lower and higher thinking levels of BRT in the textbook of learning objectives, experiments and activates (p _ value < 0.05 was considered as statistically significant).

Validity of the Research Tool or Instrument

The research tool was presented to three members of the Department of Education and Curriculum study in Begemidir College of Teacher Educations in Debre Tabor Town in order to establish its validity. They were asked to examine the definitions of the various levels in accordance with the skills and behaviors demonstrated by each level of BRT. The professionals assessed the research tool and some items that seems vague were corrected as it was valid for use in this study.

Reliability of the study

Inter-rater Reliability: In order to ascertain the inter-rater reliability of the research, 30 items that were not included in the sample textbook took for Bloom's Revised Taxonomy cognitive

domain process dimension were analyzed by two instructors of education and curriculum studies. The Kappa's value measure of agreement was calculated based on the classification of the coders, for each levels of BRT cognitive process by using the formula:

Cohen's kappa = $(PA_O – PA_E)/ (1 –PA_E)$, $PA_O = A/n$ and $PA_E = (1/n^2) (pm_i)$

Where, PA_O - stands for proportion agreement observed

PA_E - Stands for proportion agreement expected

A – Stands for number of agreement between two coders

n - Stands for number of units in common by coders

pmi - Stands for each product of marginal's

Based on the above-mentioned formulas, the obtained calculated Cohen's Kappa value was 0.93 (93%). The substantial values ($\kappa > 75$) [22] for the Bloom's Revised Taxonomy cognitive process dimensions. The obtained Kappa value indicated excellent measure of agreement between the two coders, which guaranteed a high inter-rater reliability for the research.

Intra-rater Reliability: Intra-rater reliability is similar to inter-rater reliability, except that the comparisons are made between two data collection efforts by the researcher itself in two different phases and the way of calculations are the same fashions of inter-reliability [22]. In order to ascertain the intra-rater reliability of the research, 30 items those were not included in the sample textbook for BRT cognitive domain process dimension. Therefore, the obtained Cohen's Kappa value was 0.98 (98%) for BRT cognitive process dimension in the textbook. The obtained Kappa value indicated excellent measure of agreement between the two phases, which guaranteed high intra-rater reliability for the research.

RESULTS

Learning objectives, Experiments and Activities analysis

The results obtained from the analysis and computation of various learning objectives, experiments and activities of BRT as manifested in the current Ethiopian curriculum Grade 8 chemistry student textbook were tabulated and summarized in the following tables and graphs.
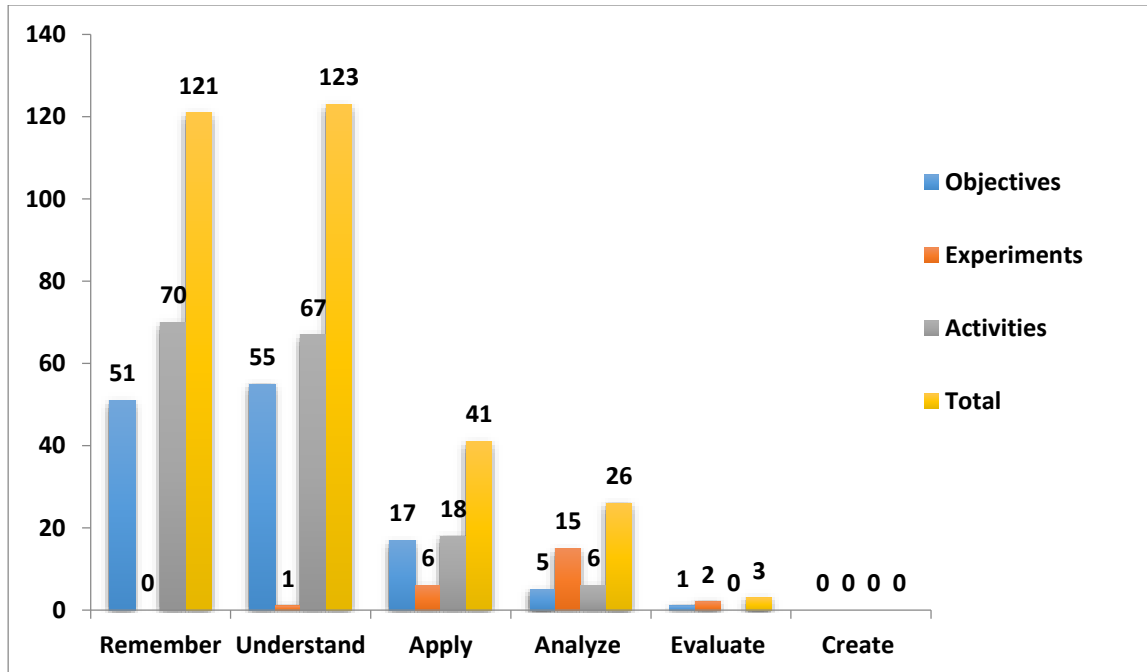

