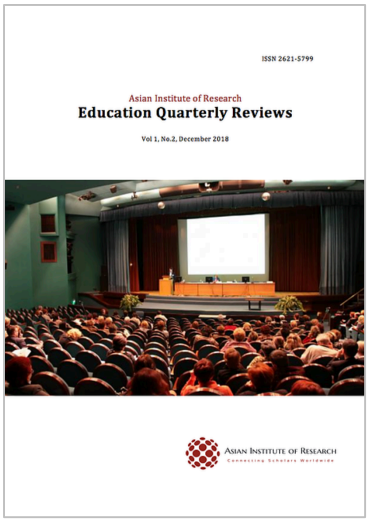

Education Quarterly Reviews

Derico, Hidaya U, Guimba, Wardah D, and Alico, Jerryk C. (2018), Learning Competencies of Two Science Textbooks for Grade 9: A Comparative Content Analysis Based on Bloom's Revised Taxonomy of Cognitive Domain. In: *Education Quarterly Reviews*, Vol.1, No.2, 254-267.

ISSN 2621-5799

DOI: 10.31014/aior.1993.01.01.27

The online version of this article can be found at:
https://www.asianinstituteofresearch.org/

Published by:
The Asian Institute of Research

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The Asian Institute of Research
Education Quarterly Reviews
Vol.1, No.2, 2018: 254-267
ISSN 2621-5799

DOI: 10.31014/aior.1993.01.01.27

Learning Competencies of Two Science Textbooks for Grade 9: A Comparative Content Analysis Based on Bloom's Revised Taxonomy of Cognitive Domain

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Abstract
The K-12 Science curriculum envisions the development of scientifically, technologically, and environmentally literate and productive members of society who are critical problem solvers, innovative and creative citizens, informed decision makers and effective communicators. To achieve these, higher order thinking skills must be developed among the learners. Textbook serves as a vehicle for the promotion of a specific vision of curricula. One of the important parts of the textbook was the stated learning objectives because it serves as the basis for any kinds of assessments. Thus, this study aimed to analyze learning objectives of science textbooks in order to determine if it contribute to the development of higher order thinking skills among the learners of grade 9. The findings revealed that the science textbooks were inadequate for the development of higher-order thinking skills. Science textbooks gave more emphasis to lower order thinking skills instead. Therefore, it is highly recommended that teacher should supplement more activities that promote higher order thinking skills and the authors of the textbook should modify the learning objectives of the science textbooks in a regressive sequence of cognitive process levels and gave more emphasis on the metacognitive knowledge dimension of Bloom's revised taxonomy.

Keywords: K-12 Science Curriculum, Learning Competencies, Textbook Analysis, Revised Blooms Taxonomy

Introduction

The Department of Education is the executive department of the Philippines government responsible for ensuring access to, promoting equity in and improving the quality of basic education. It is the main agency tasked to manage and govern the Philippines system of basic education. This department formulates, implements, and coordinates policies, plans, programs and projects in the areas of formal and non-formal basic education. It supervises all elementary and secondary education institution in both public and privates schools (DepEd vision, mission, core values and goals 2018).

One of the latest program designed by the Department of Education is the k-12 basic curriculum that aims to enhance learner's basic skills, produce more competent citizens and prepare graduates for lifelong learning and employment. "K" stands for kindergarten and "12" refers to the succeeding 12 years of basic education (Bigcas 2016).

The K-12 Science Curriculum envisions the development of scientifically, technologically, and environmentally literate and productive members of society who manifest skills as critical problem solvers, responsible stewards of nature, innovative and creative citizens, informed decision makers and effective communicators. Science education aims to develop scientific literacy among learners that will prepare them to be informed and participative citizens who are able to make judgements and decisions regarding application of scientific knowledge that may have social, health, and environmental impacts (K to 12 Curriculum Guide in Science 2018). To achieve these, higher order thinking skills must be developed among the learners.

Assaly and Smadi (2015) as cited by Shavinia (2013) claims that citizens who think critically and creatively are "guarantees of political stability, economic growth, scientific and cultural enrichment, psychological health, and the general prosperity of any society in the 21st century." As a result, more attention has been given all over the world to the importance of developing students' HOTS or higher order thinking skills.

The implementation of this K-12 Science Curriculum requires many significant components that must be considered. Among these are the textbooks that play a vital role in the teaching-learning process. Textbooks are widely accepted as common feature of classrooms worldwide and are important vehicles for the promotion of curricula. Textbooks put the curriculum into an actual situation. The Philippine government gives attention to the important role of books in nation building by creating the National Book Development Board based on R.A. 8047 that is tasked to formulate and implement a National Book Policy.

A textbook contains many parts. Learning objectives, lessons, images, graphs, activities, exercises and questions are considered content of a textbook. Learning objective is one of the most important part of a textbook. It connects the content and assessment of the textbook. It is an outcome statement that captures specifically what knowledge, skills, and attitudes learners should be able to exhibit after the lessons. It guides the selection of learning activities and exercises that will best achieve the intended goals. It also gives learners a clear picture of what to expect and what's expected from them (Creating Learning Objectives 2018). Thus, it is significant to evaluate the learning objectives in a textbook.

Bloom's Taxonomy of Cognitive Domain is a framework used to classify educational learning objectives. It was introduced by Benjamin Bloom in 1956, an educational psychologist and associate director of the Board for Examination in the University of Chicago. The initial purpose of this framework was to classify test questions that faculty member shared. However, eventually it became so relevant and useful in education. Since then and up to the present, it is being used in planning the curriculum, planning learning activities and assessment

Bloom's taxonomy of cognitive domain contains six levels progress from simple to more complex levels of thinking. The first three levels are: knowledge, comprehension and application which referred as "lower order thinking skills" and the last three levels are analysis, synthesis and evaluation which referred as "higher-order thinking skills". (Lucas and Corpuz 2014).

After 45 years since the publication of Bloom's taxonomy, Lorin Anderson and David Krathwol, Bloom's former student and partner, revised the Bloom's Taxonomy. There are some changes that have been made.

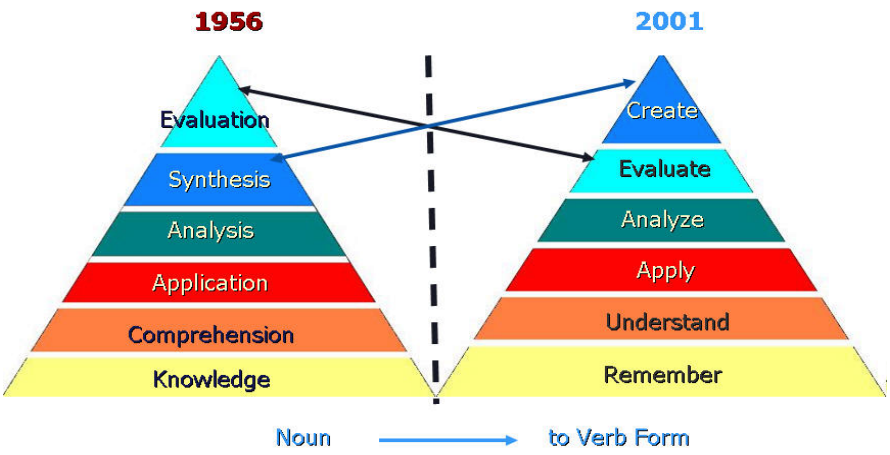

Figure 1. Bloom's Original Taxonomy vs. Bloom's Revised Taxonomy

Levels of thinking in the old taxonomy were nouns, while in the revised taxonomy they are verbs. The use of action words instead of nouns was done to highlight that **thinking** is an active process. The Bloom's revised taxonomy remains to be in hierarchical levels of increasing complexity. The **knowledge** level was changed to **remember**. The change was made because **knowledge** does not refer to a cognitive or thinking level. Knowledge is the object of the thinking. **Remember** is a more appropriate word for the first thinking level which involves recalling and retrieving knowledge. The **comprehension** level was changed to **understand**. **Synthesis** was changed to **create** and was placed as the highest level. The cognitive domain now includes two dimensions, the **cognitive dimension** and the **knowledge dimension**. The knowledge dimension of the revised taxonomy was based on the subcategories of knowledge in the old taxonomy.

	Cognitive Processes					
The Knowledge Dimensions	1. Remember	2. Understand	3. Apply	4. Analyze	5. Evaluate	6. Create
Factual						
Conceptual						
Procedural						
Metacognitive						

Figure 2. Bloom's Revised Taxonomy

The cognitive dimension includes the hierarchical or ordered levels of thinking. The thinking levels move from the simplest to the most complex. The knowledge dimension includes four knowledge categories: factual, conceptual, procedural, metacognitive. The knowledge that teachers aim to teach and students aim to learn can be about facts, concepts, procedures and metacognitive (Lucas and Corpuz 2014).

Bloom's Revised Taxonomy provides educators with a common set of terms and levels about learning objectives that help in planning across subject matter and grade levels; it helps in the drafting of learning standards across levels; it serves as a guide in evaluating the school's curriculum objectives, activities and assessments; and it guides the teacher in formulating learning objectives that tap higher-order thinking skills (Lucas and Corpuz 2014).

There are some studies that have been conducted using Bloom's original taxonomy and Bloom's revised taxonomy of cognitive domain. One of these is the study of Rahpeyma and Khosnood (2015) entitled *The analysis of Learning Objectives in Iranian junior high school English textbooks based on Bloom's revised taxonomy*. The finding of this study showed that the first three low levels in Bloom's revise taxonomy were the most prevalent than higher learning levels in Iranian junior high school English textbooks.