Figure 2: The distributions of Grade 8 learning objectives, experiments and activities by BRT

Figure 2 presents the frequencies and percentages distribution learning objectives, experiments and activities according to the current Ethiopian curriculum Grade 8 chemistry student textbook and each six levels of BRT process dimension thinking skill such learning objectives were designed to measure.
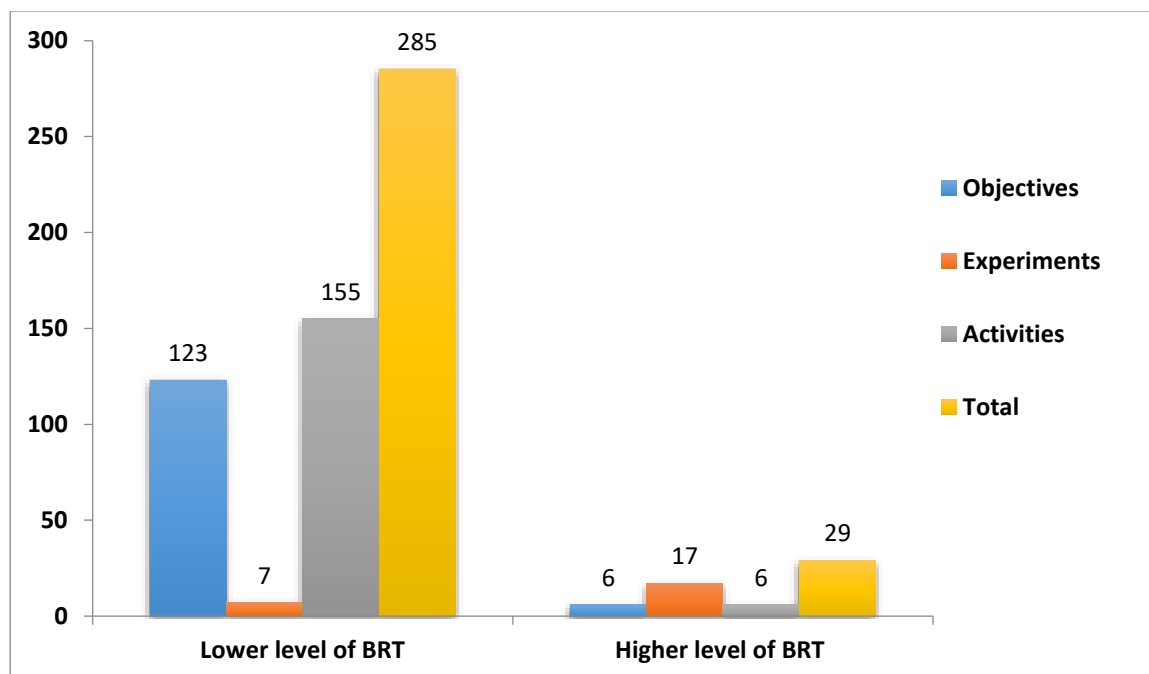
Figure 3: Distributions of Grades 8 objectives, experiments and activities with lower and higher levels BY BRT.

Figure 3 presents the distributions of learning objectives, experiments and activities of the current working Grade 8 chemistry student textbooks with the lower and higher order skill of BRT cognitive process dimension.

The chi-square test for learning objectives, experiments and activities of in Grade 8 chemistry student textbook with lower and higher levels of BRT mentioned under. Since null hypothesis assumed that 50% of learning objectives, experiments and activities were categorized under lower and the rest 50% of them are under higher levels of BRT. Mean that there is no statistically significance difference between lower and higher levels of BRT in learning objectives (p _ value < 0.05 was considered as statistically significant). However, the results listed under below.