Zareian, Davoudi, Heshmatifar and Rahimi (2015), Assaly and Smadi (2015), Dr. Olimat (205), and Al-hasanat (2016) evaluate the questions in some various textbooks using Bloom's taxonomy of cognitive process. Their findings agree on that most of the questions found in those textbooks satisfy the lower levels of cognitive process. Those textbooks fail to engage learners in the questions requiring higher levels. Moreover, the study of Al-hasanat (2016) revealed a graphic disagreement between the percentages of the distribution to the textbook assessment questions and the suggested standard percentage of cognitive process levels.

In 2017, Mizbani and Chalak conducted two separate studies about the activities in the textbook *Prospect 3* through Bloom's revised taxonomy. Their first study focused on listening and speaking activities and the second one is all about reading and writing activities. These two separate studies revealed that most of the activities in textbook *Prospect 3* were categorized in the lower levels of cognitive process.

The literatures review presented above revealed that there are some studies that have been conducted regarding textbook's questions and activities however only one study that has been conducted about the textbook's learning objectives based on Bloom's and that was on 2015. Moreover, the studies presented above only focused on the cognitive dimension and neglecting the knowledge dimension of Bloom's revised taxonomy. Aside from that, the textbooks used to analyze in the previous studies were mostly English textbooks. So, to fill in the gap of the literature, the researcher aims to analyse learning objectives of two science textbooks in order to determine if they contribute to the development of higher-order thinking skills among the learners of grade 9. This study will answer the Research Questions below:

1. How are the codes of Bloom's revised taxonomy distributed in the Science Textbooks?
2. What knowledge dimension of Bloom's revised taxonomy is most dominant in the Science Textbooks?
3. What cognitive process levels of Bloom's Revised Taxonomy are more prevalent in the Science Textbooks?
4. Do the percentage of Science textbooks cognitive process level conforms in the standard percentages of cognitive process level suggested by Al-hasanat (2016)?
5. Which science textbook highlights higher-order thinking skills?
6. Is there a significant difference in the distribution of learning objectives based on the cognitive process level in the two Science textbooks?

Methodology

The present study was a descriptive and a mixed method study containing both qualitative and quantitative parts. In qualitative parts, the total number of learning objectives in two textbook were collected and codified based on the coding scheme of the study that was Bloom's Revised Taxonomy of Cognitive Domain. In quantitative parts, the frequencies and percentages of the codes as well as intra-rater, inter-rater reliability and chi square test of homogeneity were calculated.

Two Science textbooks for grade 9 were used in this study. The first textbook was entitled *Science Learner's Module 9,* First Edition 2014 which was collaboratively written by Liza Alvarez, Dave Angeles, Hernan Apurada, Ma. Pillar Carmona, Oliver Lahorra, Judith Marcaida, Ma. Regaele Olarte, Estrella Osorio, Digna Paningbatan, Marivic Rosales, and Ma. Teresa Delos Santos. It was published by the Department of Education and printed by FEP Printing Corporation in Pasig City. This textbook was prescribed by the Department of Education for the 9th grade students in all public schools in ARMM in line with the MMA Act No. 279 Article 2, Sec. 18c stated that DepEd-ARMM shall develop appropriate curricula, quality textbooks, and teaching materials.

Second textbook used was entitled *Science Links 9,* Seamless K-12 Edition 2014 which was written by Jonna Abistado, Meliza Valdoz, Marites Aquino and Mary Anne Bascara published by REX Book store and printed by REX Printing Company, Inc. in Quezon City. REX Book store is a private publishing house. This textbook is used by some of the private schools in the Philippines.

The instruments of the study were the cognitive process dimension and knowledge dimension of Bloom's Revised Taxonomy of Cognitive Domain. When we write a learning objective, the level of thinking or cognitive process is represented by the verb, while the knowledge dimension is represented by the noun. The thinking levels move from the simplest to the most complex. It is in the hierarchical levels of increasing complexity.

The levels are remember, understand, apply, analyse, evaluate and create. *Remember* is retrieving relevant knowledge from long-term memory. *Understand* is construct meaning by connecting "new" to "prior" knowledge. *Apply* level is carrying out or using a procedure in a given situation. *Analysis* is breaking materials into its constituent parts and detecting how parts relate to one another and to an overall structure or purpose. *Evaluate* is making judgements based on criteria and standards and *Create* is putting elements together to form a coherent whole. (Lucas and Corpuz 2014) The table below is a collection of verbs used to address the different levels of cognitive process dimension.

Table 1. Collection of verbs used in six levels of Bloom's Revised Taxonomy

Remember	Understand	Apply	Analyse	Evaluate	Create
Recall Recognize Name List State Tell Reproduce Identify Locate Write Find Underline Define	Interpret Exemplify Classify Summarize Infer Compare Explain Translate Discuss Describe Report Predict Illustrate Relate	Execute Implement Use Solve Construct Practice Demonstrate Dramatize Calculate Measure Convert	Differentiate Organize Attribute Compare Contrast Distinguish Investigate Infer Separate Sequence	Check Critique Assess Debate Defend Dispute Judge Appraise Check Decide Justify Rate Determine Interpret	Generate Plan Produce Change Design Formulate Improve Plan Propose Invent Devise Generate Compose Combine Construct Make

Knowledge dimensions include four knowledge categories: factual, conceptual, procedural, and metacognitive. Factual is the basic elements that students must know. Conceptual is the interrelationships among the basic elements within a larger structure that enable them to function together. Procedural is the knowledge on how to do something. It is a method of inquiry, criteria for using skills, algorithms, techniques and methods. Metacognitive knowledge is the knowledge of cognition in general as well as awareness and knowledge of one's own cognition. (Lucas and Corpuz 2014) The table 2 illustrate the subcategories of each knowledge dimension.

Table 2. Guidelines in the Knowledge Dimension of Bloom's Revised Taxonomy

Factual	Conceptual	Procedural	Metacognitive
• Terminology • Symbols • Specific details • Specific elements	• Classification • Categories • Principles • Generalizations • Theories • Models	• Skills • Algorithm • Techniques • Methods • Criteria for judgement	• Strategies for learning • Knowledge about cognitive task • Self -knowledge

The total number of learning objectives in two textbook were collected. There are 200 learning objectives found in *Science Learner's Module 9* and 102 Learning objectives in *Science Links 9*. These learning objectives were analysed and codified according to the coding scheme of the study. The coding schemes that were used are as follows:

Table 3. The Coding Scheme Based on Bloom's Revised Taxonomy

Knowledge Dimension	Cognitive Process Dimension					
	1. Remember	2. Understand	3. Apply	4. Analyze	5. Evaluate	6. Create
A. Factual	A1	A2	A3	A4	A5	A6
B. Conceptual	B1	B2	B3	B4	B5	B6
C. Procedural	C1	C2	C3	C4	C5	C6
D. Metacognitive	D1	D2	D3	D4	D5	D6

The coding categories were labelled as A1 or remembering the factual knowledge, B1 or remembering the conceptual knowledge, C1 or remembering the procedural knowledge, D1 or remembering the metacognitive knowledge, A2 or understanding the factual knowledge, B2 or understanding the conceptual knowledge, C2 or understanding the procedural knowledge, D2 or understanding the metacognitive knowledge, A3 or applying the factual knowledge, B3 or applying the conceptual knowledge, C3 or applying the procedural knowledge, D3 or applying the metacognitive knowledge, A4 or analysing the factual knowledge, B4 or analysing the conceptual knowledge, C4 or analysing procedural knowledge, D4 or analysing metacognitive knowledge, A5 or evaluating the factual knowledge, B5 or evaluating the conceptual knowledge, C5 or evaluating the procedural knowledge, D5 or evaluating metacognitive knowledge, A6 or creating factual knowledge, B6 or creating conceptual knowledge, C6 or creating procedural knowledge, and D6 or creating the metacognitive knowledge.

In the example of learning objectives, "*at the end of the lesson, the learners will be able to explain the photosynthesis process,*" **explain** is an action word which will fall under the second cognitive process level **understand,** and **photosynthesis process** is the noun that will fall under the **procedural knowledge.** So this learning objective will be coded as *C2 which mean understanding the procedural knowledge.*

After codifying the learning objectives, the frequency and percentage of each learning objectives for each level were calculated. In Inter-rater reliability, one analyst was invited and introduced the procedure. The analyst was Dr. Jemo A. Palacio. He is a college instructor II in Lanao Agricultural College of Lumbatan, Lanao del Sur. He codified about 25% of the learning objectives. In intra-rater reliability, the researcher codified 25% random samples of the learning objectives again within a span of two weeks. Then the agreement between those two codifications will be calculated.

Results and Discussion

The *Science Learner's Module 9* have a total learning objectives of 200 but only 191 were codified based on the coding scheme of the study because the remaining learning objectives were classified belong to affective and psychomotor domain of learning.

Table 4. The Frequency of Learning Objectives Codification in *Science Learners' Module 9*

Knowledge Dimension	Cognitive Process Dimension						
	1. Remember	2. Understand	3. Apply	4. Analyse	5. Evaluate	6. Create	
A. Factual	16	12	2	4	3	3	40
B. Conceptual	9	51	8	8	2	1	79
C. Procedural	12	16	21	5	4	0	58
D. Metacognitive	0	4	0	2	1	7	14
Total	37	83	31	19	10	11	191

Table 4 indicates that *Science Learner's Module 9* textbook contains various codes of learning objectives. The most frequent code was B2 (understanding conceptual knowledge) that has a frequency of 51, followed by C3 (applying procedural knowledge), C2 (understanding procedural knowledge), A1 (remembering factual knowledge) and A2 (understanding factual knowledge). The code of D1 (remembering metacognitive knowledge), D3 (applying metacognitive knowledge) and C6 (creating procedural knowledge) were missing in the said textbook. And the remaining codes emphasis too little.