Table 2 Chi-square test for Grade 8 objectives with lower and higher levels of BRT

BRT levels	Observed	Expected	Observed − Expecte	(Observed − expected)2	$\dfrac{(Observed - Expected)2}{Expected}$
Lower level	123	64.5	58.5	3422.25	53.06
Higher level	6	64.5	-58.5	3422.25	53.06
Chi-square value					106.12

From the chi-square test were obtained as tabulated in Table 2 there is statistically significant difference between the lower and higher levels of BRT cognitive process dimension in Grade 8 chemistry students textbook learning objectives (chi-square value = 106.12, P – value <0.05)

Table 3: Chi-square test for Grade 8 experiments with lower and higher levels of BRT

BRT levels	Observed	Expected	Observed − Expecte	(Observed − expected)2	$\dfrac{(Observed - Expected)2}{Expected}$
Lower level	7	12	-5	25	2.08333
Higher level	17	12	5	25	2.08333
Chi-square value					4.167

Table 3 shows the chi-square test were obtained there is a statistical significance difference between the lower and higher levels of BRT cognitive process dimension in Grade 8 chemistry students textbook experiments (chi-square value = 4.167, P – value < 0.05)

Table 4**:** Chi-square test for Grade 8 activities with lower and higher levels of BRT

BRT levels	Observed	Expected	Observed − Expecte	(Observed − expected)2	$\dfrac{(Observed - Expected)2}{Expected}$
Lower level	155	80.5	74.5	5550.25	68.95
Higher level	6	80.5	-74.5	5550.25	68.95
Chi-square value					137.9

From the chi-square test were obtained as mentioned Table 4 there is statistically significance difference between the lower and higher levels of BRT cognitive process dimension in Grade 8 chemistry students' textbook activities which mean that reject the null hypothesis (chi-square value = 137.9, P – value < 0.05).

DISCUSSIONS

Using the results, discussions were made whether the textbook is more focus on the lower or higher order, six levels of BRT.

Learning Objectives

Learning objectives of Grade 8 chemistry student textbook were categorized based on the action verbs that were adopted from the literatures. Out of 129 learning objectives of Grade 8 chemistry student textbook, 123 (95.349%) were under lower order of thinking levels of BRT for instance 51 (39.53%) Remember, and 17 (13.18%) Apply, the remaining 6 (4.351%) belongs to higher order thinking levels of BRT with 5 (3.88%) Analyze, 0 (0%) Create (Figure 2 and Figure 3) and from the chi-square test was obtained there is a statistically significance difference between the lower and higher levels of BRT cognitive process dimension of learning objectives (chi-square value = 106.12, P – value < 0.05) (Table 2).

The result of Grade 8 chemistry student textbook learning objectives showed that most of the learning objectives are focusing on triggering remembering or lower levels of BRT followed by understanding, apply, analyze, evaluate and create- which is the least touched learning level. The result indicate that the learning objective have little influence to develop the creativity potential of students.

The results in lines with a study done by [3, 19] in Iraq. The central concern of chemistry is not merely remembering the elements of the periodic table or it is not the mere grasping of the atomic and molecular weight of an element; the central theme is to encourage new synthesis and production of compounds that are viable for the world's socio economic developments. Knowing about fuel and producing/filtering fuels is different. It is an alarming for the concerned body to take a measure to make chemistry education objective is as expected to be. The main focus of teaching Chemistry is not to know what type of minerals are found in soil and how much is it, It's goal is to cultivate students on how to purify and process it to create/ produce essential goods that eases the life of the people in the globe.

 However, this result is not similar with a study done by [27] in India. The results showed that promote or increase effective transaction of values in modern way or methods and innovative approach in the value education programs at school level and the teaching and learning objectives are prepared in using the Revised Bloom's Taxonomy the students are highly engaged in the delivered lesson. It shows that high involvements of students. The possible reasons for the difference might be the quality of the materials, the quality of curriculum, facility and infrastructure.

Experiments

The experiments to be practiced by students in Grade 8 chemistry student textbook were categorized based on the action verbs that were adopted from the literatures. The good news in Grades 8 chemistry student textbook is that experiments lay in improving the higher order thinking levels. In Grade 8 chemistry student textbook from 24 experiments: 7 (29.167%) are categorized under lower levels of BRT while 17(70.833%) are categorized under higher levels of BRT cognitive process dimension as an examples 0 (0%) Remember, and 0 (0%) Create (Figure 2 and

Figure 3) while the chi-square test indicated there is no significance difference between the lower and higher levels of BRT cognitive process dimension of experiments (chi-square value = 4.167, P – value < 0.05) (Table 3).