Table 5. The Frequency of Learning Objectives Codification in Science Links 9

Knowledge Dimension	Cognitive Process Dimension						
	1. Remember	2. Understand	3. Apply	4. Analyse	5. Evaluate	6. Create	
A. Factual	12	7	6	4	2	2	33
B. Conceptual	4	22	0	3	2	0	31
C. Procedural	2	6	9	1	3	0	21
D. Metacognitive	0	5	1	0	0	3	9
Total	18	40	16	8	7	5	94

For the second textbook entitled *Science Links 9*, a total of 102 learning objectives were collected but only 94 were codified. The table 5 revealed that out of 24 codes of Bloom's taxonomy, 18 codes were available in the said textbook. B2 (understanding conceptual knowledge) was the most dominant code with a frequency of 22, followed by A1 (remembering factual knowledge), C3 (applying procedural knowledge), A2 (understanding factual knowledge), A3 (applying factual knowledge), C2 (understanding procedural knowledge). The code of D1 (remembering metacognitive knowledge), D4 (analysing metacognitive knowledge), D5 (evaluating metacognitive knowledge), C6 (creating procedural knowledge), B6 (creating conceptual knowledge) and B3 (applying conceptual knowledge) were neglected in the textbook. And only few emphases for the remaining codes.

Regarding the first research questions, the finding of this study revealed that the codes of cognitive process level of Bloom's revised taxonomy were widely dispersed in these two Science textbooks. However, the codes of B2, C3, C2, A1 and A2 were dominated in the first textbook which is *Science Learner's Module 9* whereas the codes of B2, A1, C3, A2, C2 and A3 were also dominated in the second textbook which is *Science Links 9*. . The code of D1, D3, and C6 were not found in the first textbook. On the other, D1, D4, D5, C6, B6, and B3 were also neglected in the second textbook. As we can see, most of the codes found were classified as lower level of cognitive process. Only few learning objectives coded as higher level.

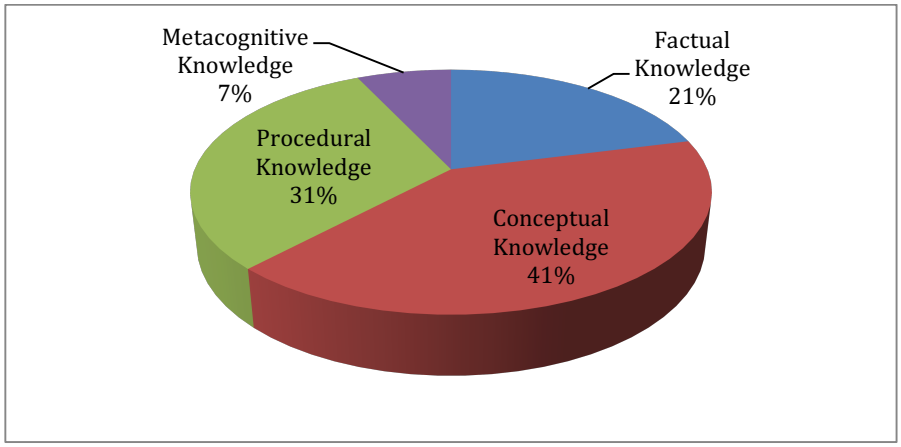

Figure 2. Percentage of Knowledge Dimension in Science Learner's Module 9

The figure 2 above illustrates the distribution of knowledge dimension in the first textbook *Science Learner's Module 9*. As shown, the factual knowledge has a percentage of 21%, conceptual knowledge has 41%, procedural knowledge has 31%, and metacognitive knowledge has 7%. The most dominant knowledge dimension in the said textbook was the conceptual knowledge.

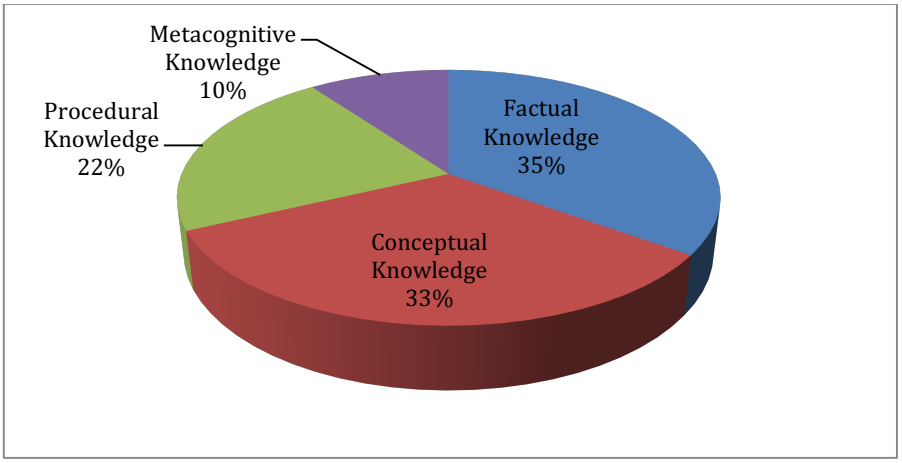

Figure 3. Percentage of Knowledge Dimension in Science Links 9

In *Science Links 9*, the figure 3 shows its distribution percentage of knowledge dimension. The factual knowledge has 35%, the conceptual knowledge has 33%, procedural knowledge has 22% and metacognitive knowledge has 10%. So, the most dominant knowledge dimension in this textbook was the factual knowledge.

Regarding the second research question, the two Science textbooks do not agree on the distribution of the knowledge dimension. The more prevalent knowledge dimension in *Science Learner's Module 9* was conceptual knowledge whereas factual knowledge in *Science Links 9*.

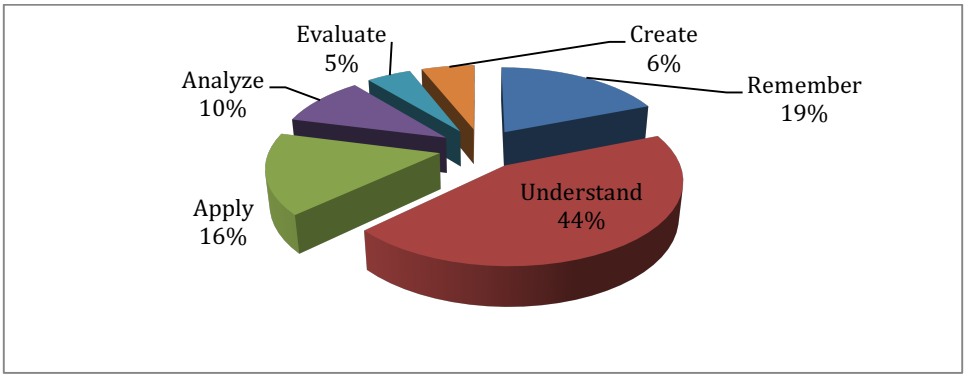

Figure 4. Percentage of Cognitive Process Level in Science Learner's Module 9

The figure above demonstrates the distribution of cognitive process level in *Science Learner's Module 9*. The remember level has a total percentage of 19%, the understand has 44%, apply has 16%, analyze has 10%, evaluate has 5% and the most complex level which is create has 6%. As shown above, the more prevalent level was *understand*, followed by the level of *remember* and then the *apply* level. These three levels were classified as lower level of cognitive process based on Bloom's revised taxonomy.

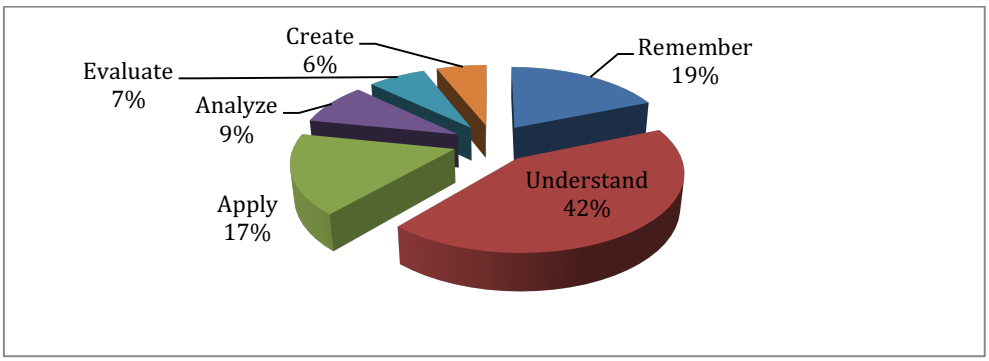

Figure 5. Percentage of Cognitive Process Level in *Science Links 9*

Figure 5 illustrates the distribution percentage of cognitive process level in *Science Links 9.* The remember level has a percentage of 19%, understand has 43%, apply has 17%, analyse has 9%, evaluate has 7% and create has the least percentage of 5%. As we can see in the figure that the more prevalent level was *understand* and then followed by *remember* and *apply* level.

For the third research question, the finding of this study revealed that the more prevalent levels of cognitive process found in the two science textbook agreed on the second level of cognitive process dimension which is *understand* and then followed by *remember* and *apply* level.

In the study of Al-hasanat (2016), he developed a standard percentage of the levels of aims of the knowledge domain based on the reference of Bloom's original taxonomy. Al-hasanat used his experience in the field and consulted some specialists. These percentages were organized in a questionnaire that was judged by professors, researchers, associated professors and assistant professors in the field of instruction and curricula while other specialist work in supervision in addition to some Arabic language teachers. The means of these percentages were calculated and introduced in a final version listed in Table 6 below.