Unfortunately, most of the experiments focus on improving the analysis potential of students; There is no any experiment that pushes students to the ladder of creativity in the textbook. Experiments are resource and labor intensive as well as time consuming in their nature, as much time and resource is invested, it is better to think on how we can formulate experiments towards creativity, which is the thinking level, that leads and step up the world from the prehistoric era until know, the technology era. It is difficult to expect "creators" for this developing country from chemistry textbook with no experiments that triggers creativity. Any concerned stakeholder should take a note and participate in modifying things towards a roadmap that initiates the thinking level of creativity at primary schools.

Activities

As for learning objectives and experiments, activities of Grade 8 chemistry student textbook were categorized based on the action verbs that were adopted from the literatures. Out of 161 activities: 155 (96.273%) are categorized under lower levels of BRT for example; 70 (43.48%) Remember, and 18 (11.18%) Apply, while 6 (3.73%) higher levels of BRT example; 0 (0%) Analyze, and 0 (0%) Create (Figure 2 and Figure 3). Additionally, the chi-square test shows as there is statistically significant difference between the lower and higher levels of BRT cognitive process dimension (chi-square value = 137.9, P – value < 0.05) (Table 4).

The result is in line with a study done by [18, 32, 33] in Iran, [15] in Turkey and [28, 31] in Jordan.

The result is not in agreement with study done by [6, 7]. The possible difference for the contradictory result would be the difference in subjects incorporated at the study, the socioeconomic development of the country that directly and indirectly influences the quality of education, the standard of the curriculum, level of education, the accessibility of infrastructures as well as facility that plays a pivotal role on teaching and learning process.

CONCLUSION, RECOMMENDATIONS AND FUTURE DIRECTIONS

Conclusions

In Grade 8 chemistry student textbook:

- Out 129 learning objectives: 123 (95.349%) are categorized in lower levels of BRT while 6 (4.351%) are categorized higher levels of BRT cognitive process dimension and there is statistically significant difference between the lower and higher levels of BRT cognitive process dimension in the textbook.

- From 24 experiments: 7 (29.167%) are categorized under lower levels of BRT while 17(70.833%) are categorized under higher levels of BRT cognitive process dimension. Moreover, chi-square test showed that there is no statistically significance difference between the lower and higher levels of BRT.

- From 161 activities: 155 (96.273%) are categorized lower levels of BRT while 6 (3.727%) are categorized higher levels of BRT cognitive process dimension and there is statistically significance difference between the lower and higher levels of BRT cognitive process dimension in the activities of Grades 7 chemistry student textbook.

Recommendations

For curriculum and textbooks designers

The learning objectives and activities of the textbook are not responsible for fostering high levels of thinking process; therefore, policy makers, syllabus and curriculum designers, is better to amend learning objectives and activities in a way that equip students in analyzing, evaluating existing knowledge and creating new ideas and phenomena. The experiments mainly emphasize on the analysis levels of BRT; hence, it is better to build up on it to incorporate evaluate and create levels of BRT for both textbooks.

Overall, every aspect of the textbook should be organized in a manner to facilitate active engagement of learners in the teaching and learning process to make students visionary, productive and creative.

After all, it is recommended, stakeholders should take their parts and parcels to make the textbook as expected to be.

Ministry of Education and regional education bureau: The Ministry and regional education bureaus better to give especial attention in amending the student textbook to make it more creative and allow students to practice self-learning. Moreover, Teachers play an important role in shaping students in a manner that is required to be for the future prospect of the country. Qualified teachers can implement the real content of the textbooks in different aspects and can fill the gap of the textbook. Therefore, a special attention has to be given in producing "up to/above the standard" teachers from Universities and teacher education colleges, starting from selection up to graduation and thereupon.

For **NGOs** and governmental organizations working towards education: Short-term in-service trainings, symposiums, workshops and conferences plays a pivotal role in changing the

paradigm of teachers, students and supportive staffs. Therefore, organizations are expected to design strategies towards curriculum development, monitoring and evaluation to foster quality education that in lines with countries development.

The current education has multifaceted problems and the government should think of a multifaceted solution.

Future Directions

This study could be further explored through the following suggestions for further research

- ✓ Affective and psychomotor domains of BRT should be studied in Grade 8 chemistry student textbook.

- ✓ Another study ought to be conducted on the BRT knowledge dimension, to further arterial evidence-based information on the textbooks, which serves as an important source for policy makers, textbook and syllabus designers.

ACKNOWLEDGMENT

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