Table 6. Standard Percentages of the Levels of Aims of the Knowledge Domain

Remembering	**Comprehension**	**Application**	**Analysis**	**Synthesis**	**Evaluation**	Total Percentages
25%	21%	19%	15%	12%	8%	100%

The suggested standard percentage was going in a regressive sequence that starts with remembering 25% and ends with the percentages of 8% representing evaluation. Based on the table above, it shows that the lower levels should be comprised of 65% and 35% intended for higher levels of cognitive process. Now, to compare the two science textbooks with the suggested standard percentage, the figure 6 below was developed.

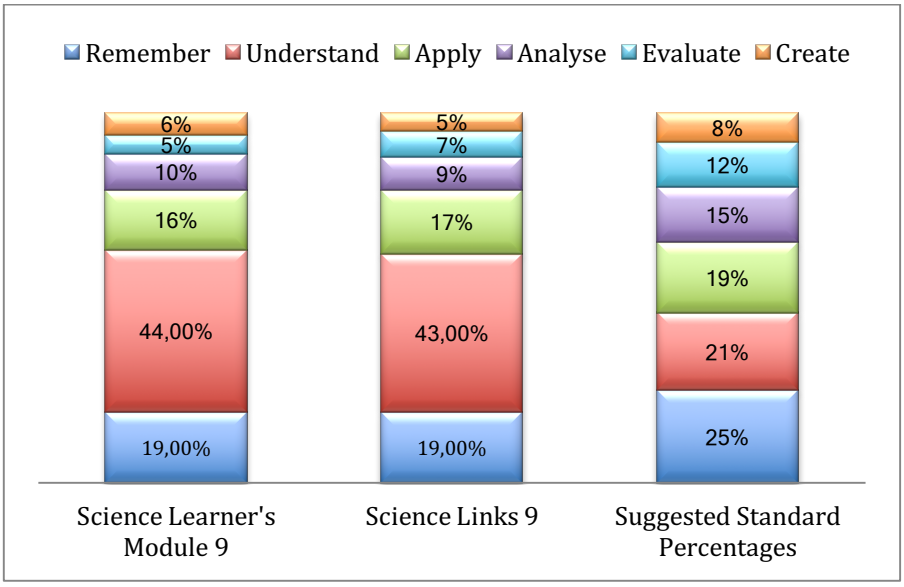

Figure 6. Comparison of two science textbooks with the suggested standard percentage of cognitive process level

To answer the fourth research question, it is clearly shown that the percentages of cognitive process level in two science textbook do not conform with the Al-hasanat's suggested standard percentages. There was a high difference between them. The two science textbooks emphasis too much on *understand* level. The *Science Learner's Module 9* has more percentage on the level of *create* over the *evaluate* level.

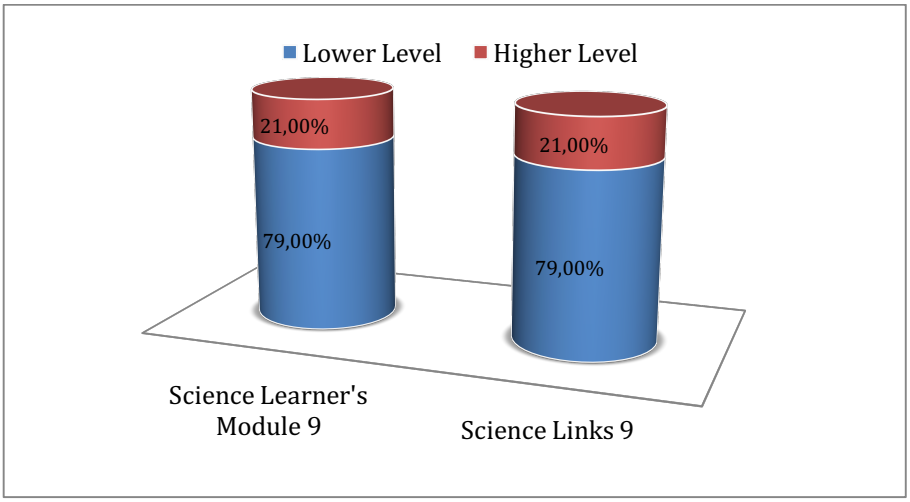

Figure 7. A comparison of two Sciences Textbooks

The Sci*ence Learner's Module 9* consists of many hands-on activities. It has a total of 200 learning objectives. On the other hand, *Science Links 9* was dominated by lessons and notes, only few hands-on activities can be found in the said textbook and it has only 102 learning objectives. The two Science Textbooks differ in presentation of its learning objectives however they agree on the division of lower level and higher level of cognitive process level. The percentages on lower and higher level were exactly the same as shown above.

To answer the fifth question, the figure 7 shows that the two sciences textbook have the same result. In other word, they highlight higher order thinking skills equally.

Now, to find out if there is a significant difference in the distribution of learning objectives based on the cognitive process level in the two Science textbooks, the chi square test of homogeneity was calculated and the result was shown below.

Table 7. Chi Square Test Result

α = 0.05	**Df = 5**	**X^2 = 3.8**	**Critical Value = 11.071**

The null hypothesis was that the two Science textbooks have no significant difference in the distribution of learning objectives in terms of the cognitive process level of Bloom's revised taxonomy. The chi square test X^2 of the two science textbooks fall inside the area of non-rejection. Therefore, the null hypothesis was accepted. This means that the two Science textbooks have no significant difference in the distribution of cognitive process level of Bloom's revised taxonomy. This answered the last research question.

For the result of inter-rater reliability, the agreement between the codification of the researcher and the analyst was about 76%. It means that the two codifications disagree on 24% of the sample learning objectives. For the intra-rater reliability, the agreement between the two codifications was 92%. The 8% of the learning objectives in two codifications disagree.

Conclusion and Recommendations

Based on the study, the coding schemes of Bloom's revised taxonomy were widely dispersed in two Science textbooks. However, the distribution was not balance. Some of the codes emphasis too much, some were not and some were definitely neglected. The codes that were emphasis too much were all classified as lower level of

cognitive process. Moreover, the codes also revealed that Science textbooks were loaded of factual and conceptual knowledge. Only few attention was given on to the metacognitive knowledge.

To conclude with, the most prevalent cognitive process level found in these two Science textbooks was the second level which was **understand** and the most dominant knowledge dimension was **conceptual knowledge**. Therefore, it can be said that the two Science textbooks emphasize "understanding of conceptual knowledge". These findings coincide in the K-12 Science Curriculum Guide that stated to pave a way to a "deeper understanding of core concepts".

So, if the science textbooks only focus on the understanding of core concepts, then there is a contradiction between the prescribed learning competencies of the textbooks and the K-12 envisions. How will the K-12 curriculum develop a scientifically, technologically, and environmentally literate and productive members of society who are critical problem solvers, innovative and creative citizens, informed decision makers and effective communicators when the prescribed learning competencies only aim to developed lower-order thinking skills among the learners?

Having lower levels than higher level of learning objectives should not affect the judgement on the textbooks. As cited by Assaly and Smadi (2015), Bloom (1956) emphasized the importance of offering lower level information to students as a basis to move to upper levels of cognition. According to Al-hasanat (2016), "what is required is not to make the percentages equal but also not to concentrate on one level and to neglect the other levels."

Bloom and his colleagues said both remembering and understanding levels are both foundation and broad – based access to other higher levels, where each level is a foundation and starting point for subsequent levels that follow it. Bloom suggests the gradual and balanced transition from one level to the other level. This transitional movement should meet the growth requirements of each level and eliminate any gaps during learning to guarantee sustainable and stable cognitive structure (Al-hasanat 2016).

The grade 9 learners have an average age range from 14-16 years old. At this age, they now belong to the formal operational stage (11 years old & above) of Jean Piaget Cognitive Development Theory. In this stage, learners begin to think abstractly and reasons about hypothetical problems. The ability to systematically plan for the future and reason about hypothetical situations are also critical abilities that emerge during this stage. Jean Piaget insisted that the formal operational stage is the final stage of cognitive development. Hence, it is very important to give more attention for the development of higher-order thinking skills at this stage because it is where the lifelong intellectual development formally started.

Therefore, it can be concluded that these two science textbooks were inadequate in developing higher order thinking skills among the students of 9th graders. Thus, the researcher recommends that teacher should not depend on the textbook as a sole source of instructional syllabus. Instead, they need supplementary activities that promote higher order thinking skills. Textbook designers need to modify the learning objectives of the textbook. There should be regressive sequence from one level to the other level of Bloom's revised taxonomy of cognitive process in order to meet the development of HOTS among the learners. Moreover, there should be a balanced distribution of knowledge dimension of Bloom's revised taxonomy. The researcher believes that promoting metacognitive knowledge can also enhance the higher-order thinking skills of the learners. The Department of Education might need to double check the content of the prescribe textbooks used nationwide in order to determine if it helps in promoting citizen that are critical thinkers, problem solvers, innovative and creative citizens, decision makers and effective communicators as the k-12 science curriculum entails. The DepEd must ensure the consistency between their visions and to their prescribed learning competencies. The National Book Development Board should see to it that the textbooks published were not only high quality and globally competitive but also promote higher-order thinking skills. Affective and psychomotor domains of Bloom's taxonomy could also be studied in science textbooks. Further research might be conducted towards the learning objectives of other textbooks using the frame work of the study in order to explore their levels of cognitive process and its distribution of knowledge dimension.

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